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THE ORIGIN AND SEASONALITY OF THE FISH FAUNA ON A NEW JETTY IN THE NORTHEASTERN GULF OF MEXICO

ROBERT W. HASTINGS[1]

SYNOPSIS: The establishment of the fish fauna on a new jetty at East Pass at the mouth of Choctawhatchee Bay, Okaloosa County, Florida, was studied from June, 1968, to January, 1971.

Important components of the jetty fauna during its initial stages of development were: (a) original residents that exhibit some attraction to reef habitats, including some sand-beach inhabitants, several pelagic species, and a few ubiquitous estuarine species; and (b) reef fishes originating from permanent populations on offshore reefs. The jetties provided artificial reef-like habitat for these species and furnished shelter and food sources on a sandy beach where such habitats were normally absent. Continued recruitment of species to the jetties consisted of (a) occasional strays from other habitats in the area, and (b) stragglers from more tropical areas carried into the northern gulf by currents.

Reef fishes of the northern Gulf of Mexico can be divided into three groups based upon their occurrence: (1) common species on the offshore reefs in the northern gulf that frequently form summer populations in shallow coastal reef habitats; (2) species also common on the offshore reefs but apparently restricted to depths greater than about 18 m and consequently not colonizing artificial reef habitats in shallow water; and (3) typical coral reef species occurring in the northern gulf as stragglers, being carried into the area by currents (by the Eastern Gulf Loop Current from the Caribbean Sea).

The only obvious successional change was the continued yearly increase in the number of species on the jetties. Average counts of species numbers from July through October were 28 in 1968, 35 in 1969, and 39 in 1970. This annual increase prevailed even though most species were absent from December through March.

Seasonal changes in the fish fauna at the jetties were pronounced. The major autumn decline in the number of species inshore occurred in November at about 20°C. Only 5 to 10 species were usually counted during winter. The annual increase in species numbers began during February or March at about 15 to 20°C.

A total of 204 species was recorded at the East Pass and St. Andrew jetties (a similar but older habitat 80 km to the east). At least 150 species were common to both habitats. In spite of minor differences observed between the two areas, the fish fauna of the East Pass jetties has apparently reached its peak in diversity and is similar to that of the St. Andrew jetties.

[1]The author is an Associate Professor of Biology at Rutgers University, Camden, New Jersey. The publication costs were subsidized in part by a grant from the Sport Fishing Institute, Washington, D.C.

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INTRODUCTION

Coral reefs support a tremendous diversity of fishes. Some reef species have rather narrow niche requirements that restrict them to living coral reefs. However, many may occupy such habitats because of the rich food supply usually associated with coral reefs, bacause of the numerous holes and crevices that provide shelter, or in some cases, because of an attraction to solid aobjects in open marine environments. Consequently, any reef-like structure that breaks the monotony of open, flat bottoms or pelagic surface waters tends to attract numerous species. Such associations are observed even in temperate and subtropical waters where coral reefs are absent.

Reef-building corals cannot survive temperatures less than about 18°C and are consequently excluded from inshore areas of the northern Gulf of Mexico where winter temperatures fall considerably below this level (Smith 1954; Lynch 1954). Natural rocky substrates (other than estuarine oyster reefs) are also rare in coastal areas of the northern gulf at depths less than about 12 m, so that natural habitat suitable for reef species is generally unavailable.

However, numerous artificial structures, such as shipwrecks, pilings, and rock piles, have enabled some typical reef fishes to become established in shallow waters of the northern gulf, and some species once considered rare are now commonly collected. Artificial habitats such as the jetties at Port Aransas, Texas, and St. Andrew Bay, Florida, are important for such new inhabitants (Baughman 1947, 1950a and b; Gunter and Knapp 1951; Caldwell and Briggs 1957;

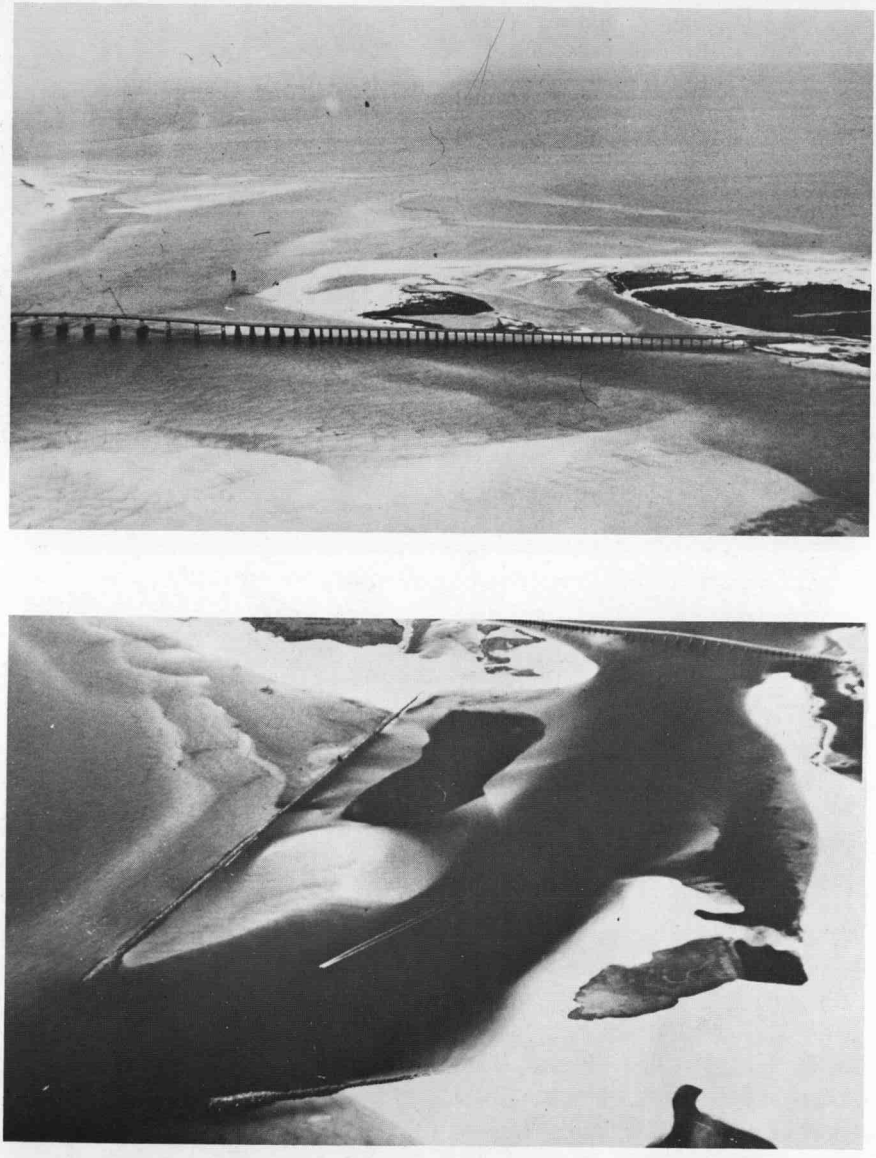

FIGURE 1.—East Pass at mouth of Choctawhatchee Bay, Okaloosa County, Florida. A. View to southeast prior to construction of jetties. B. View to northwest after construction of jetties.

Hoese 1958; Caldwell 1959; Allison 1961; Briggs *et al.* 1964). Additional records of such fishes in the northern gulf are given by Collins and Smith (1959), Dawson (1962), Caldwell (1963), Haburay *et al.* (1969), Haburay *et al.* (1974), and Moore (1975).

Man has recently begun to build artificial habitats specifically to improve angling, and a new technology of artificial reefs has evolved. References on artificial reefs (Carlisle *et al.* 1964; Stroud and Massman 1966; Unger 1966; Woodburn 1966; Oren 1968; Anon 1969; Turner *et al.* 1969; Rickards 1973; Steimle and Stone 1973; Colunga and Stone 1974) include bibliographies on the subject. Although successful studies have been made on the development of artificial reef faunas in the Virgin Islands (Randall 1963) and off the coast of California (Carlisle *et al.* 1964; Turner *et al.* 1969), detailed information is unavailable for the northern Gulf of Mexico.

An opportunity to examine the effects of an artificial reef in a northern gulf locality was presented with the construction of a jetty at East Pass, Choctawhatchee Bay, at Destin, Florida (Fig. 1). The investigation was begun in June, 1968, shortly after construction on the jetties had begun, and the development of the fish fauna on this reef system was followed, almost from the start.

Profound seasonal changes in inshore fish populations of the northern gulf over-shadowed the more subtle successional changes in the developing jetty fauna. Thus, emphasis is placed on these seasonal changes, as well as on successional changes in the reef fish populations.

Potential sources of reef fishes to habitats such as the jetties have also been analyzed. Many obligate reef species have pelagic eggs or larval stages dispersed widely by ocean currents and depend on availability of reef habitats for survival. Thus stragglers from other reef habitats often occur on artificial reefs. Two reasons have been suggested for the frequent occurrence of reef fishes in inshore areas of the northern gulf. Caldwell (1959, 1963), Dawson (1962, 1963, 1970, 1971, 1972), and Haburay *et al.* (1969) believed that most were strays from tropical areas and were carried into the northern gulf from the Caribbean. The Eastern Gulf Loop Current seasonally intrudes far into the northern gulf (Leipper 1970) and must carry large numbers of pelagic eggs and larvae into this area. In contrast, Caldwell (1963), Hildebrand *et al.* (1964), and Sonnier *et al.* (1976) emphasized that many species of supposedly "tropical" fishes were permanent residents on the subtropical natural reefs offshore in the northern gulf, and that the inhabitants of the inshore artificial reefs could represent strays from these offshore populations, rather than strays from areas such as the Caribbean. The seasonal occurrence patterns of reef fishes at the

jetties have been used in this study to speculate on the probable origins of many of these species.

Acknowledgements

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Norman G. Vick of the Bureau of Sport Fisheries and Wildlife Laboratory at Panama City provided boats during the early part of the study, and later Eugene L. Nakamura of that laboratory (renamed the Gulf Coastal Fisheries Center, National Marine Fisheries Service, NOAA) allowed the use of the R/V *Rachel Carson* for diving operations on the natural reefs offshore of St. Andrew Bay. Larry H. Ogren of that laboratory was a dependable diving partner on many trips.

Gregory B. Smith of the University of South Florida made available unpublished data on reef habitats of the eastern Gulf of Mexico and made helpful comments regarding the composition of the fish fauna of these reefs. J. B. Siebenaler of the Ft. Walton Beach Gulfarium provided storage space for equipment used during the study.

Several ichthyologists assisted with taxonomic problems or commented upon the ecology of certain species: F. H. Berry, J. C. Böhlke, H. T. Boschung, Jr., B. B. Collette, C. E. Dawson, C. R. Gilbert, E. S. Herald (deceased), E. D. Houde, G. C. Miller, W. J. Richards, C. R. Robins, and P. J. P. Whitehead.

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Materials and Methods

This study concentrated upon the fish fauna of a new jetty at East Pass, Choctawhatchee Bay, Florida. Other reef structures in the area, such as the St. Andrew Bay jetties and the natural reefs offshore from Choctawhatchee and St. Andrew bays, were studied for comparative purposes. Fish species recorded at the East Pass and St. Andrew jetties are listed in Table 1.

The study of the East Pass jetties began in June, 1968, while the jetties were being built, and was continued through January, 1971, Using snorkel or SCUBA equipment, fishes around the jetties were observed at least once monthly, but with weather permitting, biweekly.

Numbers, relative abundance, and ecological and behavioral characteristics of fish species were recorded. When possible, specimens were collected with hand nets, fish traps, spears, and angling. Small portions of the jetty were treated with rotenone to allow collection of cryptic, fossorial, and nocturnal species.

Water temperature, clarity, and movement were noted during each observation period. Water samples were taken and later analyzed for salinity using a Goldberg Temperature-Compensated Refractometer. Measurements were read in Brix units and then converted to salinity.

Relative numbers of each fish species were estimated using the terms "one or two, several, common, or abundant." These data were later plotted (see Appendix Charts 1-78; referred to in text as Charts) to show relative monthly (or biweekly) occurrence for the more numerous species, indicating the seasonal occurrence of species on the jetties.

TABLE 1.—LIST OF FISHES RECORDED AT THE EAST PASS AND ST. ANDREW JETTIES.[1]

Species	East Pass Jetties	St. Andrew Jetties
Branchiostomidae		
Branchiostoma floridae—Amphioxus	+	*
Carcharhinidae		
Unidentified Requiem sharks	+	(+)
Torpedinidae		
Narcine brasiliensis—Lesser electric ray	+	+
Rajidae		
Raja eglanteria—Clearnose skate	*	+
Dasyatidae		
Dasyatis sabina—Atlantic stingray	+	+
Dasyatis sayi—Bluntnose stingray	+	*
Gymnura micrura—Smooth butterfly ray	+	*
Myliobatidae		
Aetobatus narinari—Spotted eagle ray	+	+
Mobulidae		
Manta birostris—Atlantic manta	+	*
Lepisosteidae		
Lepisosteus osseus—Longnose gar	−	+
Elopidae		
Elops saurus—Ladyfish	+	+
Mauraenidae		
Gymnothorax moringa—Spotted moray	−	+
Gymnothorax nigromarginatus Blackedge morays	+	+
Gymnothorax saxicola	−	+
Congridae		
Conger oceanicus—Conger eel	−	+
Ophichthidae		
Ahlia egmontis—Key worm eel	−	+
Bascanichthys scuticaris—Whip eel	−	+
Bascanichthys teres—Sooty eel	−	+
Letharchus velifer—Sailfin eel	+	+
Myrophis punctatus—Speckled worm eel	+	+
Clupeidae		
Brevoortia patronus—Gulf menhaden	+	*
Harengula pensacolae—Scaled sardine	+	+
Opisthonema oglinum—Atlantic thread herring	*	(+)
Sardinella anchovia—Spanish sardine	+	+
Engraulidae		
Anchoa cubana—Cuban anchovy	−	(+)
Anchoa lyolepis—Dusky anchovy	+	+
Anchoa mitchilli—Bay anchovy	−	(+)
Engraulis eurystole—Silver anchovy	+	−
Synodontidae		
Synodus foetens—Inshore lizardfish	+	+

[1]See last page this table for footnote

TABLE 1 CONTINUED.

Species	East Pass Jetties	St. Andrew Jetties
Ariidae		
Arius felis—Sea catfish	+	+
Bagre marinus—Gafftopsail catfish	+	*
Batrachoididae		
Opsanus beta—Gulf toadfish	+	+
Gobiesocidae		
Gobiesox strumosus—Skilletfish	+	+
Antennariidae		
Antennarius ocellatus—Ocellated frogfish	+	+
Antennarius radiosus—Singlespot frogfish	–	(+)
Ogcocephalidae		
Ogcocephalus radiatus—Polka-dot batfish	+	+
Gadidae		
Urophycis floridanus—Southern hake	+	(+)
Urophycis regius—Spotted hake	+	*
Ophidiidae		
Brotula barbata—Bearded brotula	+	+
Ophidion holbrooki—Bank cuskeel	–	+
Rissola marginata—Striped cuskeel	+	+
Carapidae		
Carapus bermudensis—Pearlfish	–	+
Exocoetidae		
Hemiramphus brasiliensis—Ballyhoo	(?)	+
Hyporhamphus unifasciatus—Halfbeak	(?)	+
Hyporhamphus sp.	(?)	+
Belonidae		
Strongylura marina—Atlantic needlefish	(?)	+
Strongylura notata—Redfin needlefish	(?)	+
Tylosurus acus—Agujon	(?)	+
Tylosurus crocodilus—Houndfish	(?)	+
Cyprinodontidae		
Cyprinodon variegatus—Sheepshead minnow	+	+
Fundulus similis—Longnose killifish	+	+
Poeciliidae		
Poecilia latipinna—Sailfin molly	*	(+)
Atherinidae		
Membras martinica—Rough silverside	+	(+)
Menidia beryllina—Tidewater silverside	+	+
Holocentridae		
Holocentrus ascensionis—Squirrelfish	+	+
Holocentrus rufus—Longspine squirrelfish	–	+
Holocentrus vexillarius—Dusky squirrelfish	–	(+)
Syngnathidae		
Hippocampus erectus—Lined seahorse	+	(+)
Syngnathus floridae—Dusky pipefish	+	+
Syngnathus louisianae—Chain pipefish	+	*
Syngnathus scovelli—Gulf pipefish	+	(+)
Syngnathus springeri—Bull pipefish	+	+

TABLE 1 CONTINUED.

Species	East Pass Jetties	St. Andrew Jetties
Centropomidae		
Centropomus undecimalis—Snook	–	(+)
Setranidae		
Centropristis melana—Southern seabass	+	+
Centropristis ocyurus—Bank seabass	+	+
Centropristis philadelphica—Rock seabass	+	+
Diplectrum bivittatum—Dwarf sand perch	+	*
Diplectrum formosum—Sand perch	+	+
Epinephelus itajara—Jewfish	+	(+)
Epinephelus morio—Red grouper	+	+
Mycteroperca microlepis—Gag	+	+
Mycteroperca phenax—Scamp	+	+
Serraniculus pumilio—Pygmy seabass	+	+
Serranus subligarius—Belted sandfish	+	+
Grammistidae		
Rypticus maculatus—Whitespotted soapfish	+	+
Apogonidae		
Apogon maculatus—Flamefish	–	+
Apogon pseudomaculatus—Twospot cardinal fish	*	+
Astrapogon alutus—Bronze cardinal fish	–	(+)
Phaeoptyx pigmentaria—Dusky cardinal fish	+	(+)
Phaeoptyx xenus—Sponge cardinal fish	–	+
Pomatomidae		
Pomatomus saltatrix—Bluefish	+	+
Rachycentridae		
Rachycentron canadum—Cobia	+	(+)
Echeneidae		
Echeneis neucratoides—Whitefin sharksucker	+	+
Carangidae		
Caranx bartholomaei—Yellow jack	+	+
Caranx crysos—Blue runner	+	+
Caranx hippos—Crevalle jack	+	+
Caranx latus—Horse-eye jack	–	(+)
Caranx ruber—Bar jack	+	+
Chloroscombrus chrysurus—Atlantic bumper	+	+
Decapterus punctatus—Round scad	+	+
Oligoplites saurus—Leatherjacket	+	+
Selene vomer—Lookdown	+	*
Seriola dumerili—Greater amberjack	*	+
Seriola zonata—Banded rudderfish	+	+
Trachinotus carolinus—Florida pompano	+	+
Trachinotus goodei—Palometa	+	+
Trachurus lathami—Rough scad	+	–

TABLE 1 CONTINUED.

Species	East Pass Jetties	St. Andrew Jetties
Lutjanidae		
Lutjanus analis—Mutton snapper	–	(+)
Lutjanus apodus—Schoolmaster	–	(+)
Lutjanus campechanus—Red snapper	+	*
Lutjanus griseus—Gray snapper	+	+
Lutjanus synagris—Lane snapper	+	+
Ocyurus chrysurus—Yellowtail snapper	+	–
Lobotidae		
Lobotes surinamensis—Tripletail	–	+
Gerreidae		
Eucinostomus argenteus—Spotfin mojarra	(?)	+
Eucinostomus gula—Silver jenny	(?)	+
Pomadasyidae		
Haemulon aurolineatum—Tomtate	+	+
Haemulon plumieri—White grunt	+	+
Orthopristis chrysoptera—Pigfish	+	+
Sparidae		
Archosargus probatocephalus—Sheepshead	+	+
Diplodus holbrooki—Spottail pinfish	+	+
Lagodon rhomboides—Pinfish	+	+
Stenotomus caprinus—Longspine porgy	*	(+)
Unidentified sparids (*Calamus* or *Pagrus*)	*	+
Sciaenidae		
Bairdiella chrysura—Silver perch	+	+
Cynoscion arenarius—Sand seatrout	*	+
Cynoscion nebulosus—Spotted seatrout	+	+
Equetus lanceolatus—Jackknife fish	–	+
Equetus umbrosus—Cubbyu	+	+
Leiostomus xanthurus—Spot	+	+
Menticirrhus focaliger—Minkfish	+	+
Micropogon undulatus—Atlantic croaker	+	+
Pogonias cromis—Black drum	–	+
Sciaenops ocellata—Red drum	+	+
Mullidae		
Mulloidichthys martinicus—Yellow goatfish	+	–
Kyphosidae		
Kyphosus incisor—Yellow chub	–	+
Kyphosus sectatrix—Bermuda chub	+	+
Ephippidae		
Chaetodipterus faber—Atlantic spadefish	+	+
Chaetodontidae		
Chaetodon capistratus—Foureye butterflyfish	+	+
Chaetodon ocellatus—Spotfin butterflyfish	+	+
Chaetodon sedentarius—Reef butterflyfish	–	+
Chaetodon striatus—Banded butterflyfish	+	+

TABLE 1 CONTINUED.

Species	East Pass Jetties	St. Andrew Jetties
Pomacanthidae		
Holacanthus bermudensis—Blue angelfish	+	+
Pomacentridae		
Abudefduf saxatilis—Sergeant major	+	+
Abudefduf taurus—Night sergeant	–	(+)
Pomacentrus fuscus—Dusky damselfish	–	+
Pomacentrus partitus—Bicolor damselfish	+	+
Pomacentrus variabilis-Cocoa damselfish	+	+
Labridae		
Doratonotus megalepis—Dwarf wrasse	+	+
Halichoeres bivittatus—Slippery dick	+	+
Halichoeres caudalis—Painted wrasse	–	+
Halichoeres radiatus—Puddingwife	(+)	+
Hemipteronotus novacula—Pearly razorfish	+	+
Lachnolaimus maximus—Hogfish	–	+
Thalassoma bifasciatum—Bluehead	+	+
Scaridae		
Nicholsina usta—Emerald parrotfish	+	+
Scarus coelestinus—Midnight parrotfish	–	+
Scarus croicensis—Striped parrotfish	+	+
Sparisoma aurofrenatum—Redband parrotfish	–	+
Sparisoma chrysopterum—Redtail parrotfish	+	+
Sparisoma radians—Bucktooth parrotfish	+	+
Sparisoma rubripinne—Redfin parrotfish	+	+
Sparisoma viride—Stoplight parrotfish	–	+
Mugilidae		
Mugil cephalus—Striped mullet	+	+
Mugil curema—White mullet	+	+
Sphyraenidae		
Sphyraena barracuda—Great barracuda	+	+
Sphyraena borealis—Northern sennet	+	+
Polynemidae		
Polydactylus octonemus—Atlantic threadfin	–	(+)
Dactyloscopidae		
Dactyloscopus tridigitatus—Sand stargazer	+	+
Uranoscopidae		
Astroscopus y-graecum—Southern stargazer	+	(+)
Blenniidae		
Blennius marmoreus—Seaweed blenny	+	+
Hypleurochilus bermudensis—Barred blenny	–	+
Hypleurochilus geminatus—Crested blenny	+	+
Hypsoblennius hentzi—Feather blenny	+	+
Eleotridae		
Erotelis smaragdus—Emerald sleeper	+	–

TABLE 1 CONTINUED.

Species	East Pass Jetties	St. Andrew Jetties
Gobiidae		
Bathygobius soporator—Frillfin goby	+	−
Coryphopterus punctipectophorus—Spotted goby	−	+
Gobionellus boleosoma—Darter goby	+	+
Gobiosoma longipala—Twoscale goby	+	+
Gobiosoma robustum—Code goby	+	(+)
Acanthuridae		
Acanthurus chirurgus—Doctorfish	+	+
Acanthurus coeruleus—Blue tang	+	+
Acanthurus randalli—Gulf surgeonfish	+	+
Scombridae		
Euthynnus alletteratus—Little tunny	+	+
Scomberomorus cavalla—King mackerel	*	+
Scomberomorus maculatus—Spanish mackerel	+	+
Stromateidae		
Peprilus burti—Gulf butterfish	+	+
Scorpaenidae		
Scorpaena brasiliensis—Barbfish	+	+
Scorpaena calcarata—Smoothhead scorpionfish	−	+
Scorpaena plumieri—Spotted scorpionfish	−	+
Triglidae		
Prionotus martis—Barred searobin	+	*
Prionotus scitulus—Leopard searobin	+	+
Prionotus tribulus—Bighead searobin	+	+
Dactylopteridae		
Dactylopterus volitans—Flying gurnard	+	−
Bothidae		
Ancylopsetta quadrocellata—Ocellated flounder	+	*
Citharichthys macrops—Spotted whiff	−	+
Citharichthys spilopterus—Bay whiff	+	*
Etropus microstomus—Smallmouth flounder	+	+
Paralichthys albigutta—Gulf flounder	+	+
Paralichthys lethostigma—Southern flounder	+	(+)
Syacium papillosum—Dusky flounder	−	+
Soleidae		
Achirus lineatus—Lined sole	−	+
Trinectes maculatus—Hogchoker	*	+
Cynoglossidae		
Symphurus plagiusa—Blackcheek tonguefish	+	+
Balistidae		
Aluterus schoepfi—Orange filefish	+	+
Balistes capriscus—Gray triggerfish	+	+
Balistes vetula—Queen triggerfish	+	−
Cantherhines pullus—Orangespotted filefish	+	+
Monacanthus ciliatus—Fringed filefish	−	+
Monacanthus hispidus—Planehead filefish	+	+

TABLE 1 CONTINUED.

Species	East Pass Jetties	St. Andrew Jetties
Ostraciidae		
Lactophrys quadricornis—Scrawled cowfish	+	+
Tetraodontidae		
Sphoerides nephelus—Southern puffer	+	+
Sphoeroides spengleri—Bandtail puffer	−	+
Diodontidae		
Chilomycterus schoepfi—Striped burrfish	+	+

+ = present (parenthesis indicates literature record or record prior to this study)
− = not recorded
* = recorded in area but not on the jetties
? = members of family not identified to species

To supplement these subjective records, three plots were marked off on the west jetty during 1970, and on each observation, when diving conditions permitted, individuals of each species within each plot were counted (Fig. 2). Each plot measured 9.0 m along the jetty, with the width determined by the area of rock substrate extending out from the exposed part of the jetty.

Plot I, on the channel side, extended out from the jetty about 6.0 m and was characterized by a plateau at the edge of the exposed portion of the jetty about 30 cm deep and about 1.2 m wide. From the edge of the plateau the jetty sloped down to a water depth of ca 3.0 m about 6.0 m from the exposed portion. Plots II and III were on the gulf side of the west jetty. Plot II near the south end of the jetty extended out from the jetty about 3.0 m and the water depth ranged from 0.6 m at the inside to approximately 2.4 m on the outer side. Plot III, near the north end, was about 3.0 m wide, and the water depth from 0.6 to 1.5 m.

The counts were unavoidably biased toward larger, non-cryptic fishes. Small, inconspicuous fishes and those that remained hidden beneath rocks could not be counted. In addition, species occurring in dense schools could only be estimated as to numbers of individuals present. Occasionally larvae of some species occurred in the plots, but counts were impossible. Consequently, larval fishes were not included in plot counts. Despite these inaccuracies, the counts were useful in analyzing the seasonal changes in composition of fish populations on the jetties (Tables 2-5).

Dives were made periodically on other reef habitats in the area for comparative information. Dives on the St. Andrew jetties complemented Allison's earlier ichthyological study (1961) and the results of several collectors from Florida State University working in the area from 1958 to 1972. Specimens collected by Allison or others and catalogued in the Florida State University fish collection were reexamined to confirm or correct identifications. As the St. Andrew jetties are larger and older than those at Destin, it was assumed that their fauna was more mature and stable. Comparisons were helpful in analyzing the changes occurring on the Destin jetties.

Several dives were also made on the offshore natural reefs south of Destin and Panama City and at the Navy platforms off Panama City Beach (Hastings *et al.* 1976). Data from these populations were obtained to clarify seasonal occurrence of fishes in inshore waters, as well as possible sources of recruitment for inshore populations of certain species.

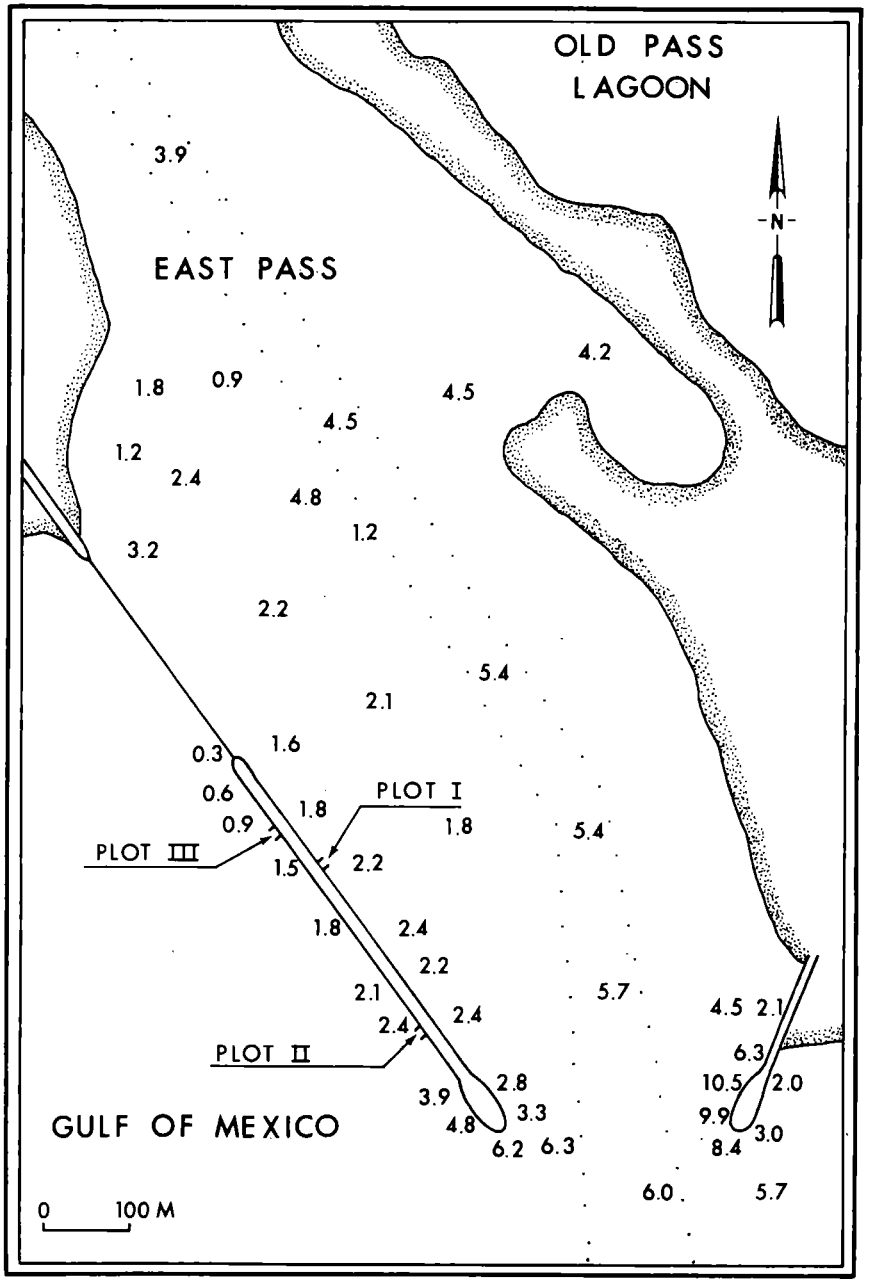

FIGURE 2.—East Pass jetties at mouth of Choctawhatchee Bay showing the location of three plots on the west jetty. Depths (in meters) were recorded in May, 1971.

TABLE 2. — COUNTS OF FISHES AT EAST PASS JETTIES DURING 1970: PLOT I, CHANNEL SIDE OF WEST JETTY (BOTTOM AREA = 64.8 M²).

	Jan		Feb		Mar	Apr		May		Jun		Jul		Aug		Sept		Oct			Nov				Dec			Jan	Average
Species	2	24	13	27	31	3	17	16	29	8	23	9	23	6	24	5	14	1	10	22	9	10	19	21	1	17	26	12	Density**
Hypleurochilus geminatus	6		4	2	3	1	2	3	2	5	17	11	10	29	14	2	2	2	5	2	17	8			2	1		1	0.083
Opsanuus beta	1		1											1		2	1	1											0.005
Gobiesox strumosus			1																										*
Urophycis floridanus			2																										0.001
Gobionellus boleosoma					1																								*
Halichoeres bivittatus						18	36	46	52	68	71	211	270	356	241	177	208	161	243	184	274	158			11	1	1		1.536
Centropristis philadelphica							1																						*
Chilomycterus schoepfi							1																						*
Hypsoblennius hentzi							1																						*
Syngnathus scovelli							2																		1	4	1		0.004
Lagodon rhomboides (adult)								6	26	13	28	26	11	4	1	3	23	28	20	15	112	93							0.225
Chaetodipterus faber								1																					*
Orthopristis chrysoptera								2	1			5	22	3			2	3			1	3			6				0.026
Serranus subligarius								3			2		7	4	1	3	1	1	1		1				2				0.014
Diplodus holbrooki									14	4	2	2	2						3		3								0.016
Leiostomus xanthurus (adult)									5	16		5	1			1		4	4	26	1	1							0.035
Paralichthys albigutta									1																				0.001
Monacanthus hispidus										1	3		1	1			2		1										0.005
Caranx crysos											1						4				1								0.003

Table 2. — Counts of Fishes at East Pass Jetties during 1970: Plot I, Channel Side of West Jetty (Bottom Area = 64.8 m²) - CONTINUED.

Species	Jan		Feb		Mar	Apr		May		Jun		Jul		Aug		Sept		Oct			Nov				Dec			Jan	Average Density**
	2	24	13	27	31	3	17	16	29	8	23	9	23	6	24	5	14	1	10	22	9	10	19	21	1	17	26	12	
Caranx bartholomaei											1																		*
Hippocampus erectus											1																		*
Syngnathus springeri											1												1						0.001
Gobiosoma longipala												1	1														1		0.002
Scaridae												9	13	3	3	1	3	2	3	3	7	3			3				0.029
Diplectrum formosum													2	2		1	2				2	1	2	2	3				0.009
Bathygobius soporator														2		1			3	1	1								0.005
Pomacentrus variabilis														1															*
Acanthurus randalli															1			1	2		1								0.003
Chaetodon ocellatus															1	1			1		1	1							0.003
Acanthurus chirurgus																1	3	5	6	4	7	6							0.018
Caranx ruber																1	1												0.001
Decapterus punctatus																30	2	30	9										0.039
Sardinella anchovia																30	1												0.017
Blennius marmoreus																1	2	3	1		2								0.005
Harengula pensacolae																	17												0.009
Oligoplites saurus																	2												0.001
Caranx hippos																					3								0.002
Serraniculus pumilio																						5	2	2	2				0.006
Thalassoma bifasciatum																							2						0.001

*Value less than 0.001

**Density equals average number counted per observation divided by bottom area of plot.

TABLE 3. — COUNTS OF FISHES AT EAST PASS JETTIES DURING 1970: PLOT II, GULF SIDE OF WEST JETTY (BOTTOM AREA = 31.5 M²).

Species	Jan		Feb		Mar	Apr	May	Jun	Jul	Aug		Sept		Oct			Nov	Dec		Jan	Average Density**
	2	24	13	27	-	17	16	8	9	6	24	5	14	1	10	22	21	1	26	12	
Anchoa lyolepis						6															0.010
Hypleurochilus geminatus						16		16		34	11	19	30	12	10	9	5				0.280
Caranx crysos							10			9	29					1					0.082
Chaetodipterus faber							10				1			1							0.020
Halichoeres bivittatus							6	10	14	57	63	44	74	58	105	83	54	17	1		0.978
Lagodon rhomboides (adult)							9	52	25	39	64	32	70	50	40	56					0.730
Orthopristis chrysoptera							1		9	34	23	1	9	2	4	6					0.148
Decapterus punctatus								1	6		30										0.062
Kyphosus sectatrix								2		2				1	1						0.010
Acanthurus randalli										2			2	2	2						0.013
Diplodus holbrooki										7	2	1	4		4	3					0.035
Scaridae										2	4	2	4	4	6	6	1	1			0.050
Acanthurus chirurgus											3	3	9	6	11	4					0.060
Oligoplites saurus											6		7								0.022
Monacanthus hispidus											1		3	1	1						0.010
Mugil cephalus													1								0.002
Caranx hippos														50	1	25					0.127
Elops saurus														30							0.050
Pomacentrus variabilis														1		1					0.003
Doratonotus megalepis														1							0.002
Lutjanus griseus															1	4					0.008
Caranx bartholomaei																2					0.003
Chilomycterus schoepfi																			1		0.002

**See footnote to Table 2.

TABLE 4. — COUNTS OF FISHES AT EAST PASS JETTIES DURING 1970: PLOT III, GULF SIDE OF WEST JETTY (BOTTOM AREA = 28.2 M²).

Species	Jan		Feb		Mar	Apr	May	Jun	Jul	Aug		Sept		Oct			Nov	Dec		Jan	Average Density**
	2	24	13	27	-	17	16	8	9	6	24	5	14	1	10	22	21	1	26	12	
Hypleurochilus geminatus						1	1	25	7	146	11	24	23	20	70	18		1			0.647
Chaetodipterus faber							30							1	2						0.062
Halichoeres bivittatus							2	19	79	128	106	107	161	76	78	40	21	44	1		1.608
Lagodon rhomboides							16	10	3	42	59	88	24	6	28	56					0.470
Orthopristis chrysoptera							1		2	16	3		2	1	.						0.047
Decapterus punctatus								2													0.004
Abudefduf saxatilis									1												0.002
Acanthurus chirurgus										1	1	4	13	8	6	3					0.067
Acanthurus randalli										1		1	4		1	1					0.015
Caranx crysos										1					1						0.004
Pomacentrus variabilis										1		2	2								0.009
Scaridae										1	5	3	12	6	8	4		2			0.077
Diplodus holbrooki											4		2			1					0.013
Serranus subligarius												3			2						0.009
Caranx ruber													4								0.007
Oligoplites saurus													3								0.006
Caranx hippos														2		50					0.097
Elops saurus														1							0.002
Leiostomus xanthurus														5							0.009

**See footnote to Table 2.

TABLE 5. — SUMMARY OF PLOT COUNTS AND TEMPERATURE RECORDS AT EAST PASS JETTIES DURING 1970.

	Jan		Feb		Mar	Apr		May		Jun		Jul		Aug		Sept		Oct			Nov				Dec			Jan
	2	24	13	27	31	3	17	16	29	8	23	9	23	6	24	5	14	1	10	22	9	10	19	21	1	17	26	12
Number of Species: Plot I	2	0	4	1	3	2	6	6	7	6	10	8	11	11	7	15	17	13	14	7	16	10	4	2	8	3	3	1
II	0	0	0	0	-	-	2	5	-	5	-	4	-	9	12	7	11	15	13	13	-	-	-	3	3	-	2	0
III	0	0	0	0	-	-	1	5	-	4	-	5	-	9	7	8	11	10	9	8	-	-	-	1	3	-	1	0
Number of Fishes: Plot I	7	0	8	2	6	19	43	61	101	107	127	270	340	406	262	255	276	242	302	235	434	279	7	4	30	6	3	1
II	0	0	0	0	-	-	22	36	-	81	-	54	-	186	237	102	213	222	188	211	-	-	-	60	24	-	2	0
III	0	0	0	0	-	-	1	50	-	56	-	92	-	337	189	152	250	126	196	173	-	-	-	21	47	-	1	0
Temperature °C Plot I Surface	14	9	14	14	18	20	24	28	28	27		28	28	31	29	30	29	28	25	22	22	18	16		16	14	14	13
Bottom							21	28																	19			
Plot II Surface	14	10	14	15			21	28		28		29		31	29	30	29	27	27	23				17	16		14	14
Bottom																									19			
Plot III Surface	14	10	14	14			23	28		28		29		31	28	30	29	26	27	22				17	17		14	14
Bottom																		27							19			

Description of the Study Area

Detailed description of the coastal environment in the vicinity of the East Pass and St. Andrew jetties is given in Hastings (1972). The coast of northwest Florida, extending from the Alabama-Florida line on the west to Cape San Blas on the east (260 km), is a biologically monotonous stretch of pure white quartz-sand beach. It is a moderate energy coast (Tanner 1960) with diurnal tides of low range (mean=36.6 cm; U.S. Coast and Geodetic Survey, 1971). Salinity is generally high (over 30°/oo), except at the mouths of estuaries during ebb tides. Water clarity (transparency) is usually very good with underwater visibility as much as 9 m. Ebb tides, strong surge, and occasional plankton blooms decrease clarity locally for short periods, but even then visibility is usually from 1.0 to 3.0 m. Water temperatures recorded 3.2 km offshore from the St. Andrew jetties are shown in Figure 3. Similar records were obtained at East Pass (Fig. 4), where the record low January water temperature was 9°C and the high August record was 32°C. Gulf waters are usually several degrees warmer than the inshore waters during the winter, and several degrees cooler during the summer.

Limited studies of currents in the coastal regions of northwest Florida indicate considerable seasonal variation in the direction of surface currents (Gaul and Boykin 1964; Talbert and Salsman 1964; Pequegnat and Pequegnat 1968). Gaul (1967) stated that the net surface circulation across the shelf between Pensacola and Panama City must sweep southeastward. Wind is apparently the controlling agent for surface currents in the area and thus could also be the factor most important in the dispersal of pelagic larval forms of reef dependent fishes and other organisms into the area. The seasonal occurrence of such organisms inshore at locations such as the jetties may depend upon onshore currents, which predominate during late spring and summer (Talbert and Salsman 1964).

The most distinctive feature of circulation in the Gulf of Mexico is the Eastern Gulf Loop Current entering through the Yucatan Channel, intruding variable distances into the gulf, and then exiting through the Florida Straits (Leipper 1954, 1970; Austin 1955; Gaul 1966, 1967; Hubertz 1967; Vick 1967; Nowlin *et al.* 1968; Nowlin 1971; Rinkel 1971). The current begins its greatest intrusion into the northern gulf in the spring and reaches the continental margin between the Mississippi delta and Cape San Blas by August (Leipper 1970). Occasionally eddy currents (rotating either clockwise or counter-clockwise) develop over the continental slope off northwest Florida (Gaul 1967), but the influence of the loop current on continental shelf waters is not completely understood.

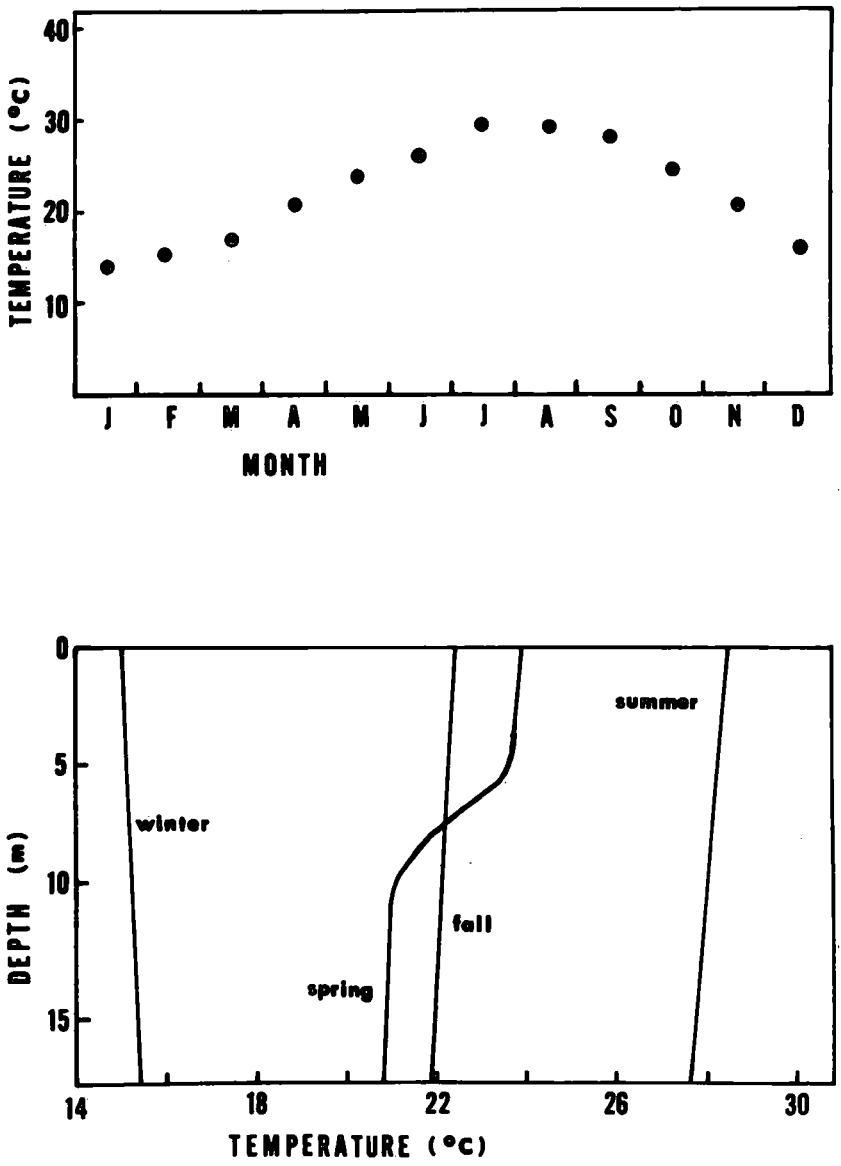

FIGURE 3.—Temperature records from Stage II Platform off Panama City, Florida. A. Annual sea surface temperature curve; six year monthly mean (1955-1961). B. Typical seasonal bathythermograph records (from data taken by Naval Coastal Systems Laboratory).

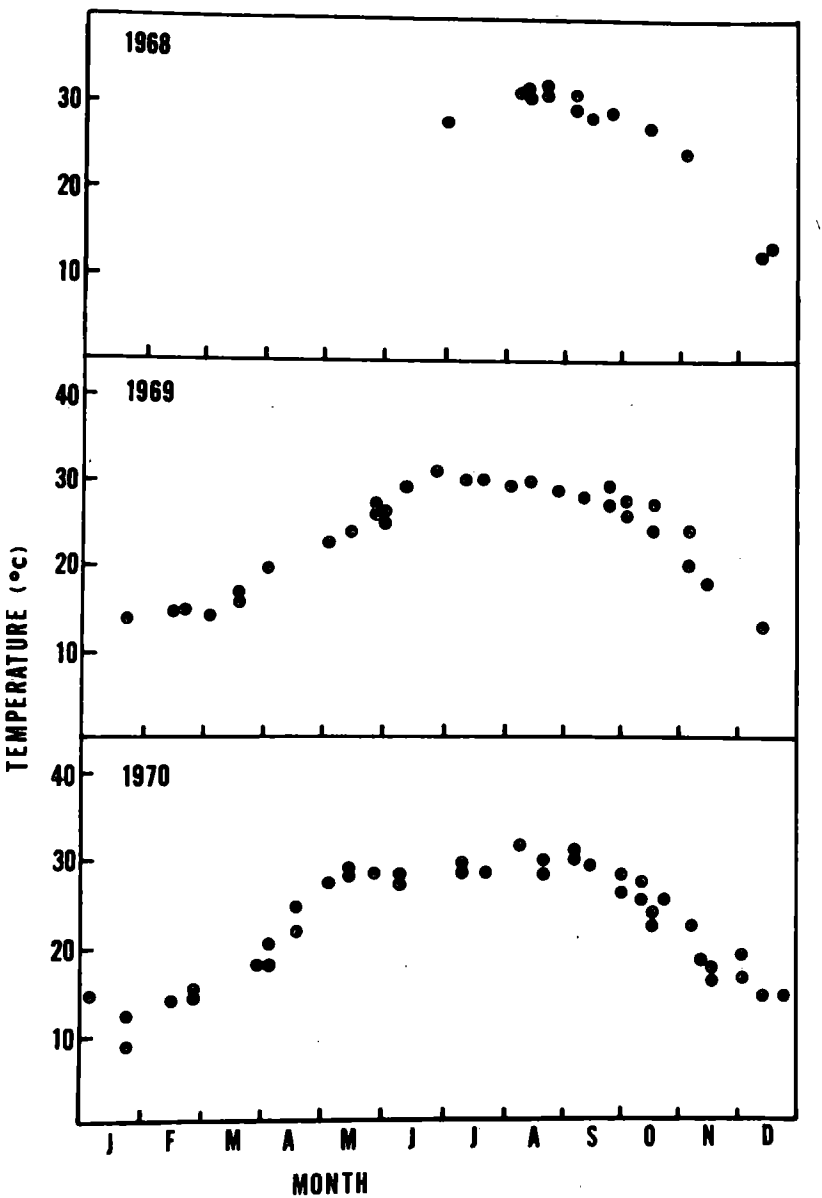

FIGURE 4.—Temperatures recorded at East Pass jetties during 1968, 1969, and 1970.

There are five major estuaries along the northwest Florida coast: Perdido Bay at the western edge, Pensacola Bay, Choctawhatchee Bay, St. Andrew Bay, and St. Joseph Bay. Rock jetties providing artificial reef habitat have been constructed at the mouths of all except St. Joseph Bay. Other structures of human origin, such as bridges, piers, or shipwrecks providing hard surfaces underwater, have contributed to an increase in the number and variety of benthic organisms and possibly also in the number of demersal fish species. Many pelagic fishes are attracted to these irregularities and large schools may be concentrated around them. In a few places artificial reefs have been constructed to attract fishes ("Fish Haven" in Fig. 5).

The East Pass jetties (Figs. 1 & 2) at the mouth of Choctawhatchee Bay were constructed between October, 1967, and the latter part of 1968 (See U.S. Army Corps of Engineers, 1964, 1967). The west jetty includes two sections separated by a weir 305 m long submerged 15 cm below the water surface. The shoreward section of the jetty was mostly shoaled over by drifting sand. The seaward portion, about 530 m long, was the site of the greater part of the field observations during this study. Depths ranged from about 1 to 3 m but at the seaward end, depths reached about 6 m. Early in the study, deeper holes (up to about 6 m) were present along the jetty, especially near the shoreward end, but these were eliminated by drifting sand or dredge spoil.

The east jetty consists of a single section originally 305 m long, but reduced to about 150 m by dredge spoil and drifting sand. On the channel side the bottom sloped from the shoreward end down to about 11 m depth at the seaward end. Depths on the gulf side were shallower with a more gradual slope to about 3 m and then a sharp drop at the seaward end.

The jetties were constructed of quarry stone obtained from Three Rivers Quarry, Smithland, Kentucky. The extreme range in size (2.3-13600 kg) and irregular shape of stones created large numbers of cavities that provided hiding places for various marine organisms. The amount of rock substrate available to marine organisms varied along the jetty with water depth, slope of the jetty, and amount of sand covering the submerged portion of the jetty.

The gulf and channel sides presented contrasting environments. The gulf was characterized by more stable conditions, with greater water clarity and salinity, but with the continued breaking of surge. The channel side afforded protection from surge but presented other problems such as strong tidal currents and major salinity changes within short periods of time.

The jetties were soon colonized by a variety of benthic algae and invertebrates (described in Hastings 1972), which provided food and habitat for some of the fishes attracted to the jetties.

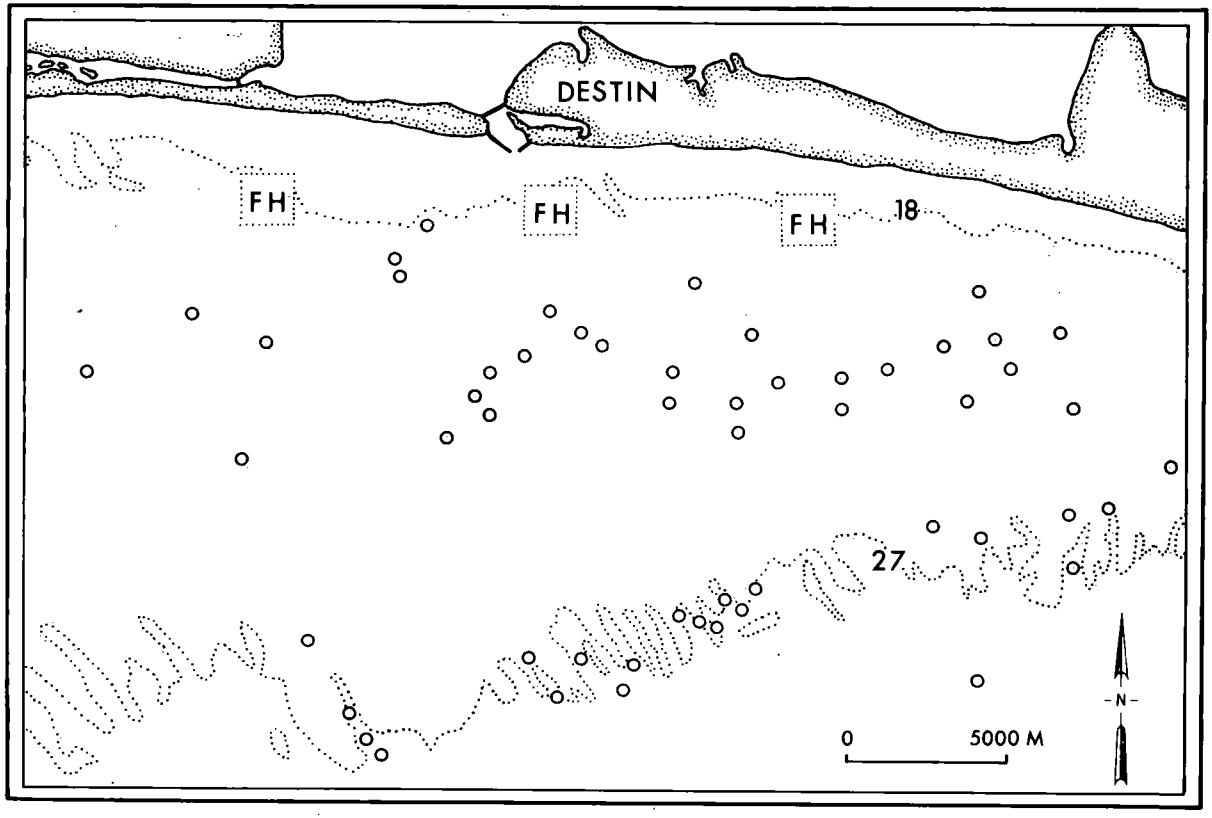

FIGURE 5.—Coastal area of Gulf of Mexico at East Pass, Choctawhatchee Bay, Florida, showing approximate locations of artificial reefs (Fish Havens) and natural rocky reefs (circles) at depths of about 18-35 m.

Although the sand substrate surrounding the jetties supports few benthic organisms, a few other sites near East Pass provide hard substrate for reef species. Extensive rock piles have been in place for a number of years at the bases of pilings supporting the U.S. Highway 98 bridge across East Pass. These have yielded several species of reef fishes (Caldwell and Briggs 1957; Caldwell 1959, 1963). A few natural rock outcrops occur in the gulf within about 3 km of the jetties, and artificial reef materials (primarily old automobile bodies) have been placed about 2-3 km southeast of East Pass ("Fish Haven" in Fig. 5). Most of the natural reefs are more than 6.4 km offshore. Several artificial fishing reefs have been constructed with Choctawhatchee Bay, but these were not examined during the present study.

The jetties at the west pass of St. Andrew Bay (Fig. 6) are similar in construction to those at Choctawhatchee Bay, but are older and in deeper water (up to 9 m). They were first constructed in 1934 (U.S. Army Corps of Engineers 1948). Bulkheads extending out to the edge of the channel were added in 1935, but after their almost complete destruction within six months, they were partially removed. Remains of these bulkheads are submerged in the west pass channel and are shown by dotted lines in Figure 6.

Small lagoons (averaging about 1.5 m deep) have formed on the landward sides of the two jetties and represent a habitat not found at the East Pass jetties. Here there was almost no surge and extensive grass beds were present near the jetties. Algal and invertebrate populations were more diverse at the St. Andrew jetties than at the East Pass jetties (see Hastings 1972), apparently correlated with the greater age of the habitat and possibly also the greater depths.

Although natural reef areas are absent inshore in the northern Gulf of Mexico, they are widespread offshore and have been shown to support a variety of typical reef organisms (Mettison 1948; Lynch 1954; Smith, F.G.W. 1954; Parker and Curray 1956; Hoese 1958; Hildebrand *et al.* 1964; Causey 1969; Tunnell and Chaney 1970; Cashman 1973; Bright and Cashman 1974; Smith, G. B. *et al.* 1975; Smith, G. B. 1976; Sonnier *et al.* 1976).

Reefs in the eastern gulf consist of portions of the basal limestone composing the continental shelf off the Florida coast. Where outcrops occur through the overlying sediments, rocky reefs are formed that support scattered growths of hard corals as well as extensive growths of sponges and alcyonarians (Smith 1954; Tierney 1954). The major reefs of this region occur in two zones, one at depths from about 60 to 100 m and another at about 160 m (Gould and Stewart 1955; Ludwick 1964; Ballard and Uchupi 1970). However, scattered patch reefs occur inshore on the 40 m isobath with the Florida Middle Ground being the

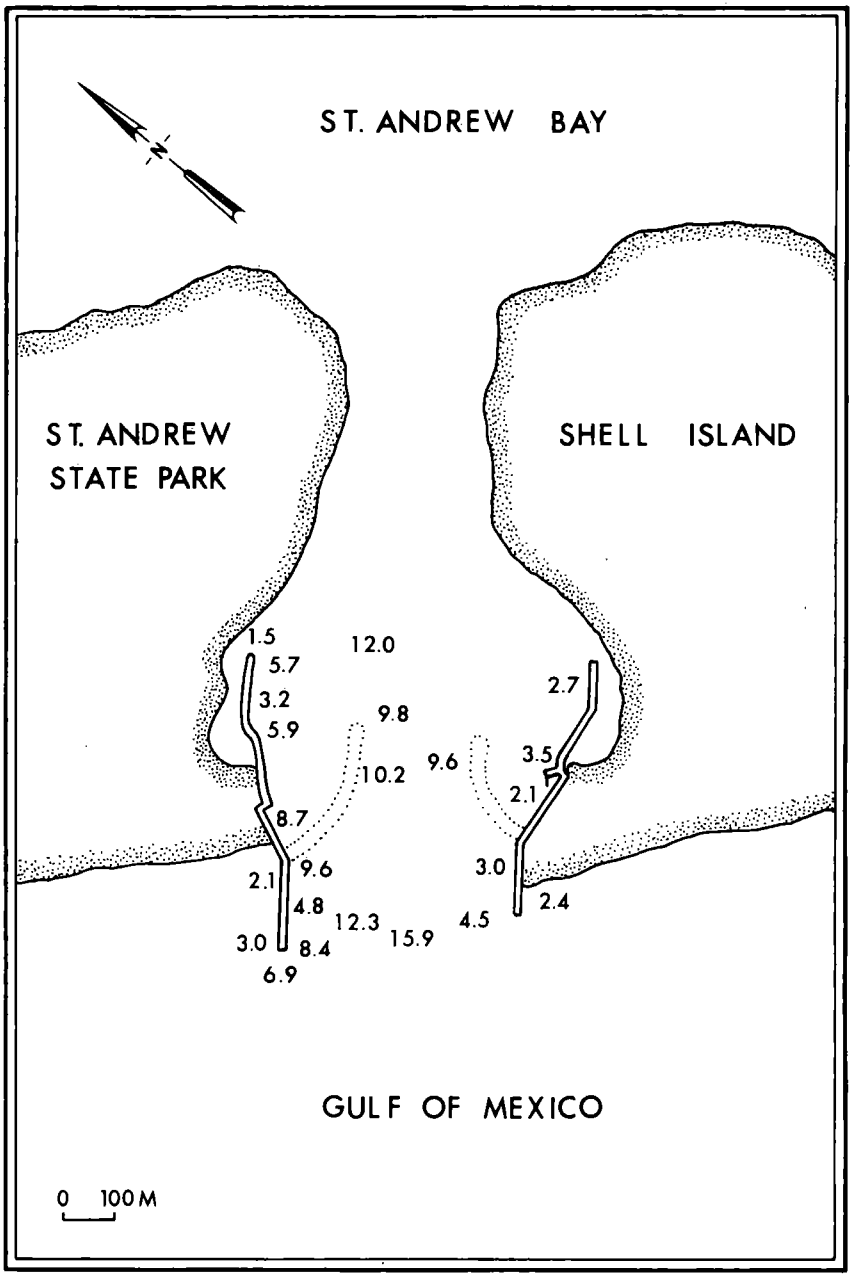

FIGURE 6.—St. Andrew State Park jetties at mouth of St. Andrew Bay, Bay County, Florida. Depths (in meters) were recorded in May, 1971.

most notable example (Jordan 1952; Smith *et al.* 1975; Smith 1976). Such patch reefs occur in an almost continuous series from the Florida Keys to the area off northwest Florida. Reefs occur in water as shallow as 5 m off the coast of peninsular Florida (Dawson and Smith 1953; Phillips and Springer 1960; Springer and Woodburn 1960; Moe 1963; Moe and Martin 1965), approximately 0.8 km offshore in the region off Tampa Bay. In contrast, reefs off the northwest Florida coast are deeper than 18 m but, because of the narrowness and steepness of the shelf in this region, are still within 4.0 km of the coast.

Off East Pass of Choctawhatchee Bay (Fig. 5), two general zones of reefs occur: one 3.7-9.3 km offshore consists of depressions and elevations at a general water depth of 18-24 m; the second approximately 13.0-18.5 km offshore is about 27-30 m deep. Most of the reefs extend only about 0.6-1.5 m above the bottom. Some are cut by deep crevices and on some the margins are hollowed out to form overhanging ledges.

The limestone composing the reefs is of algal or coralline origin, but hermatypic, reef-building corals are not common at the present time. Low winter temperatures probably prevent extensive coral growth. Sponges are the most abundant encrusting organisms, although alcyonarians, bryozoans, and ascidians are also common. Small colonies of hard corals are present but are never large. The invertebrate fauna on the reefs is diverse and no attempt has been made to identify the major species.

The fish faunas of these offshore reefs are rather poorly known. The extensive lists of fishes recorded from the stomachs of snappers and groupers taken off Pensacola (Goode and Bean 1883; Jordan and Gilbert 1883, 1884; Jordan 1885, 1887; Jordan and Swain 1885; Jordan and Evermann 1887), and the numerous collections by the R/V *Oregon* and *Silver Bay* in the northern gulf (Springer and Bullis 1956; Bullis and Thompson 1965) indicate the variety of species present on these deepwater reefs. Walls (1975) listed many species for these offshore reefs, but the subjective nature of these records and lack of documentation limit the usefulness of this publication. Springer and Woodburn (1960), Moe and Martin (1965), and Smith (1976) have published lists of fishes occurring on the reefs off Tampa Bay. Studies on the fishes of the Florida Middle Ground reef also indicate a high level of diversity (Smith *et al.* 1975; Smith 1976).

During the present study, several reefs south of East Pass were examined, and several dives were made on "Warsaw Hole," a rock outcrop 26 m deep about 13 km southwest of St. Andrew Bay. The fauna on all of these reefs was similar and included many reef fishes that occurred in relatively large numbers throughout the year.

Another habitat examined during this study was the research plat-

forms, maintained by the U.S. Naval Coastal Systems Laboratory of Panama City, are 17.7 km offshore in 30 m of water (Stage I) and 3.2 km offshore in 18 m of water (Stage II). The pilings of these platforms support extensive growths of encrusting organisms, and numerous species of fishes congregate under the platforms as well as near scattered debris on the bottom.

Systematic Accounts

A total of 204 species of fishes have been recorded at the East Pass and St. Andrew jetties, 190 during this study plus 14 others prior to the study (Table 1). Of these, 112 are described in the following species accounts either as dominant or significant members of the jetty fauna or because of zoogeographical significance (such as tropical or subtropical species characteristic of reef areas). The species not discussed were present rarely and in small numbers and thus are not considered significant members of the jetty fauna, even though some may have been common in nonreef habitats nearby. Descriptive accounts of such species are given in Hastings (1972). Occurrence charts illustrating the monthly presence of important species at the East Pass jetties appear in the Appendix (Charts 1-78). Unless otherwise noted, arrangement of families and nomenclature of fishes follows Bailey *et al.* (1970).

Carcharhinidae

Requiem Sharks (Chart 1).—Small numbers of unidentified sharks were observed at the East Pass jetties during the months of August, September, and October. None was observed at the St. Andrew jetties during this study.

Dasyatidae

Dasyatis sabina (Lesueur), Atlantic Stingray (Chart 2).—This ray was observed over the sandy areas adjacent to the East Pass jetties during all seasons of the year but at irregular intervals. Usually only small numbers were observed, but it was considered common during January, March, and April, 1969. In contrast, it was not recorded during January, February, and March, 1970. It was recorded from April to October at the St. Andrews jetties, but is reported to be present in the bay from March through December (Vick 1964).

Dasyatis sayi (Lesueur), Bluntnose Stingray (Chart 3).—This ray was observed at East Pass from April through November, usually in small numbers, but possibly it was more numerous in the spring and autumn. None was seen at the St. Andrew jetties, but it has been recorded within St. Andrew Bay (Allison 1961; Larry H. Ogren, pers. comm.).

ELOPIDAE

Elops saurus Linnaeus, LADYFISH (CHART 4).—Except for a single individual observed in May, ladyfish were recorded at the East Pass jetties only in September and October when schools of adults were present. The species was recorded at the St. Andrew jetties only during October.

MURAENIDAE

Gymnothorax nigromarginatus (Girard) AND *G. saxicola* (Jordan and Davis), BLACKEDGE MORAYS.—Recent study by Dr. James E. Böhlke (pers. comm.) has supported the earlier conclusion of some (Jordan and Davis 1892; Jordan and Evermann 1896; Ginsburg 1951) that these two species are distinct. They are considered together here because they were not distinguished in the field.

One juvenile *G. nigromarginatus* was collected at the East Pass jetties on 11 September 1969. Both species have been collected at the St. Andrew jetties and both are apparently common offshore in the northeastern gulf. One *G. nigromarginatus* was collected at the St. Andrew jetties by Allison in August, 1958, while 17 *G. saxicola*, including juveniles and adults, have been collected there during April, May, August, and October in recent years.

These morays are apparently most numerous on the offshore natural reefs and occur inshore seasonally as strays from the deeper water populations. They were observed offshore at Panama City and Destin in January, February, August, and September.

OPHICHTHIDAE

Myrophis punctatus Lutken, SPECKLED WORM EEL (CHART 5).—This species was the most numerous eel on the East Pass jetties, but it was usually only recorded during rotenone operations. Thus, it was present, at least in limited numbers, throughout the year. However, rotenone operations in January and October, 1970, failed to yield this species. Those recorded in February, 1970, were transitional leptocephalus larvae (Eldred 1966). One leptocephalus, which was probably this species, was found in the stomach of a bluefish, *Pomatomus saltatrix*, collected in December, 1970.

Myrophis punctatus has also been collected in limited numbers at the St. Andrew jetties from May to October, and two leptocephali were collected in January, 1971, in the pass between the two jetties. Jordan (1885) also recorded this species from the stomachs of red snappers taken off Pensacola.

CLUPEIDAE

Harengula pensacolae Goode and Bean, SCALED SARDINE (CHARTS

6-7).—The scaled sardine *Harengula jaguana* Poey [see Whitehead 1973] is the most abundant clupeid in the gulf near East Pass, and large schools often congregated near the jetties. It was present in relatively large numbers from about April or May to October or November during each year of the study and was common only at temperatures above about 24-27°C. Larvae and prejuveniles of *Harengula pensacolae* were collected in September and October, 1969, and in July and August, 1970 (Chart 7). Similar observations were recorded for the St. Andrew jetties, where schools of adults were common from April to October at temperatures from 24 to 31°C.

The seasonal movements of the scaled sardine are not completely understood, but it has been suggested that the species either moves southward along the coast or offshore during the winter.

Sardinella anchovia Valenciennes, SPANISH SARDINE (CHART 8).—The Spanish sardine was quite numerous at times from about May to September near the East Pass jetties, a pattern quite similar to that of *Harengula pensacolae.* However, it apparently moves out of the area earlier in the fall than does *H. pensacolae,* in September when temperatures have just begun to drop but are still quite high. The species was recorded at the St. Andrew jetties from May to October. Movements of this sardine may be controlled by factors other than temperature. Larvae and prejuveniles identified as this species were collected in November, January, and February, indicating a fall and winter spawning period, so possibly this species moves into more open waters to spawn beginning in September.

Apparently the schools of *Sardinella* remain in the northern gulf throughout the year but move offshore to deeper water during the winter. Large numbers have been observed under the Stage I and II platforms off St. Andrew Bay in December (Hastings *et al.* 1976), and near "Warsaw Hole" in January. Turner (1969) and Bullis and Thompson (1965) reported collections off north Florida from December through March.

SYNODONTIDAE

Synodus foetens (Linnaeus), INSHORE LIZARDFISH (CHART 9).—Lizardfish were not common at the East Pass jetties, but single individuals or small numbers were occasionally seen over the sand near the jetties from June to October. The species was recorded at the St. Andrew jetties from May to December, but Allison (1961) also recorded it from other parts of the bay in February and April.

ARIIDAE

Arius felis (Linnaeus), SEA CATFISH (CHART 10).—Sea catfish are abundant at East Pass and were often seen near the jetties, but only

from June through August in 1968 and from May through October in 1969 and 1970. Similar seasonal records were obtained at St. Andrew Bay, where the species was recorded in the vicinity of the jetties throughout the summer and fall (through October). The species moves out into the gulf for the winter (Gunter 1945—Texas coast) but remains inshore throughout the winter in some parts of the northern gulf (Gunter, 1938—Louisiana coast). One specimen was taken from the stomach of a gag, *Mycteroperca microlepis,* collected in February, 1971, at Warsaw Hole off St. Andrew Bay.

On 11 September 1969, and on 1 October 1970, at temperatures of 26-28°C, several tightly packed schools of about 20-50 adult sea catfish were seen swimming at the surface in the channel between the two jetties at East Pass. The schools moved deeper when approached by a boat but soon reappeared at the surface. Not all *Arius* in the area were involved in the schooling behavior since several individuals were also seen near the jetties on both occasions. The significance of such behavior is unknown.

BATRACHOIDIDAE

Opsanus beta (Goode and Bean), GULF TOADFISH (CHART 11). —The Gulf toadfish was undoubtedly not common over the open sandy bottoms of East Pass prior to construction of the jetties, and only one small juvenile (12.5 mm SL) was observed in 1968 (in September) (Chart 11). Small numbers of juveniles and adults were observed in June, July, and September, 1969 (including one of 14.2 mm SL collected in July). This species was present in 1970 from January through October. Only solitary individuals were observed in January, February, March, May, and October, but several were seen in June, July, August, and September.

Opsanus beta is common in the lagoons formed by the St. Andrew jetties, where large adults were recorded from May through October. The species was probably also present during winter but remained hidden within burrows under jetty rocks. Vick (1964) stated that it was present in St. Andrew Bay throughout the year.

GOBIESOCIDAE

Gobiesox strumosus Cope, SKILLETFISH (CHART 12).—The skilletfish may be present throughout the year at East Pass but is most numerous in summer and fall. Its secretive habits and cryptic coloration make it inconspicuous even when it may be common. The records shown in Chart 12 are mostly rotenone collections, but rotenone operations on 1 March 1969 and 24 January 1970 failed to yield this species. Of 35 specimens collected at East Pass during this study, 27 were collected on 11 September 1969.

The species is less common on the St. Andrew jetties than it has been at East Pass. In numerous rotenone collections during the present study, only two individuals were collected: one in July, 1968, and one in October, 1969. Allison (1961) collected two in October, 1958, one in May, 1959, and one in August, 1959.

ANTENNARIIDAE

Antennarius ocellatus (Bloch and Schneider), OCELLATED FROGFISH (CHART 13).—Small numbers of juvenile ocellated frogfish (20.0-102.6 mm SL) were observed at the East Pass jetties between May and November during 1968 and 1969. The species was recorded with about equal frequency on the St. Andrew jetties from May to October. Apparently, adult frogfish are residents of reef areas in deeper, offshore waters (Jordan and Evermann 1898; Springer and Bullis 1956; Bullis and Thompson 1965; Springer and Woodburn 1960).

GADIDAE

Urophycis floridanus (Bean and Dresel), SOUTHERN HAKE (CHART 14).—The southern hake was observed at East Pass from January through early May in 1969, and in January, February, April, and December, 1970. On most dates only a few were seen, but on 1 March 1969, 584 specimens (35.9-183 mm SL) were collected when a deep area adjacent to the jetty was treated with rotenone. None was seen in the area prior to dispersal of the poison, so the species could have been numerous on other dates during the winter.

The species was not recorded at the St. Andrew jetties during this study, but rotenone operations were not conducted there during the winter. Ralph W. Yerger recorded the species there in April, 1958, and Camm C. Swift collected one juvenile (about 15 mm TL) in December, 1966. Four specimens collected at East Pass on 17 December 1970 were juveniles (22.8-23.4 mm SL) observed swimming at the surface. Such young are pelagic but become demersal at about 35 mm SL (Hildebrand and Cable 1938).

Urophycis regius (Walbaum), SPOTTED HAKE.—Nine specimens (51.8-78.7 mm SL) were collected at the East Pass jetties on 1 March 1969 with 584 *U. floridanus*. The species was not recorded at the St. Andrew jetties, although Allison (1961) collected three juveniles in St. Andrew Bay in April, 1959, but misidentified them as *U. floridanus*.

ATHERINIDAE

Menidia beryllina (Cope), TIDEWATER SILVERSIDE (CHART 15).— According to Johnson (1975) this silverside should be identified as *M. peninsulae*. *Menidia beryllina* was usually abundant at East Pass, especially during the warmer months, but occurred somewhat ir-

regularly near the jetties. Occurrence records shown in Chart 15 are only for the immediate vicinity of the jetties. Most schools of *Menidia* were seen in the shallow, sandy areas at the shoreward ends of the jetties. Records at the St. Andrew jetties were similar.

HOLOCENTRIDAE

Holocentrus ascensionis (Osbeck), SQUIRRELFISH.—The squirrelfish was recorded twice at the East Pass jetties; an adult in September, 1968, and a juvenile in July, 1969. Single adults were seen at the St. Andrew jetties in August, 1967, and in October, 1971. Allison (1961) collected small numbers in August and October, 1958, and July, 1959.

Holocentrus rufus (Walbaum), LONGSPINE SQUIRRELFISH.—A juvenile *Holocentrus rufus* was collected by Ralph W. Yerger at the St. Andrew jetties on 24 October 1972. This is apparently the only record of the species along the northwest Florida coast. It has been reported from off the coast of Texas (Briggs *et al.* 1964; Cashman 1973), but is probably a straggler in the northern gulf.

Holocentrus vexillarius (Poey), DUSKY SQUIRRELFISH.—One juvenile dusky squirrelfish (48.3 mm SL-FSU 15691) was collected by Lewis Tesor of Panama City on 16 August 1967, at the St. Andrew jetties.

McKenney (1959) listed two records for the Gulf of Mexico north of the Florida Keys. These are pelagic larvae taken by dip net at the surface of R/V *Oregon* stations 1193 (26°00′N, 88°25′W) and 820 (28°42′N, 88°48′W). This species is common in the southern gulf and the West Indies (McKenney 1959; Hildebrand *et al.* 1964; Böhlke and Chaplin 1968). In view of the absence of records of adults from the northern gulf, it seems that permanent populations do not occur there, and the pelagic larvae were probably spawned in the Caribbean and carried northward by the Loop Current.

SYNGNATHIDAE

Syngnathus scovelli (Evermann and Kendall), GULF PIPEFISH (CHART 16).— No gulf pipefish were recorded at the East Pass jetties during 1968, and only one juvenile was observed in 1969, in June. During 1970, the species was recorded more often, although only small numbers were present in April, June, July, and December. It was rare on the St. Andrew jetties, where only single adults were collected in April, 1958 (by R. W. Yerger), and in August, 1967.

Syngnathus springeri Herald, BULL PIPEFISH (CHART 17).—This species does not generally occur in shallow waters (Herald 1965), but was the pipefish most often recorded at the East Pass jetties. None was recorded in 1968, and only small numbers of immature individuals (91-169 mm SL) were seen during 1969 and 1970. These appeared

rather irregularly throughout the year. Of 11 specimens collected in November and December, 1970, 10 were small juveniles (56-71 mm SL) drifting at the surface near the jetties. Larger specimens observed on the jetties were usually lying motionless on the sand bottom at the base of jetty rocks.

Collections at the St. Andrew jetties were equally uncommon, with two individuals (159 and 162 mm SL) collected in July, 1970, and one juvenile collected by R. W. Yerger in April, 1958 (FSU 19059). Allison (1961) collected one adult (285 mm SL) in the gulf off St. Andrew Bay in October, 1958.

SERRANIDAE

Centropristis melana Ginsburg, SOUTHERN SEABASS (CHART 18).—The southern seabass was not observed at East Pass during 1968, and only small numbers of juveniles or small adults were recorded irregularly during 1969 and 1970. Only one or two individuals were recorded on any date.

The species was more common on the St. Andrew jetties and may be a more important member of the fauna there. It was often quite numerous on the jetties and was present throughout the year. It was recorded as common in October, 1968 and 1969, December, 1970 and May and August, 1971. It was usually rare on the shallow parts of the jetties during the winter, but adults were numerous on the submerged bulkhead in the middle of the pass in January, 1971, at a temperature of 13°C.

Centropristis melana was usually present at the Stage II platform off Panama City Beach, including February, 1971, but was never numerous there. It was never seen at Stage I in deeper water or at natural reefs offshore.

Centropristis ocyurus (Jordan and Evermann), BANK SEABASS (CHART 19).—Chart 19 illustrates the unusual pattern of occurrence for this species at the East Pass jetties. It was recorded there only from August to November, 1969, and only small numbers of juveniles (46-76 mm SL) were observed.

Similar records were obtained at the St. Andrew jetties. One juvenile (54 mm SL) was collected in May, 1968, but none was seen during October, 1968. It was more numerous in the fall of 1969. Several juveniles were seen in October and they were common in December. None was seen during 1970. In January, May, July, August, and October, 1971, no *C. ocyurus* were observed on the jetties during dives, or on the submerged bulkhead in January, but juveniles were common on the bulkhead during May and August.

Centropristis ocyurus is abundant on most offshore reefs in the

northeastern gulf and was observed on every dive on these reefs, as well as at the Navy platforms off Panama City Beach. Both juveniles and adults were common in all seasons during both 1970 and 1971. The species was first described from specimens taken from the stomachs of red snappers caught on the reefs off Pensacola and between Pensacola and Tampa (Jordan and Gilbert 1883; Jordan and Evermann 1887).

Centropristis philadelphica (Linnaeus), Rock Seabass (Chart 20).—The rock seabass was common at the East Pass jetties during the summer of 1968, even before construction of the jetties was completed, less common during September and October, and none was seen during November and December. It did not reappear in 1969 until May, and only small numbers were seen during May, June, and July. None was seen after the first part of July in 1969. During 1970 small numbers were recorded from April to August and in October. All *C. philadelphica* recorded at the East Pass jetties were juveniles (14.8-101 mm SL). The rock seabass was rare at the St. Andrew jetties, and only a single juvenile (79 mm SL) was recorded there during this study. Allison (1961) never recorded the species at the jetties, but he collected several specimens within St. Andrew Bay in February, April, August, and October. No rock seabass were seen during dives on the offshore reefs in the area.

Diplectrum formosum (Linnaeus), Sand Perch (Chart 21).—The sand perch was a common fish on both the East Pass and St. Andrew jetties, as well as on the offshore reefs. It was present at East Pass throughout the summer and fall during the three years of the study and was also recorded in January, February, and March, 1969. Most seen were juveniles but adults were also present from August to October, 1968, May to November, 1969, and August to December, 1970. The occurrence of the species on the jetties during the winter of 1969 may be a result of milder than usual temperatures (Fig. 3). The lowest temperatures recorded in December, 1969 (10°C), and January, 1970 (9-12°C), may have prevented the movement of juveniles into the shallow waters at the jetties.

The sand perch was recorded on nearly every dive on the shallower parts of the St. Andrew jetties from April to December, and small numbers were also seen during January and February, 1971, on the submerged bulkhead in the middle of the channel, at a temperature of 13°C.

Both juveniles and adults were seen on nearly every dive on the offshore reefs, usually over the sand substrate very near the reefs, and were common throughout the year. This is another of the many species recorded from the stomachs of snappers and groupers taken on the reefs of the northeastern Gulf of Mexico (Jordan and Gilbert 1883; Jordan 1885).

Epinephelus morio (Valenciennes), RED GROUPER.—Only one red grouper was seen at the East Pass jetties, a small adult recorded in December, 1970. The species is occasionally caught by anglers fishing on the artificial reefs within Choctawhatchee Bay, but it is not common. It was observed more often at the St. Andrew jetties, and rotenone operations there showed that it was occasionally common. It was recorded from July to December, but was most numerous during the fall (October to December). This grouper is abundant and commercially important in offshore areas of the eastern Gulf of Mexico (Moe 1969; Rivas 1970), but it was rarely observed offshore during this study. It appears to be less common on these reefs than the gag, *Mycteroperca microlepis.*

Mycteroperca microlepis (Goode and Bean), GAG (CHART 22).—The gag (known locally in the northeastern gulf as black grouper) was not seen at East Pass during 1968, but was present in small to moderate numbers from about August or September to November during 1969 and 1970. In addition one small juvenile (20.1 mm SL) was collected in May, 1969, and two juveniles (about 10-15 cm) were seen in July, 1969.

The gag was present throughout the year at the St. Andrew jetties, but was most numerous from October to December (and possibly also in April and May). It was common in December, 1969 and 1970, at temperatures of 16.5 and 17°C; several were seen in January, and one in February, 1971, when the temperature was 13°C.

The gag is the most common grouper on the reefs offshore of Destin and Panama City. Small adults were almost always common on these reefs, even in January and February, and no seasonal changes in abundance were observed.

Serraniculus pumilio Ginsburg, PYGMY SEABASS (CHART 23).—This species was recorded at the East Pass jetties during each year of the study and during all months except January and April. It was usually rare or absent during the winter and was observed in February, March, and May, only during 1969. Chart 23 indicates a rather sporadic occurrence at the jetties, indicating that individuals may move about considerably, although it may at times be present but overlooked because of its small size, cryptic coloration, and sedentary habits.

The species was recorded at the St. Andrew jetties during May, August, October, and December, and was common at times. It was not observed on the natural offshore reefs during this study, but it was probably often present and overlooked. It should be expected to be common in such cases (Hastings 1973).

Serranus subligarius (Cope), BELTED SANDFISH (CHART 24).—The belted sandfish was an important species at both the East Pass and St. Andrew jetties. It was first recorded at East Pass during the latter

part of August, 1968, when three small juveniles were seen (27-29 mm SL). The species was not recorded during September but both juveniles and adults were common in October. Several were present in November, but the species had disappeared from the area by December and was not recorded again until March, 1969. During 1969 and 1970 it was quite numerous from about April or May through November. The largest numbers were seen from May to August, and it was listed as abundant during May, June, and July, 1969. Although usually rare from December to March, several were present in December, 1970, although none was seen on a subsequent dive in January, 1971. One juvenile was seen in January, 1970, at a temperature of 9°C, and several juveniles (31-41 mm SL) and one small adult (58 mm) were collected in March, 1969.

The belted sandfish was one of the most numerous fishes at the St. Andrew jetties and was common or abundant from April through December. It was not recorded there in January and February during this study, but Allison (1961) listed a sight record of one individual in January, 1959.

This is a common fish on natural rocky reefs throughout the Gulf of Mexico (Clark 1959; Springer and Woodburn 1960; Causey 1969) and was present throughout the year on the reefs off Panama City and Destin. It was common during the coldest part of the year (January and February—15°C) on these reefs at depths of 25 m.

GRAMMISTIDAE

Rypticus maculatus Holbrook, WHITESPOTTED SOAPFISH.—This soapfish was recorded only three times at East Pass. One juvenile (19.0 mm SL) was collected on the jetty in September, 1969, and two juveniles (29 and 49 mm SL) were collected in October, 1970. Rotenone was used in both cases. One adult soapfish was seen on a rock pile under the U.S. Highway 98 bridge at East Pass in May, 1970. This fish is especially secretive during daylight hours and may have been present at times but not seen. Yet it was never common at East Pass.

Rotenone operations at the St. Andrew jetties revealed that *Rypticus maculatus* was often common there. It was recorded in March, May, July, August, and October, and was common in rotenone collections in both May and October. No rotenone collections were attempted during the winter so its absence then is not certain.

This soapfish was recorded throughout the year (January, April, August, and September) on the natural reefs off Panama City and Destin, although it was only occasionally seen due to its secretive habits. It is common on some rocky reefs in the Gulf of Mexico (Springer and Woodburn 1960; Causey 1969) and is probably also common on those in the northeastern gulf. It is quite numerous below the Navy platforms off Panama City.

APOGONIDAE

Apogon maculatus (Poey), FLAMEFISH.—*Apogon maculatus* was recorded only once during this study. Eight adults (70-74 mm SL) were collected with rotenone on the St. Andrew jetties on 19 October 1971. Allison (1961) collected two adults there in August, 1959. This species may be widely distributed in the Gulf of Mexico but is apparently not common in the northeastern portion. None was seen on any of the offshore reefs examined during this study, although *A. pseudomaculatus* was always present and at times was abundant. Study on the reefs off Tampa Bay (Smith 1976) has shown that *A. pseudomaculatus* is common but has failed to reveal *A. maculatus*.

The species may be more common in the western Gulf of Mexico. Briggs *et al.* (1964) collected nine specimens (28.3-73.5 mm) from the north jetty at Port Aransas, Texas, on 17 September 1962. Causey (1969) found *A. maculatus* present throughout the year at Seven and One-Half Fathom Reef off Padre Island, Texas, and Cashman (1973) noted the species as common at the West Flower Garden Reef off Texas. Neither of these authors mentioned *A. pseudomaculatus*. Sonnier *et al.* (1976) listed both species at reefs off Louisiana but indicated that *A. maculatus* was common while *A. pseudomaculatus* was rare.

Apogon pseudomaculatus Longley, TWOSPOT CARDINAL FISH.—This species was not recorded at East Pass during this study but Caldwell and Briggs (1957) reported one specimen (72 mm SL) collected during February, 1956, under the U.S. Highway 98 bridge. At the St. Andrew jetties, four adults (72-92 mm) were collected in October, 1968, and one adult (75 mm) was collected in May, 1971. Ralph W. Yerger (pers. comm.) reported collecting 10 adults at the jetties in October, 1972.

This cardinal fish is one of the most numerous fishes on the natural reefs off Destin and Panama City where it is present in considerable numbers throughout the year. It is also common throughout the year on reefs off Tampa Bay (Smith 1976).

References by Jordan and others to *Apogon maculatus* from the snapper banks in the northern Gulf of Mexico are referable to *A. pseudomaculatus* (Jordan and Gilbert 1883; Jordan and Evermann 1896). Their description of two black spots on the side, with the second "smaller, on the upper part of tail on each side, just before root of caudal" applies to *A. pseudomaculatus*, not *A. maculatus*.

Apogon pseudomaculatus apparently tolerates greater depths and lower temperatures than does *A. maculatus* (Longley and Hildebrand 1940; Böhlke and Chaplin 1968), and one should expect it to be more common in the northern gulf. The records of *maculatus* in the northwestern gulf remain a mystery. Occasional records of *A. maculatus*

in the gulf could result from the immigration of pelagic larvae carried by currents, but this could not explain the permanent populations found by Causey (1969) and others off Texas and Louisiana. Some environmental factor or factors must account for the differences in distribution of the two species, but these factors are at present unknown.

Astrapogon alutus (Jordan and Gilbert), BRONZE CARDINAL FISH.—This species was not recorded at East Pass, but Allison (1961) collected single individuals at the St. Andrew jetties in October, 1958 (32.3 mm SL), and in June, 1959 (19.2 mm SL). I have also examined a specimen (UF 5695) taken there in October, 1956.

The species is apparently common on the natural reefs offshore in the northeastern gulf and was first described on the basis of specimens taken from the stomachs of red snappers from off Pensacola and Tampa (Jordan and Gilbert 1883; Jordan and Evermann 1896). Springer and Woodburn (1960) and Smith (1976) found the species common on the rocky reefs off Tampa Bay.

Phaeoptyx pigmentaria (Poey), DUSKY CARDINALFISH.—One adult *Phaeoptyx pigmentaria* (46 mm SL) was collected at the East Pass jetties in October, 1970, at a temperature of 25°C. One specimen (also 46 mm SL) that is apparently also this species was collected, with a number of other cardinalfishes which are more like *P. xenus,* at the St. Andrew jetties in October, 1972, by Ralph W. Yerger. Other records of this species in the northern gulf are discussed under the following account of *P. xenus.*

Phaeoptyx xenus (Böhlke and Randall), SPONGE CARDINALFISH.—Several specimens of *Phaeoptyx* that are more similar to *P. xenus* than to *P. pigmentaria* have been collected at the St. Andrew jetties. These specimens have been examined by James E. Böhlke who was unable to identify them to species, although he also concluded that they are most like *P. xenus.* During some years, this *xenus*-like species was apparently common at St. Andrew Bay. On August 1, 1967, Camm C. Swift and the author observed a small group of these cardinalfish just within the hollow end of a log near the southwest shore of Grand Lagoon about one mile from the jetties. These fish would retreat deeper into the log when approached, but three were collected and measured 23-26 mm SL. On 4 August 1967, nine specimens were collected with rotenone on the lagoon side of the east jetty. Single individuals were collected at the east jetty in October, 1968 (30 mm SL), and in October, 1969 (18 mm SL). Ralph W. Yerger collected 10 *Phaeoptyx* at the St. Andrew jetties in October, 1972, one of which is *P. pigmentaria* (46 mm SL) while nine are the *P. xenus* form (30-40 mm

SL). He collected seven specimens that are all the *P. xenus* form (25-45 mm SL) in October, 1973. Allison (1961) collected three juveniles in October, 1958, and one in August, 1959, which are also this form. Caldwell and Briggs (1957) reported collecting three juvenile specimens 26-27 mm SL (which they identified as *Apogon pigmentarius*) at the St. Andrew jetties in October, 1955. These specimens (UF 5389) have been examined by the author and are the *P. xenus* form.

Phaeoptyx was never observed on the offshore reefs during this study. It was not collected in the Gulf of Mexico by the R/V *Oregon* and *Silver Bay* (Springer and Bullis 1956; Bullis and Thompson 1965) nor was it recorded from snapper and grouper stomachs in the extensive studies of Jordan and others. However, Herbert M. Austin (pers. comm.) reported finding one *Phaeoptyx* (FSU 19148) that was damaged, but may be this type, in the stomach of a *Mycteroperca phenax* collected during June, 1967, in the Gulf of Mexico. Springer and Woodburn (1960) recorded four specimens as *Apogon conklini,* a similar species, from the offshore reefs, but my examination of specimens collected in that area by Springer indicates that these too are *P. xenus.* Smith (1976) collected specimens that are *Phaeoptyx xenus* from natural patch reefs off Tampa Bay and suggested that this species is the most common in the eastern gulf. Causey (1969) and Cashman (1973) listed *conklini* from reefs off the Texas coast, and Cashman had three *Phaeoptyx pigmentaria* (12.0, 40.1, and 47.2 mm SL) from the West Flower Garden Reef.

Accurate descriptions of the distribution of species of *Phaeoptyx* in the gulf will require extensive collecting using special techniques, as their cryptic habits have prevented the collection of large series. It seems that *Phaeoptyx pigmentaria* is a straggler in the northern gulf, but the *P. xenus* form is apparently widely distributed in the northeastern gulf and may be a permanent resident.

POMATOMIDAE

Pomatomus saltatrix (Linnaeus), BLUEFISH (CHART 25).—The bluefish was not recorded at the East Pass jetties during 1968, but occasionally schools congregated near the jetties between June and September in 1969 and between May and December, 1970. The species was less often recorded at the St. Andrew jetties but was common at times and was usually present from May through December. During 1971 it was present in February at a temperature of 13°C. According to sport fishermen in the area, the bluefish are usually absent from December to March.

ECHENEIDAE

Echeneis neucratoides Zuieuw, WHITEFISH SHARKSUCKER (CHART 26).—Identification of sharksuckers seen during this study was based upon characteristics given by Böhlke and Chaplin (1968). Sight records could include *Echeneis naucrates,* but apparently *E. neucratoides* is the more common of the two inshore in the northern gulf.

At the East Pass jetties, only one sharksucker was seen during 1968, and only four or five in 1969. During 1970, one or more individuals were seen during all months between April and November, except August. Those seen were most often free-swimming, and the increase in numbers at the jetties is apparently not a result of an increase in the numbers of any particular host species. The increase may be related to the general increase in diversity of fishes on the jetties.

Sharksuckers were recorded at the St. Andrew jetties in May, July, August, October, and December. Sharksuckers were also commonly seen attached to larger fishes in the vicinity of offshore reefs.

CARANGIDAE

Caranx bartholomaei Cuvier, YELLOW JACK (CHART 27).—Juvenile or small adult yellow jacks (up to 25 cm long) were recorded at East Pass from July to September during 1968, from June to September during 1969, and from May through November during 1970. They were usually seen in groups of about 3-5 individuals of similar size. Observations of this species at the St. Andrew jetties were fewer but show the same general seasonal occurrence, with the species present from May through October. This species was never observed on the natural reefs offshore, but was occasionally seen under the Stage II platform off Panama City.

Caranx crysos (Mitchill), BLUE RUNNER (CHART 28).—The blue runner was the most numerous carangid at the East Pass jetties and was present for a greater part of the year than was any other species of jack. However, its occurrence (Chart 28) shows a distinct seasonal pattern, with the species first appearing in the area in May and remaining through October or November. The species was recorded from April to December at the St. Andrew jetties. Water temperatures on the dates in May when it was first recorded at East Pass were 24°C (1969) and 28°C (1970). Temperatures on dates when the species was last seen in the fall were 24°C (November, 1968 and 1969) and 18°C (November, 1970), although the species was still quite numerous at the St. Andrew jetties in December, 1970, at a temperature of 17°C. These records agree with temperatures given by McKenny *et al.* (1958), who found larvae and juveniles at 17.3-30.8°C, but suggested that the species

was normally found at temperatures above 20°C. Berry (1959) suggested that *Caranx crysos* along the Atlantic coast of the United States either migrates to the south or moves offshore during the colder months. It apparently migrates southward in the Gulf of Mexico, along the Florida coast.

The species was not recorded on the natural reefs offshore, but large numbers were present during the summer and fall near the Navy platforms off Panama City. Klima and Wickham (1971), while studying the attraction of fishes to artificial structures at depths of 11-13 m off Panama City, found that structures placed at the water surface attracted significantly more jacks, including blue runners, than did structures placed in midwater. Many pelagic fishes such as *Caranx crysos* are attracted to reefs and other solid structures, but it appears that more are attracted to such structures only when they come near or actually break the water surface.

Caranx hippos (Linnaeus), CREVALLE JACK (CHART 29.—The occurrence of *Caranx hippos* at the East Pass jetties shows an increasing seasonal pattern. Adult crevalle (about 0.5 m long) were seen at the jetties only during May but were present in schools of about 20-30 individuals during that month in both 1969 and 1970. Such schools were also seen in May, 1968 and 1970, at the St. Andrew jetties. These larger individuals did not remain in the area and were not seen again later in the year.

In August or September, larger schools of smaller crevalle (14-18 cm SL) began to congregate about the East Pass jetties and remained through about November. Schools of crevalle of comparable size were recorded at the St. Andrew jetties in October and December. These are apparently the young "of about one pound weight" that Stearns (*in* Goode 1884) reported as coming out of the salt water bayous in the fall on their way to the sea. Since the first stage of this migration begins when temperatures are still at the maximum (about 30°C), some factor (or factors) other than temperature must control the migrations. These northern gulf populations probably migrate southward for the winter, but studies to support this theory are lacking.

Caranx ruber (Bloch), BAR JACK (CHART 30).—This species was not recorded at the East Pass Jetties in 1968, but small groups (fewer than 10) of juveniles and small adults were seen during July, August, and September, 1969, and during August and September, 1970. Single individuals were also seen during October and November, 1970. Small groups were seen at the St. Andrew jetties during the months of July and October, 1970 and 1971, and the species was relatively common near the surface at the Stage I and II platforms off Panama City during the summer and fall.

The bar jack is rare in most parts of the Gulf of Mexico (Berry 1959), probably as a result of its affinity for shallow reef habitats and high temperatures (Randall 1968). Larval and juvenile bar jack may be carried into the Gulf of Mexico by the Yucatan current but apparently do not form permanent populations because of the absence of reef habitats near the water surface. The occurrence of small adult individuals at the jetties indicates that at least some fish of larger sizes frequently migrate northward in the gulf, or that some remain for several years in the northern gulf.

Decapterus punctatus (Agassiz), ROUND SCAD (CHART 31).—Schools of round scad were usually present at the East Pass jetties from April or May to September and some were present in November, 1969, and in October, November, and December, 1970. It was recorded at the St. Andrew jetties from April through October. Large schools were nearly always present under the Navy platforms off Panama City, especially during the summer and fall, and the species was also seen near natural reefs off Panama City in January.

This species is one of the most important bait fishes along the northwest Florida coast. Large schools are seen in open water but the species shows considerable attraction to solid structures (Klima and Wickham 1971) and often concentrates in large numbers near bridges, piers, or jetties. It does not occur inshore in most parts of the gulf (Tampa Bay, Springer and Woodburn 1960; Cedar Key, Reid 1954; Alligator Harbor, Joseph and Yerger 1956; Mobile Bay, Alabama, Boschung 1957; or Texas, Gunter 1945 and Hoese 1958), but may be restricted to clear high-salinity, oceanic water. Its abundance along the northwest Florida coast may be attributed to the unique hydrological conditions of the area.

Oligoplites saurus (Bloch and Schneider), LEATHERJACKET (CHART 32).—Schools of leatherjacket first appeared near the East Pass jetties in April and May (of 1969 and 1970). These schools apparently moved out of the area (possibly into the bay), and only small groups of several individuals were present sporadically in June and July. None was observed in those months in 1968. The species was much more numerous during August, September, and October, and several were still present in November (during 1968 and 1969). All had disappeared by December.

Oligoplites saurus was recorded at the St. Andrew jetties from April to October, but the number of observations was not sufficient to indicate a bimodal pattern. The species was never recorded offshore during this study.

Selene vomer (Linnaeus), LOOKDOWN (CHART 33),—This species was recorded only irregularly at East Pass (in November, 1968, October, 1969, and June, 1970) and was not recorded at the St. Andrew jetties nor on the offshore reefs during this study.

Seriola zonata (Mitchill), BANDED RUDDERFISH (CHART 34).—*Seriola zonata* was consistently present at the East Pass jetties for a brief period during late spring and summer. It was present in moderate numbers in June, July, and August, 1968, but only small numbers were present during May and June, 1969. The species was present only during June in 1970, but was common during part of that month. The reason for the brief occurrence of the species at East Pass is not known. The species was rarely seen at the St. Andrew jetties and was never observed on the offshore reefs.

Trachinotus carolinus (Linnaeus), FLORIDA POMPANO (CHART 35).—The Florida pompano was often seen swimming very near the East Pass jetties from May to October but was more common in the open areas around the jetties and along the gulf beaches. It is characteristic of sandy beaches of the northern gulf coast but shows little attraction for reef structures. It was most numerous at East Pass during 1968 and was present from June through October. In 1969 the species was first recorded in May but was not seen after August. It was rare in 1970 and was seen only during two dives in July and October. There was apparently a general decline in the abundance of this species in the Destin area during 1969 (which was also recognized by commercial fishermen in the area), and the decline apparently continued through 1970. Irby (1974) found that commercial landings of pompano in Okaloosa and Walton counties were considerably fewer during 1969 and 1970 than in 1968. Although juvenile pompano were recorded in this study as common at the St. Andrew jetties during June, July, and August, 1970, Irby also reported declines in landings for Gulf, Washington, and Bay counties (which include St. Andrew Bay).

Trachurus lathami NICHOLS, ROUGH SCAD.—Small juveniles of this species were recorded at the East Pass jetties drifting near objects in the water. Several were seen in August, 1969, under a large jellyfish, and one was seen in April, 1970, under a jellyfish. In June, 1970, a group of juvenile fishes, including two *Trachurus lathami* (14.9 and 15.4 mm SL), two *Chloroscombrus chrysurus,* and 13 *Monacanthus hispidus,* was collected beneath a small paper cup as it drifted with the current near the jetty. Several adult *Trachurus lathami* were seen in the deeper water on the submerged bulkhead at St. Andrew Pass in May, 1971, but no others were recorded at the St. Andrew jetties.

Adults were often present in large numbers below the Navy platforms off Panama City where they always seemed to remain near the bottom, and small schools of adults were present near the bottom at Warsaw Hole during January, 1971.

Adults of this species are characteristic of deeper reef habitats in the northern gulf and do not normally occur at depths as shallow as those at the jetties. Jordan (1885; also Jordan and Gilbert 1883, 1884) recorded specimens (as *T. saurus, T. trachurus,* and *Caranx trachurus*)

from the stomachs of snappers and groupers from the northern Gulf of Mexico.

LUTJANIDAE

Lutjanus campechanus (Poey), RED SNAPPER.—One red snapper (318 mm SL) was collected at the East Pass jetties on 21 November 1970. No others were recorded although single juvenile snappers that could have been this species were observed in October and November, 1968, and in September, 1970. None was recorded at the St. Andrew jetties although juveniles are often collected in St. Andrew Bay (Allison 1961; Vick 1964; Larry H. Ogren, pers. comm.).

Small red snappers were seen on most dives on the natural reefs offshore, and party boats catch them throughout the year. There appears to be some movement offshore during the winter and inshore in summer (Moe 1963; Moseley 1966b), but adults apparently rarely move into shallow coastal waters.

Jordan (1885, and others) compiled an extensive list of fishes that had been recorded from the snapper banks off Pensacola, including many that were taken from the stomachs or "spewings" of red snappers. Although some of these were taken from other species of snappers and groupers, most came from *Lutjanus campechanus* since this was the dominant species in the catches. Jordan's studies not anly gave information regarding the feeding habits of snappers but also added several new species to the known fauna of North America.

Lutjanus griseus (Linnaeus), GRAY SNAPPER (CHART 36).—*Lutjanus griseus* is the only snapper that was consistently present at the East Pass jetties. It was always present and most numerous from about August to November, but small groups or single individuals were present sporadically from March through July. One was also seen in December, 1970. Almost all the gray snappers recorded at East Pass were small adults, approximately 19-28 cm SL. Two small juveniles (11.8 and 10.0 MM SL) were collected in July, 1969, one juvenile (49.5 mm SL) was collected in September, 1968, and several juveniles (approximately 10-15 cm SL) were seen during November, 1970. Snappers were usually seen in loose aggregations on the deeper parts of the jetties, usually at the south ends. They were recorded at temperatures as low as 14°C (one adult recorded in March, 1969) but were common only at temperatures above 20-25°C.

Lutjanus griseus was recorded at the St. Andrew jetties from April to October. Juveniles were more common there than at East Pass, possibly because of the presence of grass beds and the shallow water lagoons. Juveniles were common only in October, but one was also seen in April. Allison (1961) collected juveniles in the grass flats behind the east jetty in October, 1958, and from shore areas within the bay in June, July, and August.

Vick (1964) noted that *Lutjanus griseus* is uncommon in the offshore snapper fishery but that commercial fishermen often catch this species along the edges of the navigation channel inside the St. Andrew jetties. These catches probably represent schools that congregate about the submerged bulkhead in the pass.

Gray snappers were occasionally seen during dives on the offshore reefs, although they were never common in these locations. They were common at times below the Navy platforms off Panama City. They were present throughout the winter on offshore reefs, at temperatures as low as 15°C.

GERREIDAE

Eucinostomus sp. MOJARRAS (CHART 37).—Prejuvenile fish of this family (9.0-11.8 mm SL) were recorded at the East Pass jetties at irregular intervals from July or August to November during 1969 and 1970. These were probably either *Eucinostomus argenteus* Baird and Girard or *E. gula* (Quoy and Gaimard), the two most common gerreids in the northern Gulf of Mexico, but were too small to be positively identified. In November, 1970, two adult gerreids that appeared to be *E. gula* were seen near the East Pass jetties, and small schools of *E. argenteus* were occasionally seen in the lagoons at East Pass. Both species were collected at the St. Andrew jetties during this study, usually from the lagoon formed by the east jetty, and mostly in the months of October. These two species are thought to spawn offshore in the gulf (Kilby 1955; Springer and Woodburn 1960), and the occurrence of large schools of prejuveniles at the jetties probably results from their movement into the estuary from the open gulf.

POMADASYIDAE

Haemulon aurolineatum Cuvier, TOMTATE.—The tomtate was recorded only twice at East Pass during this study. A rather large school of small juveniles (about 15-20 mm SL) was seen at the south end of the west jetty in October, 1969, and one juvenile was seen on the east jetty in August, 1970. The species was more common at the St. Andrew jetties where both juveniles and adults were collected. Small juveniles (less than 30 mm SL) were recorded during August and October, and adults were observed during May, August, October, and December, but were usually most common in October.

This species is a dominant fish in parts of the Gulf of Mexico, and it was commonly recorded on the reefs offshore of Destin and Panama City, where it was present throughout the year. It was abundant at times and was usually also abundant below the Navy platforms off Panama City Beach.

In reference to the occurrence of this species at Pensacola and Key

West, Jordan and Evermann (1898) stated that "*at the latter place* the young swarm everywhere about the wharves and shores," This statement has been misquoted by several authors (Hildebrand 1954; Reid 1954; Boschung 1957), who have suggested that juvenile *H. aurolineatum* are abundant at Pensacola. "At the latter place" refers to Key West and the species is rare inshore at Pensacola, just as it is in most other parts of the northern gulf.

Jordan and Gilbert (1883) and Jordan (1885) collected specimens from the stomachs of snappers and groupers taken off Pensacola, and Springer and Woodburn (1960) recorded hundreds of small specimens from the spewings of a single *Epinephelus morio* off Tampa.

Haemulon plumieri (Lacepede), WHITE GRUNT.—The white grunt was recorded once at East Pass, a single adult being seen in December, 1970. The species was present at the St. Andrew jetties from about April or May to December at temperatures as low as 17°C, and several adults were observed on the submerged bulkhead in the middle of the channel during January, 1971, at 13°C. Allison (1961) reported sighting one adult at the east jetty in January, 1959. Although not numerous, *Haemulon plumieri* is a consistent member of the fauna at the St. Andrew jetties and has been recorded each year between 1967 and 1971.

The white grunt is a characteristic species on the offshore reefs of the Gulf of Mexico but was not often observed during dives on these reefs and was never present in large numbers. It was recorded throughout the year, however, including February and March.

Orthopristis chrysoptera (Linnaeus), PIGFISH (CHART 38).—*Orthopristis chrysoptera* is an abundant species inshore in the northern Gulf of Mexico and was one of the dominant species at the East Pass and St. Andrew Bay jetties. It is most characteristic of grassbeds but is also often common in other habitats that provide suitable food sources, such as the jetties with their abundant algal growth and invertebrates. The species may have some affinity for reef structures, however, since large schools were present on the jetties during the initial stages of this study, even before most rocks had become encrusted with algae and invertebrates.

The pigfish is a seasonal resident of inshore waters of the northern gulf, as shown by its occurrence at the East Pass jetties (Chart 38). The species was common (or abundant) through November in 1968, but was completely absent during the following two and a half months when the water temperature was between 12 and 14°C. One or two adults were seen during the latter part of February, 1969, at 15°C, and several adults were present during March. Large schools of adults had appeared by the first part of April (at a temperature of 20°C), and

large numbers were present throughout the spring, summer, and fall until the latter part of November. The species was common on November 3 at temperatures of 20 (surface) to 24°C (bottom). On November 28 the species was no longer present and the temperature had dropped to 17°C. The winter of 1969-1970 was considerably colder than the preceding one, and pigfish did not reappear until the latter part of April (temperature 21.5-24°C). They were not common until May (27°C). These latter temperatures are considerably higher than those recorded when pigfish were first observed in 1969, so possibly the schools had moved farther offshore during the colder winter and required more time to return inshore. The species was common through December during 1970 when the temperature had dropped as low as 14°C, but these were present mostly on the deeper parts of the jetties and had completely disappeared by 12 January 1971, when the temperature was 13-14°C. *Orthopristis chrysoptera* is also a dominant species at St. Andrew jetties and was recorded from April through December, at temperatures from 16.5 to 31°C. Prejuvenile pigfish (10-25 mm SL) were collected at East Pass in May, 1971, and at the St. Andrew jetties in April and May, 1970, and in May, 1971.

Pigfish are rare on the offshore reefs of the northern gulf, although they were unusually numerous below the Stage II platform off Panama City Beach. The inshore populations apparently move offshore in the gulf to spend the winter (Moe and Martin 1965), but most of them apparently remain over open sandy bottoms.

SPARIDAE

Archosargus probatocephalus (Walbaum), SHEEPSHEAD (CHART 39).—Sheepshead occurred irregularly on the jetties at East Pass, but Chart 39 indicates that the species was present during two periods of the year, and was possibly migrating through the area when observed. It was most numerous during late winter or spring (from February to May). According to fishermen, large numbers of sheepshead are caught during the winter under the Highway 98 bridge over East Pass. Only single individuals or pairs of individuals were seen during the remainder of the year, although none was recorded during June and July (of all three years), and only single individuals were recorded during August and September (of 1969). The species was more consistently present in October, November, and December than in the summer season, but only small numbers were observed.

Sheepshead were recorded at the St. Andrew jetties throughout the year, but the seasons when it was most numerous correspond to those at East Pass, except that the species tended to remain on the St. Andrew jetties through the winter. It was common there during January,

February, April, May, and December, at temperatures from 13-25.5°C, but small numbers were also recorded during June, August, and October.

Sheepshead were not often observed on the offshore reefs. Single individuals were recorded offshore in April, August, and September, and 5-10 were seen off Destin during February at a depth of 21 m.

Apparently the sheepshead in the northern Gulf of Mexico migrate inshore during the fall, spend the winter near suitable structures providing food in the form of encrusting invertebrates, and then migrate offshore in late winter or spring (Stearns *in* Goode 1884). Apparently the St. Andrew jetties provided a more favorable habitat for sheepshead than did the East Pass jetties, possibly because of greater water depth and greater substrate area for browsing.

Diplodus holbrooki (Bean), SPOTTAIL PINFISH (CHART 40).—The occurrence chart for *Dipolodus holbrooki* at East Pass indicates that the population using the jetty habitat during the spring, summer, and fall continued to increase throughout the three-year period of study. During 1968, several juveniles (about 10 cm SL) were recorded in June, a single small adult was recorded in September, and several juveniles or small adults (about 15 cm SL) were recorded during October and November. The species was not seen subsequently until the following June 28 when a single juvenile (about 7 cm SL) was observed. Small numbers of juveniles or small adults were present during the months of July, August, September, and October, and during the early part of November. In 1970 spottail pinfish appeared inshore earlier and occurred in greater numbers than during the previous two years. Juveniles (about 12 cm SL) were first seen during April, and a school of 14 small juveniles (one measured 30.6 mm SL) was seen in May. The species was present through the remainder of the year until the latter part of December and was recorded as common during July, August, September, October, and December.

Records at the St. Andrew jetties were similar to those obtained at East Pass during 1970. The species was recorded in March (1968 only), April, May, June, July, August, October, November and December, and was common from May to December. Large adults (up to about 25 cm SL) were often seen.

The spottail pinfish was not observed during this study on the natural reefs offshore, but fishermen report that it does occur on some of these reefs. Springer and Woodburn (1960) reported seeing large specimens near rocky reefs off Tampa Bay in February.

Lagodon rhomboides (Linnaeus), PINFISH (CHARTS 41 and 42).—The pinfish was the second most numerous non-pelagic species at the East

Pass jetties. It was a dominant member of the jetty fauna, and adults were almost always abundant from May through about November. During the remainder of the year, considerably fewer pinfish were present inshore but were replaced by large schools of prejuveniles (11.0-27.0 mm SL). However, during the relatively mild winter of 1968-69, adult pinfish were quite common at East Pass although considerably less numerous than during the warmer part of the year. Schools of adults were also seen below the Highway 98 bridge during January, 1969. Possibly correlated with the occurrence of adults at the jetties during February and March, 1969, prejuveniles were not recorded at the jetties that winter but were collected in shallow water under the bridge in February, 1969.

At the St. Andrew jetties adults were consistently abundant from May to about October or November but were also recorded as abundant on March 30 and during April, 1968. Adults were always rare or absent during December, January, and February. Prejuveniles or juveniles were present in large numbers from December through May.

No pinfish were observed on the natural reefs offshore during this study although the species was common throughout the warmer months under the Stage II platform off Panama City Beach, and small numbers were observed in the winter.

Lagodon rhomboides is a ubiquitous species in the northern Gulf of Mexico and is found in numerous inshore habitats, although Caldwell (1957) found it most characteristic of vegetated areas and secondarily near irregularities such as rocks, pilings, docks, and breakwaters. Springer and Woodburn (1960) found pinfish abundant along the sandy beaches at Tampa Bay most of the year, so pinfish were probably common at East Pass prior to construction of the jetties. These structures may have increased the pinfish populations there by increasing desirable habitat and food sources.

SCIAENIDAE

Bairdiella chrysura (Lacepede), SILVER PERCH (CHART 43).—Adult silver perch were recorded at the East Pass jetties from May to October but were present rather irregularly. In 1968, the species was common from June to September and was considered abundant during July. In 1968, it was observed only twice, on May 31 when several were seen near the south end of the west jetty and on August 16 when one large school was seen on the west jetty. During 1970, there was a bimodal occurrence corresponding to the dates of occurrence recorded during 1969. Large schools were recorded in late May and early June, but none was recorded during the latter part of June or in July. The species was again abundant in August and large numbers were present

from then through October. The species was also observed in Old Pass Lagoon (Fig. 2) in December, 1970.

Silver perch were also sporadic in occurrence at the St. Andrew jetties, although at times they were abundant. They were recorded during the months of April, May, July, August, and October. None was ever observed offshore on the natural reefs or at the Navy platforms off Panama City.

Equetus lanceolatus (Linnaeus), JACKKNIFE FISH.—The jackknife fish was never recorded at East Pass but was recorded twice at the St. Andrew jetties. One small juvenile (28.0 mm SL) was collected in September, 1967, and two juveniles (45.5 and 46.0 mm SL) were collected in October 1969. Adults were commonly seen in dives on the offshore reefs, and were usually present at the Navy platforms off Panama City, including in February, 1971, at a temperature of 13°C. Three collected then measured 163, 166, and 174 mm SL. The species is common offshore in the Gulf of Mexico, where it is usually associated with reef areas, but only small juveniles venture inshore to shallow waters.

Equetus umbrosus Jordan and Eigenmann, CUBBYU.—One juvenile cubbyu was seen at the East Pass jetties in June, 1969, and single adults were observed in August and December, 1970. The species was common at times on the St. Andrew jetties and was collected on almost every occasion that rotenone was used. Adults were recorded in the months of May, August, October, and December, and were considered common during both May and October. Small juveniles were recorded during April, May, and October. Allison (1961) collected the species at the jetties during August, September, October, and November, and reported sighting one juvenile during January, 1959.

Equetus umbrosus was common on the offshore reefs where it was recorded throughout the year (January, February, March, April, August, and September).

Another, undescribed species of *Equetus* (or *Pareques*) was recorded offshore in this study. One juvenile (88 mm SL; 110 mm TL) was collected on 21 January 1971, at Warsaw Hole off Panama City, under a rock ledge with a large group of *E. umbrosus*, and Larry H. Ogren (Hastings *et al.* 1976) collected two juveniles (67 and 92 mm TL) at the Stage I platform on 7 September 1971. This species is said to be common at depths of 30-35 fathoms (54-63 m) along the south Atlantic coast of the United States (George C. Miller, pers. comm.). Bullis and Thompson (1965) listed this species as "*Equetus* sp. nov." and reported it from off Texas, North Carolina, and northwest Florida. Struhsaker (1969) reported the species as "Blackbar drum, *Pareques* sp. (undescribed)" and listed it as common along the shelf edge of the

southeastern United States coast. This species apparently never occurs inshore.

Leiostomus xanthurus Lacepede, SPOT (CHARTS 44 and 45).—The Spot was a dominant species at the East Pass jetties. Adults were present in variable numbers from April through November or December (Chart 44). They were abundant during most of 1968, but were less numerous although almost always present in 1969 and 1970. During early November of each year, large masses of adult *Leiostomus xanthurus* were observed schooling over sandy areas near the jetties. Such schools were observed on 1 November 1968 (temperature 24°C), 3 November 1969 (20-24°C), and 9 November 1970 (22°C), and are believed to have been spawning aggregations. Specimens collected from these aggregations had well-developed gonads in spawning condition. On the subsequent observation following each of these dates (on 14 December 1968, 14 November 1969, and 19 November 1970), large numbers of larvae or prejuveniles (7.5-13.3 mm SL) were present (Chart 45). These young spot remained on the jetties through the winter and were the most numerous species from December through March. Most had disappeared from the area of the jetties by April or May, probably moving into the bay, although some larger juveniles remained on the jetties and are included in the records shown in Chart 44.

Records at the St. Andrew jetties are similar, and show the same pattern of occurrence. Advanced juveniles and adults were recorded in April, May, June, July, August, and October, and larvae and prejuveniles were recorded in December, January, and April. No *Leiostomus xanthurus* were recorded on offshore reefs during this study, but adults were usually common during the summer and fall at the Stage II platform off Panama City.

The spot is most characteristic of flat, open bottoms of sand or mud in estuaries, but evidently has some attraction to solid structures such as rock jetties. Springer and Woodburn (1960) found that it is a major component of the beach fauna along the west Florida coast only during spring and early summer. Adults of the species apparently remained throughout the spring, summer, and fall at East Pass as a direct result of the existence of the jetties, since those seen in the area were usually very near or actually among the jetty rocks.

Menticirrhus focaliger Ginsburg, MINKFISH (CHART 46).—Two small adult minkfish (124 and 117 mm SL) were collected with rotenone in September, 1968, at the East Pass jetties, and one juvenile (86.5 mm SL) was collected and one large adult was seen near the beach at East Pass in May, 1969. Small juveniles were collected on 22 March (21.2 mm SL), 30 May (25.5 mm SL) and 12 June 1969 (7, 9.5-23.0 mm SL), and on 9 July 1970 (3, 16.2-30.0 mm SL). Two

juveniles (18.1 and 20.6 mm SL) were collected at the St. Andrew jetties on 25 April 1970.

Sport fishermen catch whiting (including *M. americanus* and *M. littoralis* as well as *M focaliger*) along the sandy beaches of the northwest Florida coast from March to October, but the species are apparently not attracted to reef-like structures.

KYPHOSIDAE

Kyphosus incisor (Cuvier), YELLOW CHUB.—On 18 May 1971, one large *Kyphosus incisor* (290 mm SL) and one *K. sectatrix* (248 mm SL) were collected with rotenone at the east jetty at St. Andrew Bay. Several other chubs were seen at the time on the channel side of the jetty, but *K. incisor* was not recognized in the field, and it is not known how many of each species were present. Only *K. sectatrix* has been previously recorded in the Gulf of Mexico north of Tortugas (Moore 1962) and Campeche bank (Chavez 1966). However, the two species are similar in appearance, and some *K. incisor* could have been incorrectly identified as *K. sectatrix,* especially in the case of sight records.

Kyphosus sectatrix (Linnaeus), BERMUDA CHUB (CHART 47).—*Kyphosus sectatrix* (possibly including some *K. incisor* as noted above) was present erratically at the East Pass jetties from the latter part of May through October or November, but the species was also common on 1 December 1970 (16-19°C) and five adults were seen on 12 January 1971 (13-14°C). Those present at the jetties were almost always seen at the seaward ends of the jetties where they darted in and out among the larger rocks near the surface. They seemed to prefer areas with the greatest amount of surge. The species was recorded at the St. Andrew jetties from April to October and appeared to occur with about the same frequency as at East Pass. It was not seen on the natural reefs offshore, but several were usually present during the warmer months at the Navy platforms off Panama City.

Dawson (1963) suggested that *K. sectatrix* was a tropical or subtropical stray carried into the northern gulf as pelagic larvae or juveniles. The records from west Florida indicate that it is a more characteristic member of the northern gulf fauna and should be expected where suitable habitat, such as the jetties, is available. Some apparently remain through the winter since large adults have been recorded inshore early in the spring (April and May).

Moore (1962) noted that south Florida and Caribbean populations of *K. sectatrix* differed in the number of scales in a straight line from the cleithrum to the caudal peduncle. In this respect specimens collected at the East Pass, St. Andrew, and Pensacola Bay jetties (52-54 scales) are more similar to south Florida populations (most with 48-54 scales) than to Caribbean populations (54-58 scales), further indicating that these northern gulf chubs have not drifted from the Caribbean.

EPHIPPIDAE

Chaetodipterus faber (Broussonet), ATLANTIC SPADEFISH (CHART 48).—Schools of juveniles or small adult spadefish were often present on the East Pass jetties from April through November, and some remained in the deeper areas at the south end of the west jetty through December, 1970, and January, 1971, when the temperature had dropped to about 13-14°C. Its occurrence at the jetties was sporadic, especially during 1969, indicating that schools of spadefish were continually moving into and out of the area. Those observed near the jetties were most often inactive and hidden in crevices between rocks or else swimming in close proximity to the jetties.

Spadefish were recorded at the St. Andrew jetties from April through December, but large schools were observed on the submerged bulkhead in the channel during January and February, 1971, at temperatures of 13°C. In February they were considered abundant.

Spadefish were often seen on the offshore reefs but were most numerous offshore during the winter. Apparently the largest adults (more than 300 mm SL) remain offshore in the vicinity of reefs and rarely come inshore.

CHAETODONTIDAE

Chaetodon capistratus Linnaeus, FOUREYE BUTTERFLYFISH.—The foureye butterflyfish was recorded twice at East Pass. Single juveniles were observed on the jetties on 28 August and 27 September 1969. The one recorded in September was 35.2 mm SL. Small numbers were usually present at the St. Andrew jetties during late summer and fall. Allison (1961) collected single juveniles at the east jetty during June (27.6 mm SL) and July (17.5 mm), in 1959, but observed many there in November, 1958. During this study, one juvenile was recorded during August, 1967, several juveniles (one measured 44.4 mm) during October, 1969, two juveniles during August, 1971, and several juveniles or small adults during October, 1971. Five collected on the latter date measured 33.1, 46.6, 49.4, 58.5, and 60.4 mm SL. None was observed at the St. Andrew jetties during 1970 despite several observations there during April, May, June, July, August, October, and December.

This species was not recorded on the offshore reefs during this study, but Gregory B. Smith (1975, 1976) has found it rare at depths of 12-18 m off Tampa Bay, and it is also rare on the Florida Middle Ground (Smith *et al.* 1975) and the Texas Flower Gardens (Sonnier *et al.* 1976). Haburay *et al.* (1969) recorded small numbers of juveniles at the mouth of Pensacola Bay, but there are apparently no other published records of the species in the northern Gulf of Mexico. In contrast it is the most common butterflyfish in the Bahamas and West

Indies (Böhlke and Chaplin 1968; Randall 1968). It apparently occurs in the northern gulf only as a straggler.

Chaetodon ocellatus Bloch, SPOTFIN BUTTERFLYFISH (CHART 49).—Spotfin butterflyfish were recorded at the East Pass jetties from July or August to November. Small juveniles (less than 25 mm SL) were recorded during August and October, 1968, and during September and November, 1969 and 1970. Adults were recorded from July to November. Caldwell and Briggs (1957) reported one adult (88 mm SL) collected in August, 1955, under the Highway 98 bridge at East Pass.

The species was recorded from May through December at the St. Andrew jetties. Small juveniles were recorded during May, July, August, September, and October and adults were recorded from May to December. Caldwell (1959) reported collecting four specimens (18, 22, 25, and 39 mm SL) at the St. Andrew jetties during June, 1958. Several adults were observed on the channel side of the jetties on 11 December 1970 at a temperature of 17°C. Thus, some butterflyfishes might be able to survive at the jetties through the winter, especially during mild years. Yet none has been seen during the limited number of winter dives at the St. Andrew jetties, so most either move offshore for the winter or else are killed by low winter temperatures. Both juveniles and adults (up to 100 mm SL) were recorded at the jetties, indicating that recruitment of populations on the jetties results both from immigration of recently spawned young and from movement of adults inshore from the offshore reefs. Thus, if adults can successfully move inshore to the jetties in the summer, they should also be capable of moving offshore to the natural reefs to spend the winter.

Adults were often seen on the natural reefs off Destin and Panama City, and usually were seen in pairs. They were present throughout the year, including the winter at temperatures of 15°C. The species is apparently widely distributed on the continental shelf of North America and is found throughout the Gulf of Mexico where suitable rocky substrates are present (Longley and Hildebrand 1941; Springer and Bullis 1956; Springer and Woodburn 1960; Bullis and Thompson 1965; Moe *et al.* 1966; Cashman 1973; Smith *et al.* 1975). It has also been recorded inshore at localities throughout the Gulf of Mexico (Baughman 1947, 1950b; Hildebrand 1955; Collins and Smith 1959; Miller 1965; Haburay *et al.* 1969).

Chaetodon sedentarius Poey, REEF BUTTERFLYFISH.—The reef butterflyfish was not recorded at East Pass during this study and only once at the St. Andrew jetties. One juvenile (43.5 mm SL) was collected at a depth of 9 m on the channel side of the west jetty on 21 May 1970. None was observed on the natural reefs offshore, but a few were seen below the Stage I platform at a depth of 32 m off Panama City.

Chaetodon sedentarius is normally found in deeper water than the other western Atlantic species of *Chaetodon* (except for *C. aya*) (Randall 1968), and has been recorded only rarely in shallow water in the Gulf of Mexico (Collins and Smith 1959; Briggs *et al.* 1964). It may be common in offshore reef areas on the continental shelf of North America, including the Gulf of Mexico (Springer and Bullis 1956; Briggs *et al.* 1964; Bullis and Thompson 1965; Moe *et al.* 1966; Causey 1969; Struhsaker 1969; Powell *et al.* 1972), but only rarely strays inshore.

Chaetodon striatus Linnaeus, BANDED BUTTERFLYFISH.—One banded butterflyfish (about 60 mm SL) was seen at the East Pass jetties on 14 September 1970. Caldwell (1959) reported three specimens (33, 35, and 39 mm SL) collected in June, 1958, near Destin but did not give the exact location of their capture. Small numbers were also recorded at the St. Andrew jetties. Single juveniles were observed in May, 1966, October, 1969, and July and October, 1971. Caldwell and Briggs (1957) reported sighting one adult there in November, 1958, and collected small individuals in June (35.7 mm SL), August (52.5 and 53.8 mm), and September (61.4 mm), 1959. Bullis and Thompson (1965) listed one collection of *C. striatus* from offshore of St. Andrew Bay (R/V *Silver Bay* Station 110- 29°43'N, 85°59'W; 28 July 1957, depth, 34-41 m). Haburay *et al.* (1969) reported collecting specimens near Pensacola in May (28 mm) and in August (69.3 mm), 1967. Smith (1975, 1976) collected specimens at depths of 12-20 m off Sarasota for several months following the 1971 "red tide" but had not recorded the species prior to that time. The species is apparently uncommon in the western Gulf of Mexico (Sonnier *et al.* 1976) and occurs in the eastern gulf only as a straggler.

POMACANTHIDAE (AFTER FEDDERN 1972 AND BURGESS 1974)

Holacanthus bermudensis Goode, BLUE ANGELFISH (CHART 50).—Juvenile blue angelfish (89-134 mm SL) were observed in deeper water at the seaward ends of the East Pass jetties from August to November, 1969, and one was recorded during August, 1970.

The species was more often seen at the St. Andrew jetties, but only in the deeper water on the channel side of the jetties or near the submerged bulkhead in the channel. Adults were present during all seasons, including the winter (January and February) at temperatures as low as 13°C. Records of *H. ciliaris*, the queen angelfish, at the St. Andrew jetties (Caldwell and Briggs 1957; Allison 1961) are apparently referable to *H. bermudensis*, although one specimen in the University of Florida collection (UF 5694) may be a hybrid of the two, as described by Feddern (1968) (Carter R. Gilbert, pers. comm.).

Blue angelfish were seen on nearly every dive on the natural reefs

offshore of Destin and Panama City and were also usually present swimming about the pilings of the Navy platforms off Panama City. The species is widely distributed in the Gulf of Mexico and along the continental shelf of North America from North Carolina to Yucatan (Springer and Hoese 1958; Springer and Woodburn 1960; Bullis and Thompson 1965; Moe *et al.* 1966; Causey 1969; Struhsaker 1969; Swingle 1971; Powell *et al.* 1972; Cashman 1973; Smith *et al.* 1975). It is apparently more tolerant of temperate and subtropical temperatures than generally supposed and is replaced in most insular coral reef areas by *H. ciliaris,* which is rare or completely absent in most continental areas. Although occasionally reported from the northern Gulf of Mexico (Springer and Bullis 1956; Springer and Woodburn 1960; Bullis and Thompson 1965; Moe *et al.* 1966; Powell *et al.* 1972; Cashman 1973; Smith *et al.* 1975; Sonnier *et al.* 1976), *H. ciliaris* was not observed during this study. It is undoubtedly rare in the northern gulf and any records in the area could be suspected of being misidentifications of the more common *H. bermudensis,* or possibly hybrids between the two (Feddern 1968). Environmental factors affecting the distribution of the two species are not completely understood, but may include temperature, salinity, water clarity, and bottom type, all of which contrast to some extent between continental and insular areas of the western Atlantic (Robins 1971).

POMACENTRIDAE

Abudefduf saxatilis (Linnaeus), SERGEANT MAJOR (CHART 51).—Juvenile sergeant majors were observed at East Pass only during 1970 and only in small numbers. Single individuals were seen on 9 July, 6 August, and 1 October; and three were seen on 1 December 1970. The species was seen at the St. Andrew jetties only during 1971, when two small individuals were seen on 24 July and one on 19 October 1971. Caldwell and Briggs (1957) reported collecting one sergeant major (42 mm SL) at the St. Andrew jetties on 30 July 1956. Several were seen near the pilings and cross-members of the Stage I platform off Panama City during the summer and fall, but all were seen very near the water surface. None was seen on the natural reefs off Destin and Panama City.

Abudefduf saxatilis has been recorded from various localities throughout the Gulf of Mexico (Baughman 1950b; Gunter and Knapp 1951; Springer and Woodburn 1960; Dawson 1962; Richmond 1968; Causey 1969; Haburay *et al.* 1969; Cashman 1973) but is rarely common in the northern portion and apparently is restricted to shallow water areas. Even in tropical reef areas in the western Atlantic, where the species is abundant, it rarely occurs at depths greater than 12 m,

and thus apparently cannot survive on the deeper water reefs of the northern gulf. Those present in shallow waters of the northern gulf most likely result from pelagic larvae carried north from the Caribbean. Floating *Sargassum* may be important in such dispersal of this species (Dawson 1962; Fine 1970; Dooley 1972).

Abudefduf taurus (Muller and Troschel), NIGHT SERGEANT.—*Abudefduf taurus* was not recorded during this study, but Allison (1961) collected two juveniles (23.5 and 34.2 mm SL) at the St. Andrew jetties on 27 June 1959. Apparently the only other record of this species in the northern Gulf of Mexico is that of Brigge *et al.* (1964), who reported two juveniles taken in July, 1963, at Port Aransas, Texas. This species is also restricted to shallow water (Böhlke and Chaplin 1968) and cannot survive on the deep water reefs of the Gulf of Mexico. Individuals occurring in the northern gulf must be carried there as pelagic larvae or juveniles and must rarely if ever survive the low winter temperatures.

Pomacentrus fuscus (Cuvier), DUSKY DAMSELFISH.—Greenfield and Woods (1974) and other recent authors have used the generic name *Eupomacentrus* for this and the following two species, and also the specific name *dorsopunicans* for the dusky damselfish. Nomenclature used here follows Bailey *et al.* (1970) and Rivas (1960).

The dusky damselfish was not recorded at the East Pass jetties during this study and only small numbers were recorded at the St. Andrew jetties and only during the summers of 1967 and 1971. Several juveniles were seen in June and August, 1967, and during July, 1971. Two collected measured 35.6 and 37.7 mm SL. Other divers reported seeing additional specimens at the St. Andrew jetties and also in the Pensacola area in the summers of 1971 and 1972 (Haburay *et al.* 1974). None was recorded between 1967 and 1971, despite numerous observations at the St. Andrew and East Pass jetties. The East Pass jetties were not studied during 1971 so the species may have been present there that year. Robert L. Shipp (pers. comm.), who had collected fishes at the St. Andrew jetties for several years prior to this study, commented that small numbers of juvenile *P. fuscus* were observed periodically at the jetties.

The dusky damselfish has only rarely been reported from the northern gulf (Dawson 1962; Briggs *et al.* 1964; Haburay *et al.* 1974), but Causey (1969) reported the species as a "benthic resident" at Seven and One-Half Fathom Reef (13.5 m) off Padre Island, Texas. It is one of the most common pomacentrids in inshore waters of the Caribbean Sea (Cervigon 1966; Randall 1968) and also on Campeche Bank and at Blanquilla Reef on the coast of Mexico (Hildebrand *et al.* 1964; Chavez 1966). It is a shallow water species most often found at depths less

than 6 m, and always less than 15 m (Böhlke and Chaplin 1968; Emery 1973). Thus, the species is apparently unable to survive on the deep-water (over 18 m) natural reefs off northwest Florida, and the occasional strays that are carried northward by currents must be killed by the low winter temperatures in shallow inshore waters.

Pomancentrus partitus (Poey), BICOLOR DAMSELFISH.—One juvenile bicolor damselfish was recorded at the East Pass jetties in this study (21.5 mm SL–collected 6 August 1970), and the species was recorded only in 1967 and 1971 at the St. Andrew jetties. One juvenile (28.0 mm SL) was collected there on 12 September 1967 and several were observed in July, August, and October, 1971. Four collected on 24 July 1971 measured 29.8, 32.9, 34.5, and 34.5 mm SL and three collected on 19 October 1971 were 43.9, 50.4, and 53.4 mm SL. Juveniles were occasionally seen swimming about the pilings near the surface at the Stage I platform off St. Andrew Bay but none was recorded on the natural reefs. Haburay *et al.* (1974) reported collecting this species in the Pensacola area in 1971.

Pomancentrus partitus is apparently not common on most reefs of the Gulf of Mexico north of the Florida Keys but is present on some reefs where conditions are favorable. It is common on the Florida Middle Ground reef (Smith *et al.* 1975) and also on the Flower Garden Reefs of Texas (Cashman 1973). Smith (1975, 1976) found it at depths from 12 to 36 m off Tampa Bay during the summer of 1972 following a severe "red-tide" the previous year, but suggested that it was more typical of the deeper reefs of the West Florida Shelf. Factors preventing its establishement on most reefs of the northern gulf are unknown but are probably in some way related to temperature. Possibly it cannot survive the low winter temperatures on the deep water reefs even though it can inhabit such depths in more tropical areas (Emery 1973; a few meters to 45 m). A unique combination of environmental conditions apparently allows the bicolor damselfish to occur at the Florida Middle Ground reef (Smith *et al.* 1975) and this may also be the case at the Flower Garden Reefs off Texas. Böhlke and Chaplin (1968) cited a record of this species being collected at "200 to 210 fathoms off Puerto Rico," apparently referring to Bullis and Thompson (1965), who listed the foregoing data for R/V *Oregon* Station 2630. Collection data for this station were incorrectly transcribed and *Oregon* Station 2630 was actually off the Leeward Islands at a depth of 19 fathoms (34.2 m).

Pomacentrus variabilis (Castelnau), COCOA DAMSELFISH (CHART 52).—The cocoa damselfish was rare at the East Pass jetties in 1968, when only four individuals were recorded. One juvenile (10.0 mm SL) was collected in September, one small adult was seen in October, and one juvenile and one adult were recorded in November. No others were

seen until June, 1969, when two small juveniles (10.3 and 12.4 mm SL) were collected. Subsequently the species was recorded on every dive through November 1969. In 1970 the same pattern of occurrence was observed, although the species did not appear as early in the year. None was recorded during June and only one small juvenile was seen in July. Several small adults were observed on most dives through November and two were seen on 1 December 1970 at the south end of the west jetty at a temperature of 19°C. All of the cocoa damselfish observed at the jetties apparently belonged to the first year spawning class since there was a gradual increase in size noticed for the fishes in the population (see Beecher 1973), although small juveniles (less than 20 mm) were also seen in August. No spawning was observed at the East Pass jetties, but Caldwell (1963) noted eight specimens (40-100 mm SL) collected in the Ft. Walton Beach area. He failed to give the exact location or date of capture.

Pomacentrus variabilis is a common fish at the St. Andrew jetties, and was considerably more numerous there than at East Pass. It was present from about late March or April (at temperatures about 20°C) through about November or December. Most began to disappear in November when the temperature dropped to about 20°C, but some were usually present through December at temperatures as low as 16°C. Large adults were common at the jetties early in the spring, indicating that they had spent the winter in deeper water where temperatures are more moderate, and then returned inshore as the water warmed in the spring. Small juveniles were observed as early as 13 April, but in most years, no juveniles less than 20 mm SL were present until May. During May large numbers of small juveniles appeared on the jetties, undoubtedly from spawnings on the offshore reefs. Adults that were already present on the jetties in May began to show sexual differences in coloration, and spawning was observed on 21 May 1970. Young from these initial spawnings (or contemporary spawnings by other populations) consitute the majority of the damselfish population on the jetties through the summer and fall, and a gradual increase in the mean size of the first year fish on the jetties can be seen (Beecher 1973). However, a few small juveniles appear through the summer and fall, indicating that some spawnings may continue at least through August or September. Caldwell and Briggs (1957) (and Caldwell 1959) collected specimens of this species as small as 11 mm SL at the St. Andrew jetties in October, 1955 (51 individuals measuring 11-59 mm).

Cocoa damselfish are common throughout the year on the natural reefs off Destin and Panama City. The species is obviously a permament resident of these reefs. Unfortunately, observations on these deep water populations were too limited to determine whether their

numbers increased substantially in winter as a result of offshore movement of inshore populations.

The species is widely distributed in the Gulf of Mexico and should be expected wherever rocky substrate is availabe (Springer and Woodburn 1960; Yerger 1961; Briggs *et al.* 1964; Hildebrand *et al.* 1964; Causey 1969; Haburay *et al.* 1969; Cashman 1973; Smith *et al.* 1975; Smith 1976). A number of references citing *Pomacentrus leucostictus* in the northern Gulf of Mexico are apparently misidentifications. Jordan and Swain (1885) recorded a specimen (as *Pomacentrus caudalis*) from the stomach of a snapper collected off Pensacola. Jordan and Evermann (1898) subsequently reidentified this specimen as *Eupomacentrus leucostictus,* but their mention of "a jet-black, ink-like spot, ocellated with blue on the back of the tail" clearly indicates that this fish was not *leucostictus* but most likely *P. variabilis.* Rivas (1960) noted that the type collection of *P. caudalis* included six *P. leucostictus* and one specimen that was probably *P. variabilis.* Three specimens reported from Clearwater Harbor and identified as *E. leucostictus* by Goode and Bean (1880) were also noted as having black ocelli on the tail and are probably *P. variabilis.* Nahhas and Powell (1971) described a new species of digenetic trematode from damselfishes collected at Panama City, Florida. Although the host fish were identified as *E. leucostictus,* they were undoubtedly *P. variabilis.* Springer and Hoese (1958) recorded one specimen (71 mm SL), which was identified by H. H. Hildebrand as *P. leucostictus,* collected on 28 March 1954, at a depth of 21 m SE of Pass Cavallo, Matagorda Bay, Texas. In view of the absence of other records of *leucostictus* in the northern gulf and the late winter collection date of this large adult specimen, it seems probable that this specimen also is *P. variabilis.*

The absence of *P. leucostictus* as a straggler in the northeastern gulf is strange, as it is said to stray north to New England on the Atlantic coast. Struhsaker (1969) found it common on the continental shelf of the southeastern United States from Florida north to North Carolina. In contrast *P. variabilis* has not been recorded on the Atlantic coast north of Florida (Böhlke and Chaplin 1968). Emery (1973) noted that *P. variabilis* might be responsible for the northerly records of *P. leucostictus,* which is reportedly rare at depths greater than 7.5 m. *Pomacentrus variabilis* was the most ubiquitous species studied by Emery at Alligator Reef and is the species most tolerant of low temperatures. Therefore, it should be expected to range farther north than the other species of *Pomacentrus.*

LABRIDAE

Doratonotus megalepis Gunter, DWARF WRASSE.—Two *Doratonotus megalepis* were recorded at the East Pass jetties in this study,

one specimen (50.5 mm SL) collected on 14 September 1970 and another approximately the same size seen on 1 October 1970. Three (34-46 mm SL) were collected with rotenone at the St. Andrew jetties on 13 October 1970, and Allison (1961) collected five (28-45 mm SL) there on 22 August 1959.

Apparently the species is rare in the northern Gulf of Mexico and occurs only as a stray from more tropical waters. The only published record of its occurrence in the northern gulf is a collection at R/V *Oregon* Station 295 at a depth of 31 m off the coast of Louisiana on 4 May 1951 (Bullis and Thompson 1965).

Halichoeres bivittatus (Bloch), SLIPPERY DICK (CHART 53).—After becoming established on the East Pass jetties, *Halichoeres bivittatus* became the most numerous species present from about April through November or December. On the first sighting at the jetties on 9 June 1968, one adult was seen. Later in June and July, several adults were present and several juveniles about 25-50 mm SL were recorded. By August adults had become common and large numbers of small juveniles (less than 25 mm) were present. Subsequently the species was common through November, but then disappeared and none was seen until February.

In February, 1969, one juvenile was seen under the Highway 98 bridge, and two juveniles were seen on the west jetty at temperatures of 14.5 and 15°C. This species gradually became more numerous during the next two months, and large adults were first recorded in April. In May adults were again considered common, and late in May small juveniles (less than 25 mm) were common, indicating that spawning had occurred some time previously. By late June the species was abundant and remained one of the dominant species on the jetties through November when it again disappeared.

On 2 January 1970 adults were common in the deeper water at the seaward end of the east jetty but were not seen on other parts of the jetties. On 24 January two small adults were seen in shallow water on the west jetty. No others were seen until April when both juveniles and adults again became common. The species was considered abundant from May through November, but it was still common on 1 December (at temperatures of 16-19°C) and three adults were recorded on 26 December at 14°C. None was seen on a subsequent dive on 12 January 1971.

Counts made during 1970 of the number of *Halichoeres bivittatus* in plots on the jetties emphasize the occurrence pattern of this species (Tables 2-4). The species first appeared in the plots in April and gradually increased in number through June. In July there was a pronounced increase in the number of individuals, especially juveniles on

the channel side of the jetties, undoubtedly resulting from increased spawning activity in May or June. Numbers were high through December until the species was again absent on 12 January 1971. Counts were usually higher on the channel side either because of the greater water depth there or because of the greater protection from surge. After the middle of November counts were higher for the gulf side, probably because of the higher temperatures of the gulf water.

Halichoeres bivittatus was also a dominant species on the St. Andrew jetties. It was always common or abundant from the last part of March or April through November or December, but was never seen, even in the deep water in the channel, in January and February.

Some *H. bivittatus* were seen on most dives on the offshore reefs, and it is a characteristic and permanent member of the fauna on such reefs. In most cases *H. caudalis* was more common offshore than was *H. bivittatus*, although these two species are similar and could have been confused at times. Smith (1976) made similar observations off Tampa Bay, where *H. bivittatus* is common at depths from 12 to 24 m and *H. caudalis* from 24 to 42 m. The inshore populations undoubtedly move offshore to deeper water during the winter, but the location of their winter habitat has not been definitely determined. Dives on the offshore reefs were not numerous enough to indicate differences in winter and summer populations. The occurrence of large numbers in the deeper water at East Pass in January, 1970, could indicate that schools move about considerably during the winter and may remain close to shore.

Halichoeres bivattatus has been recorded from various locations in the northern Gulf of Mexico (Reid 1954; Springer and Hoese 1958; Causey 1969; Cashman 1973). Jordan and Gilbert (1883) described two specimens from Laguna Grande near Pensacola as *Platyglossus florealis* and Jordan and Gilbert (1884) and Jordan (1885) reported the species (as *Platyglossus radiatus* and *P. bivittatus*) from the stomachs of snappers and groupers taken off Pensacola.

Halichoeres caudalis (Poey), PAINTED WRASSE.—One juvenile *Halichoeres caudalis* (100 mm SL) was collected on 19 October 1971 on the channel side of the east St. Andrew jetty at a depth of about 4.5 m. One adult *Halichoeres* that was apparently this species was seen near the submerged bulkhead in the channel on 9 August 1971. None was ever seen at the East Pass jetties. It could have been present in small numbers on other occasions and been undetected because of the abundance of *H. bivittatus*.

As noted above, *H. caudalis* is primarily an offshore species more common at depths greater than about 24 m and is the common labrid on the natural reefs of the northern gulf at moderate depths. It was

seen on nearly every dive made on the offshore reefs during this study and was also usually present at the Navy platforms off Panama City. It apparently occurs throughout the gulf where suitable rocky substrate within its depth range is present (Randall and Böhlke 1965; Richmond 1968; Springer and Bullis 1956; Swingle 1971). It has also been recorded from the stomachs of snappers and groupers taken off Pensacola and Tampa (Jordan and Gilbert 1883, 1884; Jordan 1885, as *Platyglossus caudalis;* Jordan and Evermann 1898, as *Iridio pictus*).

Halichoeres radiatus (Linnaeus), PUDDINGWIFE.—The puddingwife was not recorded at the East Pass jetties during this study but P. A. Hastings and Bortone (1976) recorded the species there in August, 1974. Two juveniles were seen together at the St. Andrew jetties on 19 October 1971. One collected measured 86.3 mm SL. The species is rare in the Gulf of Mexico (Randall and Böhlke 1965), although Richmond (1968) reported it at Horn Island, Mississippi, and Cashman (1973) reported two adults (337 and 384 mm SL) from the West Flower Garden Reef off Texas.

Hemipteronotus novacula (Linnaeus), PEARLY RAZORFISH (CHART 54).—The pearly razorfish was occasionally seen near the East Pass jetties but was usually present only in small numbers from about August to November, although single small juveniles were collected in 1969 in March (64.7 mm SL) and in May (54.0 mm). In addition a large adult (about 120 mm SL) was collected in shallow water in the lagoon at East Pass in May, 1970. The species was less often recorded at the St. Andrew jetties, but small numbers were noted in July and October, and Allison (1961) collected the species at the jetties during August, September, and October.

Pearly razorfish observed on the jetties usually were hovering near jetty rocks or other objects on the bottom, and would dart into the sand when approached. Thus the species showed some attraction to the rocks on the jetties, but was considerably more common over sandy bottoms at depths of 18 m off Destin and Panama City. Here individuals constructed mounds of shell fragments above which they hovered and into which they darted when threatened. Jordan and others reported pearly razorfish from the stomachs of snappers and groupers taken off Pensacola and Tampa (Jordan and Gilbert 1884; Jordan 1885, 1888; Jordan and Evermann 1898; listed as *Xyrichthys jessiae, X. lineatus, X. psittacus,* and *Xyrula jessiae*).

Lachnolaimus maximus (Walbaum), HOGFISH.—One hogfish was recorded at the jetties during this study, an individual about 200 mm SL seen at the St. Andrew jetties in May, 1968. The species is not common along the northwest Florida coast but occasional individuals are seen on the offshore reefs. It is apparently common on offshore

reefs along the west Florida coast at least as far north as the Florida Middle Ground (Springer and Woodburn 1960; Bullis and Thompson 1965; Smith *et al.* 1975; Smith 1976).

Thalassoma bifasciatum (Bloch), BLUEHEAD.—Single blueheads (about 75 mm SL) were seen on the East Pass jetties on 22 October and 10 November 1970, and two small juveniles were seen there on 19 November 1970. The species was recorded with about the same frequency at the St. Andrew jetties and was present there only in some years. In 1967 juveniles and small adults were numerous during June and August and adults were common in November. None was recorded subsequently until 1970 when small numbers of juveniles were present in July and several adults in October. Several juveniles were also seen in July and October, 1971. Caldwell (1969) reported collecting one bluehead at the St. Andrew jetties during the summer, 1958, and Allison (1961) recorded several juveniles and adults there in July and August, 1959.

None was recorded on the natural reefs off northwest Florida, although small numbers were seen on the pilings and cross members of the Stage I platform off Panama City, always near the surface. None was recorded on the reefs off Tampa Bay by Springer and Woodburn (1960), but Smith (1976) recorded small numbers there at depths of 12-18 m and adults on the Florida Middle Ground reef at depths of about 24 m (Smith *et al.* 1975). Cashman (1973) has also found the bluehead common at the Flower Garden Reefs off Texas and Sonnier *et al.* (1976) listed it as common on reefs off Louisiana. The bluehead is a coral reef species that is abundant in the West Indies and Florida Keys, and also on Campeche Bank (Hildebrand *et al.* 1964). Unique environmental conditions at the Florida Middle Ground and the Flower Gardens allow permanent populations to exist, while in other parts of the northern Gulf of Mexico the bluehead occurs only as a straggler.

SCARIDAE

The parrotfishes presented special problems during this study, as juveniles of several similar species were present at the jetties and often could not be identified in field observations. The species of the genus *Sparisoma* were particularly difficult to identify in the field, and consequently no occurrence charts for these are given, even though some species, such as *S. radians,* were common at times as revealed by rotenone collections. Most species were present only during the summer and fall. *Nicholsina usta* and *Sparisoma radians* were the species most often recorded, but several other species were also consistently present.

Nicholsina usta (Valenciennes), EMERALD PARROTFISH (CHART 55).—The emerald parrotfish was present at the East Pass jetties

primarily from June to November. But in 1969 several juveniles were present during February and March (at temperatures as low as 14°C) and several juveniles and adults were seen in May of that year. During December, 1970, the species was still common, at a temperature of 13°C, but none was seen on a subsequent dive in January, 1971. It was also a common species at the St. Andrew jetties where it was present from about late March or April to December. It may be more numerous in grass bed areas, since Allison (1961) collected most of his specimens from shore areas within the bay.

Nicholsina usta has been reported from several localities in the northeastern Gulf of Mexico (Jordan 1887, 1891; Jordan and Evermann 1898; Reid 1954; Springer and Bullis 1956; Springer and Woodburn 1960; Swingle 1971; Powell *et al.* 1972; Smith *et al.* 1975), but it has never been reported either inshore or from the offshore reefs in the northwestern gulf. Its occurrence pattern in the northern gulf is not completely understood, although it is more widely distributed and present for a greater part of the year than any other scarid. Some individuals must remain in the northern gulf through the winter, as advanced juveniles and adults (up to 130 mm SL) were observed inshore early in the year. Permanent populations may exist on the offshore reefs of the northern gulf, although none was observed offshore during this study. This parrotfish is a continental resident and does not occur in the coralline areas of the West Indies (Randall 1968).

Scarus coelestinus Valenciennes, MIDNIGHT PARROTFISH.—The midnight parrotfish was not recorded at East Pass, but several juveniles were seen at the St. Andrew jetties on 19 October 1971. Three collected were 81.5-108.3 mm SL. Allison (1961) collected single juveniles (which he identified as *S. guacamaia*) at the jetties on 25 October 1958 (84.6 mm) and 22 August 1959 (68.4 mm). The life color of the fish observed in 1971 was uniform blue with no distinctive markings noted. In preservative the fish were dark bluish gray with a narrow pale band on the chin. Allison's specimens are uniform brown with a light band on the chin. This is another species that occurs in the northern Gulf of Mexico only as a straggler.

Scarus croicensis Bloch, STRIPED PARROTFISH (CHART 56).—The striped parrotfish was recorded at the East Pass jetties during 1968 and 1970 but always on the basis of just a few juveniles. One (about 75 mm SL) was seen in August, 1968, and about four (one measured 53.7 mm) were seen during September, 1968. Several were also seen in November. No others were seen until July, 1970, when one juvenile was seen on two separate dates. It was recorded at the St. Andrew jetties in August, 1967 (2 specimens 18.0 and 19.6 mm), October, 1968 (2 specimens—56.4 and 64.3 mm), and in August and October, 1971,

when it was common. Twenty-one collected with rotenone in October measured 34.2-80.6 mm SL (mean—58.0 mm). Allison (1961) collected five (16.0-42.0 mm) there in July, 1959.

Apparently *Scarus croicensis* is not a permanent resident in most of the northern gulf but a straggler from more tropical areas. Schultz (1958) listed the type locality of *S. bollmani* and *S. evermanni* (=*S. croicensis*) as the snapper banks off Pensacola, but actually the type specimens of these two nominal species came from the stomachs of *Epinephelus morio* from off Tampa Bay (Jordan and Evermann 1887, 1898). Smith (1975, 1976) recorded it at depths of 12-36 m off Tampa Bay, and it is quite common on the Florida Middle Ground reefs (Smith *et al.* 1975). It is rare in other parts of the northern gulf.

Sparisoma aurofrenatum Valenciennes, REDBAND PARROTFISH.—One juvenile (83.4 mm SL) of this species was collected at the St. Andrew jetties 19 October 1971. It is rare in the northern gulf, although Smith *et al.* (1975) reported it at the Florida Middle Ground, and Cashman (1973) reported two juveniles collected at the West Flower Garden reef off Texas.

Sparisoma chrysopterum (Bloch and Schneider), REDTAIL PARROTFISH.—One juvenile redtail parrotfish (82.5 mm SL) was collected at the East Pass jetties on 26 October 1970. Four (39.5, 51.8, 53.4, and 135.5 mm) were collected at the St. Andrew jetties on 13 October 1970. Allison (1961) collected 13 juveniles (28.6-83.5 mm) at the jetties on 25 October 1958 and two (44.0-48.6 mm) on 22 July 1959. He also collected three other juveniles (49.5, 49.6, and 65.7 mm) within St. Andrew Bay in July, 1959. One additonal specimen (70.6 mm) in the Florida State University fish collection was taken at the St. Andrew jetties on 11 October 1958. Obviously this parrotfish is present in the northern gulf irregularly and is a straggler from more tropical regions.

Sparisoma radians (Valenciennes), BUCKTOOTH PARROTFISH.—This parrotfish was recorded at the East Pass jetties only in 1970 when it was present from July to December. It was collected on 9 July (2 specimens—31.6 and 58.4 mm SL), 14 September (one—104.0 mm), and on 26 October (2 specimens—44.8 and 102.0 mm). It was recorded at the St. Andrew jetties in every year of the study and was usually present from July to October. Allison (1961) collected 116 specimens at the St. Andrew jetties from June to October during 1958 and 1959 and believed that it was the most common parrotfish in the St. Andrew Bay area. My observations indicate that *Nicholsina usta* is usually more numerous.

Although occasionally common at St. Andrew Bay, *Sparisoma radians* may not be a permanent resident of the northern Gulf of Mexico, as those collected early in the year (June) were small individuals (less

than 60 mm SL). It is apparently never recorded in most coastal areas of the northern gulf. Smith *et al.* (1975) reported it as rare at the Florida Middle Ground. The author collected three (43.3, 94.0, and 102.6 mm SL) in grass beds at the mouth of Alligator Harbor, Florida, in October, 1970, along with several *Nicholsina usta* and *Sparisoma rubripinne.* These were the first scarids collected in that area, despite extensive collecting by personnel from Florida State University since 1949. It is also rare in the northwestern gulf (Leary 1956; Springer and Hoese 1958).

Sparisoma rubripinne (Valenciennes), REDFIN PARROTFISH.—One juvenile *Sparisoma rubripinne* (45.9 mm SL) was collected at the East Pass jetties in July, 1970, and three (58.2, 79.0, 129.2 mm) were collected there in October, 1970. The species was collected once at the St. Andrew jetties in this study, in October, 1970, when four juveniles (47.4-56.6 mm) and three adults (102.2-128.4 mm) were collected with rotenone. Allison (1961) collected one (37.6 mm) in October, 1958, and several in July, August, and September, 1959 (14 specimens, 35.5-108.9 mm SL). As noted above, the species was also recorded at Alligator Harbor, Florida, in October, 1970. The absence of published records of this species in the northern Gulf of Mexico indicates that it is a straggler from more tropical areas where it is common (Randall 1968). Its occurrence at three separate locations (East Pass, St. Andrew Bay, and Alligator Harbor) in 1970 indicates that a large number of larvae must have been carried into the northern gulf that year.

Sparisoma viride (Bonateere), STOPLIGHT PARROTFISH.—One juvenile of this species (34.1 mm SL) was collected at the St. Andrew jetties on 23 October 1969. Allison (1961) also collected one juvenile (47.6 mm) there on 22 July 1959 but listed it as *S. abildgaardi.* No other records are known in the eastern Gulf of Mexico north of the Tortugas, so the species must be rare in the areas, despite the distribution ("including the Gulf of Mexico") given by Böhlke and Chaplin (1969). Cashman (1973) reported one specimen (92 mm SL) collected at the West Flower Garden reef off Texas and noted several sight records of adults there. Permanent populations may exist there, but it appears to be a straggler in other parts of the northern gulf.

MUGILIDAE

Mugil cephalus Linnaeus, STRIPED MULLET (CHART 57).—The striped mullet was present irregularly at the East Pass jetties, but was nearly always present within the lagoons on each side of the pass. Most adults apparently leave the area during the winter but some may remain inshore throughout the year. They apparently move offshore in the fall to spawn (Gunter 1945; Anderson 1958; Arnold and Thompson 1958), and then small juveniles move inshore from about November to

January. Juveniles less than about 25 mm SL were recorded at East Pass in December, February, and March. Adults were usually not common during December, but large dense schools of adults, which were possibly congregating to spawn, were seen at the jetties in December, 1968.

The species was recorded at the St. Andrew jetties most of the year, but adults were most numerous from about April through December. Small juveniles were most common in December.

The striped mullet is an abundant, free-swimming fish in the coastal waters of the northern Gulf of Mexico. Those seen at the jetties were usually swimming in open water some distance from the jetties. However, individuals were occasionally seen feeding by scraping material from the jetty rocks.

Mugil curema Valenciennes, WHITE MULLET (CHART 58).—The white mullet was occasionally common at the East Pass jetties, but was recorded only irregularly in 1968 and 1969 and was not seen during 1970. It was recorded from July to October in 1968 and from May to August in 1969. Small juveniles were collected in May, June, and July. At the St. Andrew jetties, the white mullet was recorded infrequently between April and August. It is uncommon in most of the northern Gulf of Mexico, and only juveniles are commonly recorded in most places (Gunter 1945; Springer and Woodburn 1960), although in some years it may become quite numerous in the northern gulf (Moore 1975).

SPHYRAENIDAE

Sphyraena barracuda (Walbaum), GREAT BARRACUDA.—A single great barracuda (about one m SL) was seen at the south end of the west jetty at East Pass on successive dives on 6 and 24 August 1970. One juvenile (27.5 mm SL) was collected at the St. Andrew jetties on 11 August 1967 and one adult (about one m SL) was seen in July 1970 at a wreck off the beach about 100 m west of the jetties. No others were recorded at the jetties during this study, but other divers have reported seeing the species there.

Barracuda were quite numerous during the warmer months under the Stage I and II platforms off Panama City, and some were usually present at Stage I through the winter (Hastings *et al.* 1976). The species was never seen on the natural reefs during this study, or in that of Springer and Woodburn (1960:99).

Sphyraena borealis DeKay, NORTHERN SENNET (CHART 59).—Juveniles were common at the East Pass jetties in the first observation of this study (9 June 1968) but were not seen subsequently during 1968. Small numbers of juveniles (41.4-54.5 mm SL) were recorded between March and July, 1969, and two about 150 mm SL were seen in

July. During 1970, juveniles (about 20-50 mm SL) were present from April through June, and large schools of adults (one measured 245 mm SL) were present in August and September at the seaward ends of both jetties. Juveniles (five collected were 39.4-79.0 mm SL) were recorded at the St. Andrew jetties during April and May of 1968, 1970, and 1971. Allison (1961) collected juveniles there in July and August, 1969. The species was not recorded on the offshore reefs during this study.

BLENNIIDAE

Blennius marmoreus Poey, SEAWEED BLENNY (CHART 60).—The seaweed blenny was not recorded at the East Pass jetties during 1968 and only one (67.6 mm SL) was seen in 1969 (on 3 November at a temperature of 24°C). In 1970 the species was present from June through November and was common during September and October. Only one adult was seen in late November and none was recorded subsequently. The species was recorded from late April to December at the St. Andrew jetties and was usually common during the summer and fall. Adults were present in April and May, indicating that some may remain on the jetties through the winter. Blennies are rather sedentary fish and seasonal migratory movement between the offshore reefs and the jetties seems improbable.

This is the common blenny on the natural reefs off northwest Florida, where it is a permanent resident and common through the winter. Jordan and Gilbert (1883) reported specimens (as *Blennius stearnsi*) from the stomachs of snappers taken off Pensacola. It is apparently widely distributed in the Gulf of Mexico (Briggs *et al.* 1964; Moe and Martin 1965; Causey 1969; Powell *et al.* 1972), and may be restricted only by the presence of suitable rocky habitat.

Hypleurochilus bermudensis Beebe and Tee-Van, BARRED BLENNY.—One small adult of this species (27.0 mm SL) was collected on 18 May 1971 at the St. Andrew jetties. This is apparently only the second specimen collected in the northeastern Gulf of Mexico. Randall (1966) reported one specimen (22.2 mm SL) collected at the "jetties at Panama City" in October, 1956, by the staff of the Gulfarium at Ft. Walton Beach. One other individual, which was probably this species based upon its distinctive color pattern), was seen at the St. Andrew jetties on 10 May 1968. Cashman (1973) reported one specimen collected at the West Flower Garden Reef off Texas.

The species is apparently rare in the Gulf of Mexico, but it is also uncommon over its entire range (Randall 1966), and its benthic habits and association with rocky substrates may have prevented its collection.

Hypleurochilus geminatus (Wood), CRESTED BLENNY (CHART 61).—The crested blenny was one of the most common species on the East Pass jetties during this study, and was the third most numerous species counted in 1970 (Tables 2-4). In the first dive on the jetties on 9 June 1968, only one adult was seen, but on the next dive on 27 June, juveniles and small adults were common. Subsequently the species was listed as either common or abundant from April through October and some were usually seen in other months. Some movement to deep water in the winter may occur, but many apparently remain on the jetties through the winter and become inactive. Moderate numbers were collected with rotenone in the winter and some could usually be revealed by turning over rocks, even when superficial examination failed to reveal the species.

The crested blenny was also a common species at the St. Andrew jetties, but it was less numerous than at East Pass. Rotenone collections at East Pass in September and October usually yielded several hundred specimens, while similar operations at the St. Andrew jetties netted less than a hundred. The species was present throughout the year, but was less numerous during the winter. As noted for East Pass, large numbers were observed early in the spring so the apparent scarcity of crested blennies during the colder months may result from inactivity and concealment of these cryptic fishes.

Although usually present on the pilings of the platforms off Panama City, this blenny was not observed on the natural reefs offshore during this study, but it might be expected in such habitats. Springer and Woodburn (1960) and Clark (1959) recorded the species on reefs off Tampa Bay and Causey (1969) recorded it on a reef off Texas. Most records, however, have been from shallow water where the species is said to inhabit wharf and bridge pilings and rocks of breakwaters (Hildebrand and Cable 1938). Jordan and Evermann (1898) described it as "abundant in empty shells and clusters of tunicates," but it seems to be especially adaptable to artificial reef habitats. Its abundance in areas such as East Pass and St. Andrew Bay has been greatly increased by the construction of such habitats. It probably provides an important source of food to larger piscivorous fishes that also inhabit these artificial reefs.

Hypsoblennius bentzi (Lesueur), FEATHER BLENNY (CHART 62).—Small numbers of adult *Hypsoblennius bentzi* were recorded at the East Pass jetties. The species was present early in the study (July, 1968) but never became established as an important part of the fauna. Four specimens collected were 38.0, 50.2, 77.5, and 82.8 mm SL. Three were collected at the St. Andrew jetties: two on 10 May 1968 (63.3 and 78.9 mm) and one on 21 May 1970 (66.8 mm). The absence of juveniles on the jetties, even in rotenone collections, indicates that those present arrived as adults, possibly as strays from other habitats.

GOBIIDAE

Bathygobius soporator (Valenciennes), FRILLFIN GOBY (CHART 63).—The frillfin goby was not recorded at East Pass during 1968, but in 1969 one adult (52.4 mm SL) was collected on 14 November and two adults were seen on 12 December. It was present from July to November 1970 and was more numerous but never common. Except for one juvenile (11.5 mm SL) collected in July, those seen in 1970 were all adults (32.2-53.7 mm). The maximum number seen on any date was five, recorded on 5 September 1970. The species was not recorded at the St. Andrew jetties during this study and Allison (1961) failed to collect it in St. Andrew Bay.

Coryphopterus punctipectophorus Springer, SPOTTED GOBY.—A single adult spotted goby was collected at the St. Andrew jetties on 24 October 1972 by Ralph W. Yerger. The species is quite common on the natural reefs offshore of northwest Florida but rarely appears inshore. Causey (1969) also recorded it on a reef off the Texas coast.

Gobionellus boleosoma (Jordan and Gilbert), DARTER GOBY (CHART 64).—Single adult darter gobies were collected at the East Pass jetties on 31 March (23.8 mm SL) and 23 July 1970 (25.5 mm). In addition small prejuveniles that were tentatively identified as this species were collected on 27 February 1970 (9.3 mm), 23 July 1970 (8.0 mm), and 21 November 1970 (9.2 and 9.5 mm). Meristics used to identify these also fit *Evorthodus lyricus*, but this species was never recorded on the jetties, although one adult was collected in the west lagoon at East Pass in September, 1970. The prejuveniles also had a single distinct pigment spot on the ventral side of the caudal peduncle. *Gobionellus boleosoma* was usually common in the west lagoon, but records from that location are not shown in Chart 64. Single adults were collected at the St. Andrew jetties in October, 1969 and 1970.

Gobiosoma longipala Ginsburg, TWOSCALE GOBY (CHART 65).—*Gobiosoma longipala* was occasionally common at the East Pass jetties, but it is small and secretive, usually remaining hidden in depressions under rocks or other objects, so it may have been more numerous than the records in Chart 65 indicate. It is a permanent resident of the deeper waters in the channel at East Pass (where 4 adults were collected in February, 1969) and was also recorded in the lagoons on the east side of the pass. These records and its occurrence at the jetties as early as June, 1968, indicate that it was already a characteristic member of the East Pass fauna prior to the construction of the jetties. The jetties have apparently increased the suitable habitat for the species, and thus may have increased its numbers at East Pass. Single adults were collected on 23 October 1969 and on 4 April 1970 at the St. Andrew jetties.

ACANTHURIDAE

Acanthurus chirurgus (Bloch), DOCTORFISH (CHART 66).—*Acanthurus chirurgus* was present at the East Pass jetties from July through November in 1968, from May through November in 1969, and from August through December in 1970. It was common during most of this time, but only two juveniles were present in May, 1969, and in December, 1970, several juveniles and adults were present on the first and only one individual (75.3 mm SL) was seen on the 26th. The water temperature on the latter date was 13°C. The species was first recorded inshore at temperatures of 28°C (July, 1968), 26°C (May, 1969), and 31°C (August, 1970), so apparently the inshore movement of these fish lags behind the warming of inshore waters to temperatures suitable for the species. However, the early arrival of doctorfish at the jetties in 1969 may have resulted from the rather mild temperatures during the winter of 1968-69. Possibly the distance that such fish move offshore is determined by temperature. The milder temperatures may have caused them to move only a short distance offshore, and they required a shorter time to make the migration back inshore in the spring. Temperatures in the fall when the species was last considered common were 24°C (November, 1968 and 1969) and 22°C (November, 1970).

Acanthurus chirurgus was recorded at the St. Andrew jetties from May through December, but the greatest numbers were seen from about June or July through October and November. The species was also recorded there by Allison (1961) and Caldwell and Briggs (1957).

No acanthurids were seen on the offshore reefs during this study, but the reefs that were observed were devoid of extensive plant growth that could support surgeonfishes. *Acanthurus chirurgus* (as well as *A. randalli*) are permanent residents of the northern Gulf of Mexico (since advanced juveniles and adults occur inshore early in the summer) so some of the offshore reefs must be suitable habitat. The species is widely distributed in the gulf but has not been collected often (Briggs *et al.* 1964; Haburay *et al.* 1969; Smith *et al.* 1975; Sonnier *et al.* 1976).

Acanthurus coeruleus Bloch and Schneider, BLUE TANG (CHART 67).—*Acanthurus coeruleus* was recorded at the East Pass jetties from August to November 1969, but usually only one or two individuals were seen in a single day. One was seen on 1 October 1970. Two were seen on 23 October 1969 and also on 13 October 1970 at the St. Andrew jetties. Caldwell and Briggs (1957) collected one (56 mm SL) there on 30 July 1956 and Allison (1961) collected one on 22 July 1959 and two on 22 August 1959. Most of those recorded during this study were juveniles (in the bright yellow phase), but a few in the blue phase and possibly approaching adulthood were seen in October and November, 1959. This is the least common of the three species of surgeonfishes in the northern Gulf of Mexico and is not a permanent resident. It is car-

ried into the northern gulf in its pelagic "acronurus" larval stage. Springer and Woodburn (1960) also reported juveniles off Tampa Bay at depths of 12-18 m from September through December, but it is apparently rare in that area (Smith 1976). Those recorded may also be strays from more southern areas. Cashman (1973) reported two adults (135 and 143 mm SL) from the West Flower Garden Reef off Texas so the species could be a permanent resident at that unique locality.

Acanthurus randalli Briggs and Caldwell, GULF SURGEONFISH (CHART 68).—The occurrence of *Acanthurus randalli* at East Pass was quite similar to that of *A. chirurgus* and the two species commonly schooled together. Both species were most numerous from August to November, but both arrived early (in May) in 1969 and remained through December in 1970. *Acanthurus randalli* was generally less numerous than *A. chirurgus*. One small juvenile *A. randalli* was recorded in May, 1970, but no others were seen until August. The species was also recorded at the St. Andrew jetties from May to December, but it was most common from July or August through October. Allison (1961) collected it from May to October in 1958 and 1959 and found it more numerous than *A. chirurgus*. He collected 45 *A. randalli* and only 18 *A. chirurgus*. Briggs and Caldwell (1957) (also Caldwell and Briggs 1957) had more *A. randalli* (18) than *chirurgus* (5) in one collection taken in July, 1956.

Acanthurus randalli may be endemic to the northeastern Gulf of Mexico (Briggs and Caldwell 1957), but its occurrence pattern on the natural reef habitats of the area is not known. It was not observed on the offshore reefs during this study, but permanent populations must exist on some of the deeper water reefs, possibly at depths greater than those studied during this project. Caldwell (1959) reported one specimen from off Destin, Florida, and Moe *et al.* (1966) listed one specimen taken in 1960 off Okaloosa County. They also listed a collection of *A. bahianus* (FSBC 1802) with the same data, but this collection was apparently taken in the Florida Keys (Powell *et al.* 1972). C. Richard Robins (pers. comm.) has recently found that *A randalli* occurs occasionally as far south as Dade County, Florida. However, Gregory B. Smith (pers. comm.) failed to record either *A. randalli* or *A. bahianus* off the west coast of peninsular Florida. Cashman (1973) and Sonnier *et al.* (1976) noted sight records of *A. bahianus* at the reefs off Texas and Louisiana and it seems possible that these could be *A. randalli*. Bullis and Thompson (1965) reported one collection of *A. randalli* from Serrana Bank in the Caribbean Sea, but this is most likely a misidentification.

Acanthurus randalli is a striking exception to the generalization that species of surgeonfishes are relatively wide-ranging (Böhlke and Chaplin 1968), as a result of the long pelagic stage, the "acronurus." There must be some limit to the transport of *A. bahianus* into the

northern gulf and to the movement of *A. randalli* out of the gulf, but such a situation does not seem plausible in view of the numerous other species that are transported into this area.

SCOMBRIDAE

Euthynnus alletteratus (Rafinesque), LITTLE TUNNY (CHART 69).—*Euthynnus alletteratus* were recorded at the East Pass jetties primarily from July through September, but several were also seen in June, October, and December during 1970. Little tunny were recorded at the St. Andrew jetties from May to December and were commonly caught by anglers on the jetties. Groups were occasionally seen feeding on bait fish schools near the jetties. The species is caught by sport fishermen throughout the year offshore of northwest Florida but occurs inshore only during the warmer months.

Scomberomorus maculatus (Mitchill), SPANISH MACKEREL (CHART 70).—The Spanish mackerel is common inshore along the northwest Florida coast during the spring, summer, and fall, but its occurrence at the East Pass jetties reveals an unusual pattern. It was not seen at the jetties during 1968, and in 1969 it was observed only during April and May when fairly large schools of adults were seen swimming near the jetties. In 1970 the species was present during March, April, and May, corresponding to the period when it was present in 1969, and during September, October, and November, when large schools were again seen near the jetties. The Spanish mackerel is a migratory species and populations in the eastern Gulf of Mexico spend the winter in the area around the Florida Keys, then migrate northward along the coast in the spring (Klima 1959). The two periods of occurrence at East Pass correspond to the times of its arrival in the spring and its departure in the fall. After their arrival in the northern gulf, the schools of Spanish mackerel become more scattered (Reid 1954) and may move into the estuaries. The schools re-form in preparation for the southward migration in November or December. A similar pattern of occurrence was observed in *Caranx hippos,* and possibly also *Elops saurus,* which have similar migratory patterns.

Observations of the Spanish mackerel at the St. Andrew jetties were less numerous but correspond to the pattern observed at East Pass. In 1970 the species was common during April and May and one was collected in December.

STROMATEIDAE

Peprilus burti Fowler, GULF BUTTERFISH (CHART 71).—The Gulf butterfish was not recorded at the East Pass jetties during 1968 and only once in 1969, when three adults were seen on 3 November near a large school of *Leiostomus xanthurus* that were apparently spawning.

Although the *Peprilus* remained near the school of *Leiostomus,* no direct interaction was observed and the significance of the association is not known. In 1970 groups of small juveniles were observed on four occasions, in February, April, November, and December. Most were seen associated with jellyfishes drifting near the jetties, but two seen in December were associated with an isolated rock about 6 m from the jetty.

At the St. Andrew jetties, small juveniles were seen in May, 1970, associated with a jellyfish, and small adults about 10 cm long were seen in May, 1971, swimming with a school of *Decapterus punctatus.* Juveniles were also seen associated with small jellyfish and ctenophores near the water surface at Warsaw Hole off Panama City in February and March, 1971.

SCORPAENIDAE

Scorpaena brasiliensis Cuvier, BARBFISH (CHART 72).—The barbfish was recorded irregularly at the East Pass jetties, but its cryptic coloration and habits often conceal it from detection, so it may have been more numerous at times. One juvenile (94.3 mm SL) was collected on 12 September 1968. The species was somewhat more numerous in 1969. Seven juveniles (26.8-47.5 mm SL) were collected with rotenone on 1 March, one juvenile (45.6 mm) was collected on 10 July, and one juvenile (36.7 mm) was collected on 11 September. Then on 27 September six large adults (155-200 mm SL) were seen in a small area in the midpart of the west jetty on the gulf side. All were conspicuously resting on the surfaces of rocks, behavior atypical for this species. The significance of this behavior is not known. One adult (200 mm) was collected on 28 November. In 1970 one adult was seen on 1 October, one juvenile (56.6 mm) on 26 October, and one adult on 9 November 1970. The species was recorded with about equal frequency between April and October at the St. Andrew jetties. It was not seen on the offshore reefs during this study but it does occur there. Eschmeyer (1965) listed several collections from offshore in the Gulf of Mexico.

BOTHIDAE

Paralichthys albigutta Jordan and Gilbert, GULF FLOUNDER (CHART 73).—Single juvenile or small adult gulf flounders were recorded at the East Pass jetties in June, August, and September, 1968. The species was recorded more frequently in 1969 from March through November but only one or a few individuals were ever observed. Most were juveniles or small adults. In 1970 the species was present from May through November and large adults (up to 419 mm SL) were often seen in September, October, and November. One larval *Paralichthys* that was possibly this species was collected on 3 April 1970.

Paralichthys albigutta was recorded at the St. Andrew jetties from April through October. It is most common a short distance offshore in the gulf and was often seen in the vicinity of the natural reefs. Spear fishermen in the area take large numbers of large flounders throughout the year. A large female (435 mm SL) was collected at Warsaw Hole off St. Andrew Bay in February, 1971.

Paralichthys albigutta was the flounder most often observed in this study and was the only species that was consistently present near the jetties or offshore reefs. It shows some attraction to reef structures, as individuals were occasionally seen among the jetty rocks or actually on the surface of rocks.

BALISTIDAE

Balistes capriscus Gmelin, GRAY TRIGGERFISH (CHART 74).—The gray triggerfish was most numerous at the East Pass jettties in 1968, and was present from the first observations in June through October. It was considerably less numerous in 1969, when only one or two individuals were seen in May, August, September, and October. It was not recorded at East Pass during 1970.

The species was often common at the St. Andrew jetties between May and October, but the numbers present fluctuated considerably, indicating that individuals were frequently moving into and out of the area. Several were observed there in 1970, even though none was seen at East Pass that year. One large adult was seen on the submerged bulkhead in the St. Andrew channel on 30 January 1971 (temperature 13°C), but no others were recorded inshore during the winter months.

Balistes capriscus was usually common and present throughout the year near the offshore reefs. Large numbers were often seen swimming in midwater and near the water surface above these reefs. The species is widely distributed in the Gulf of Mexico and is occasionally taken inshore in most parts of the gulf.

Balistes vetula Linnaeus, QUEEN TRIGGERFISH.—One juvenile *Balistes vetula* (112 mm SL) was collected on 9 August 1968 and one individual (about 250 mm) was seen on 5 September 1970 at the East Pass jetties. No others were seen during this study, either at the St. Andrew jetties or on the offshore reefs. It is not common in the Gulf of Mexico but has been collected at several localities; some may be present throughout the year on the offshore reefs (Baughman 1950b; Springer and Bullis 1956; Moseley 1966a; Cashman 1973). It is the common triggerfish in the coral reef areas of the West Indies and occurs only as a stray in the northern gulf.

Cantherhines pullus (Ranzani), ORANGESPOTTED FILEFISH (CHART 75).—Adult *Cantherhines pullus* (102-109 mm SL) were recorded at the

East Pass jetties from June through October, 1968, and from August through October, 1970. None was seen during 1969. Usually only one or two individuals were seen on one date, but several were present in June and August, 1968, and in September, 1970. At the St. Andrew jetties, two were collected in July, 1968, and one was seen in July, 1971. It was not recorded offshore during this study, but it has been recorded occasionally offshore in the gulf (Berry and Vogele 1961; Bullis and Thompson 1965; Cushman 1973). Dawson (1962) recorded three juveniles dipnetted from floating *Sargassum* off the coast of Mississippi in August and September. Baughman (1950b) listed one specimen from off the coast of Texas, but Hoese (1958) indicated that this identification was incorrect.

Monacanthus hispidus (Linnaeus), PLANEHEAD FILEFISH (CHART 76).—Juvenile *Monacanthus hispidus* (up to 120 mm SL) were present at the East Pass jetties from June to September in 1968 and were considered common in July. The species was rare during 1969, but a few were seen from July to October. It was considerably more numerous in 1970, was considered common during much of the period from June to December, and was abundant in August. Small adults up to about 140 mm SL were observed from September to December. On 8 June 1970, 11 juveniles (9.2-11.9 mm) were collected under a paper cup drifting near the south end of the west jetty, in company with two juvenile *Chloroscombrus chrysurus* and two juvenile *Trachurus lathami*. On 21 November, five juveniles (10.0-12.4 mm) were collected as they drifted at the water surface near the west jetty.

Juvenile or small adult *Monacanthus hispidus* were usually present from about May through October on the St. Andrew jetties, and large adults were often seen on the submerged bulkhead in the channel. Several adults (two measured 191 and 209 mm SL) were seen there in January, 1971, at a temperature of 13°C.

Large adults were also seen at times near the natural offshore reefs and also near the Navy platforms off Panama City. These offshore reefs are the usual habitat of such large filefishes, which are rarely collected inshore. In contrast, small juveniles are commonly collected in inshore grassbed habitats. As individuals mature, they show more attraction to reef structures, and large adults may be restricted to such habitats.

OSTRACIIDAE

Lactophrys quadricornis (Linnaeus), SCRAWLED COWFISH (CHART 77).—Tyler (1965a, b) used the family name Ostraciontidae and recognized the genus *Acanthostracion* to classify the cowfishes as distinct from the trunkfishes (*Lactophrys*). Terminology used here follows Bailey *et al.* (1970).

Cowfish were never common at the East Pass jetties, but one or a few were recorded rather irregularly throughout most of the year. Most were seen from August to November. Those seen on the jetties were adults except for one juvenile (about 75 mm long) seen on 1 December 1970. The cowfish was recorded from March through December on the St. Andrew jetties and usually only one or a few adults were present. On 30 January 1971 one or two adults were seen on the submerged bulkhead in the channel at the St. Andrew Pass (temperature 13°C). The species was recorded in the months of January, February, May, and September on offshore reefs. It is present in such areas throughout the year, but again only one or a few adults were seen on any date.

DIODONTIDAE

Chilomycterus schoepfi (Walbaum) STRIPED BURRFISH (CHART 78).—Several adult *Chilomycterus schoepfi* were present at the East Pass jetties at the time of the first dive in June, 1968, and the species was present continuously through the first part of March, 1969. The mild temperatures during the winter of 1968-69 may be correlated with the occurrence of *Chilomycterus* inshore in that period. The species was not seen from late March through early May and could have moved offshore to spawn (Reid 1954; Springer and Woodburn 1960). The species reappeared in May, 1969, and was present through the first part of November. It was not observed during the winter of 1969-70 but was again present in late April, 1970, and subsequently was recorded on almost every dive through the end of the year. In additon on 12 January 1971 many adults were present (42 were counted) between Plot II and the south end of the jetty (temperature 13-14°C). The species was often recorded at the St. Andrew jetties between April and December, and one adult was seen on the submerged bulkhead in the channel in February, 1971. None was seen on the natural offshore reefs during this study, but small numbers were occasionally seen near the Navy platforms off St. Andrew Bay.

DISCUSSION

As indicated previously 204 species have been recorded at the two jetties (Table 1): 143 species at the East Pass jetties and 180 species at the St. Andrew jetties. This species list forms the basis for the following discussion.

ORIGIN OF THE JETTY FISH FAUNA

ORIGINAL RESIDENTS OF THE AREA

Although the coastal area at East Pass is a relatively unproductive

area biologically, a few species of fishes are characteristic of such sandy beach environments, and many pelagic species frequent such areas. In addition to these, many fishes that inhabit estuaries often move through the pass and could be expected to be common at times along the outer beach. Fishes of these three groups were already present in the area prior to the construction of the jetties, but some exhibit some attraction for reef structures and thus were the earliest colonizers of this new habitat.

Although not studied prior to jetty construction, the general nature of this original fish fauna can be described on the basis of sand beach studies in other areas of the gulf (Gunter 1959; Springer and Woodburn 1960; McFarland 1963) and the subjective but usually reliable observations of professional fishermen in the area. Numerically dominant species recorded by both Springer and Woodburn (1960) and McFarland (1963) are *Harengula pensacolae, Menidia beryllina, Trachinotus carolinus, Leiostomus xanthurus, Menticirrhus littoralis, Lagodon rhomboides,* and *Mugil cephalus.* Of these, *Harengula pensacolae, Leiostomus xanthurus,* and *Lagodon rhomboides* were abundant at East Pass and were commonly seen on the East Pass jetties in the earliest part of the study. In contrast, *Menidia beryllina, Trachinotus carolinus,* and *Mugil cephalus* were also abundant at East Pass but did not seem to be attracted to the jetties. *Menticirrhus littoralis* and two other species considered abundant by Springer and Woodburn (1960), *Strongylura timucu* and *Trachinotus falcatus,* were not recorded at East Pass, although unidentified species of *Strongylura* were occasionally seen near the jetties. Other dominant species recorded by McFarland (1963) are *Polydactylus octonemus, Chloroscombrus chrysurus,* and *Conodon nobilis,* which were either rare or unrecorded at East Pass.

Of the other sand beach inhabitants listed in either or both of these papers, *Sardinella anchovia, Oligoplites saurus, Lutjanus griseus, Archosargus probatocephalus, Bairdiella chrysura, Chaetodipterus faber, Scomberomorus maculatus, Paralichthys albigutta,* and *Chilomycterus schoepfi* were attracted to the jetty habitat and became more numerous there than in surrounding waters. Other species recorded at East Pass in the study but not attracted to the jetties were *Dasyatis sabina, Elops saurus, Brevoortia patronus, Synodus foetens, Arius felis, Caranx hippos, Eucinostomus gula, Menticirrhus focaliger, Mugil curema, Astroscopus y-graecum, Scomberomorus cavalla, Prionotus tribulus, Aluterus schoepfi,* and *Sphoeroides nephelus.*

Additional demersal species that were commonly seen at East Pass early in the study and thus may have been original residents of the area are *Hemipteronotus novacula, Centropristis philadelphica,*

Diplectrum formosum, Serraniculus pumilio, and *Gobiosoma longipala.* These fishes were associated with the jetties and may have an affinity for reef structures, although they are also widely distributed in sandy areas where shell hash and other objects provide shelter.

Several additional pelagic species not listed by Springer and Woodburn (1960) nor McFarland (1963) are characteristic of coastal areas of northwest Florida and should also be considered as early colonizers of the jetties. Some of these species may be more common along the northwest Florida coast than in other coastal areas of the gulf because of the clear, high-salinity, oceanic water characteristic of this area. This group includes *Anchoa lyolepis, Pomatomus saltatrix, Caranx crysos, Decapterus punctatus, Kyphosus sectatrix, Sphyraena borealis,* and *Euthynnus alleteratus.* Of these, *Caranx crysos, Decapterus punctatus,* and *Kyphosus sectatrix* were most attracted to the reef structure and were common on the jetty early in the study. *Sphyraena borealis* also was common at the time of the first observation on the jetties in June, 1968, but was not seen again during that year. *Balistes capriscus* and *Cantherhines pullus* were also present early in the study.

Four additional early colonizers, *Orthopristis chrysoptera, Nicholsina usta, Monacanthus hispidus,* and *Lactophrys quadricornis,* are common species in estuaries of the northwest Florida area, and are most closely associated with grassbeds, although they also show some attention to reef habitats. The jetties offered rich food supplies as well as shelter for these species, and they soon became common at this new habitat.

The species discussed thus far were present at East Pass prior to the construction of the jetties and thus are not dependent upon reef habitats. Many of these are never associated with reef structures and consequently have not been directly affected by the jetties. However, some have shown an attraction to the jetties and have become quite numerous there. The increased food supply present may have contributed to an increase in the population size of some of these species at East Pass.

Reef Fish Component

Another important group of colonizers are those typical of reef habitats that arrived in the areas as pelagic eggs, larvae, or juveniles, or as occasional stray adults from nearby reef habitats. The large number of recruits of some of these species, as well as their consistent seasonal occurrence, indicates that they are permanent residents of the natural reefs offshore in the northern gulf. Direct observations on the

offshore reefs have confirmed this theory for some of the species. The most important of these typical reef inhabitants are *Halichoeres bivittatus* and *Hypleurochilus geminatus*. Both species were present during the early part of the study, but in small numbers. A few adult *Halichoeres* were seen during June, 1968, but the species was not common until after the appearance of numerous small juveniles in July and August. *Hypleurochilus geminatus* was common in June and July, 1968, but only juveniles were present and adults had not colonized the jetties. Subsequently, these two species became two of the three dominant demersal fishes on the jetties. Additional residents of the offshore reefs that established populations at the jetties are *Serranus subligarius, Diplodus, holbrooki, Chaetodon ocellatus, Pomacentrus variabilis, Acanthurus chirurgus,* and *Acanthurus randalli.* In general, these species did not become numerous until late in the summer or fall (August to October) but eventually became important components of the jetty fauna. Additional immigrants from these offshore reefs did not become established in 1968 and are discussed in the section below on successional changes.

Additional Sources of Recruitment

Continued recruitment of new species to the jetties originated from several sources. Common estuarine species occasionally stray into the area, and many must necessarily pass the jetties during their fall exodus from shallow water and in their spring immigration. A few species such as *Elops saurus, Caranx hippos, Oligoplites saurus,* and *Scomberomorus maculatus* were most numerous near the jetties in the periods when they first arrived after their spring migrations into the area, and again when they were forming schools to leave in the fall. Other species present along the northwest Florida coast, both pelagic and demersal, should be expected to occur occasionally near the jetties.

Occasional strays from the natural reefs offshore in deeper water occur at times inshore. Examples of these are *Gymnothorax nigromarginatus* (or *G. saxicola*), *Holocentrus ascensionis, Syngnathus springeri,* and *Holacanthus bermudensis.* Several additional species were either rare or absent at East Pass but common at the St. Andrew jetties, possibly because of the greater depths there.

Apparently many pelagic larvae of typical coral reef fishes are commonly carried to the jetty habitats by currents. The fact that these species are almost never common and first appear in the spring or summer only as juveniles indicates that they are not permanent residents of the northern gulf. Observations on the natural reefs offshore to depths of about 30 m in this study have also failed to reveal these species, even in the summer. Such recruitment of tropical species

occurs each year but may vary depending upon the strength and northward penetration of the Loop Current or the average spring and summer temperatures in the northern gulf (Moore 1975). Some species that were usually not common were recorded quite often: *Chaetodon capistratus, Chaetodon striatus, Abudefduf saxitilis, Thalassoma bifasciatum, Scarus croicensis, Sparisoma radians,* and *Acanthurus coeruleus.* Other species are only occasionally recorded in the northern gulf and only in certain favorable years. Thus, 1971 was an especially productive year for tropical species at the St. Andrew jetties, and several rare species were present. Examples of these are *Apogon maculatus, Pomacentrus fuscus, Pomacentrus partitus, Halichoeres radiatus, Scarus coelestinus,* and *Hypleurochilus bermudensis.* The East Pass jetties were not studied during 1971 so some of these species could have been present there also. P. A. Hastings and Bortone (1976) recorded *H. radiatus* (and *H. poeyi*) at the jetties in August, 1974. Additional rare species occasionally recorded in the northern gulf are *Holocentrus vexillarius, Abudefduf taurus, Doratonotus magalepis, Sparisoma chrysopterum, S. rubripinne,* and *S. viride.* Addition of similar rare species to the faunal lists of the northern gulf will undoubtedly continue and all of these species may eventually be recorded at the East Pass jetties.

Unfortunatley, these coral reef stragglers have often been grouped with the northern gulf reef residents discussed in the preceding section and referred to collectively as "tropical" marine fishes (Caldwell 1959, 1963; Dawson 1962, 1963, 1970, 1971, 1972; Haburay *et al.* 1969). Possibly the term "tropical" should be used in a more restricted sense to refer to those fishes that are unable to survive the low winter temperatures of the northern gulf, either inshore or offshore, and must be recruited each spring or summer from spawning populations in more southern waters. In contrast, a number of fishes that are members of typical coral reef families are permanent residents of offshore reefs in the northern gulf, even though they cannot tolerate the colder winter temperatures inshore. This is no justification for calling them "tropical," since most of the typical temperate water fishes of the northern gulf also disappear from inshore waters in the winter, apparently moving offshore to deeper water where temperatures are more stable.

To cite one example, the blue angelfish, *Holacanthus bermudensis,* usually referred to as tropical, and the bank seabass, *Centropristis ocyurus,* usually referred to as subtropical or temperate, have basically the same geographical distribution: from about North Carolina south along the Continental Shelf of the Atlantic coast and the Gulf of Mexico. Both species are rare in the West Indies. In contrast, the queen

angelfish, *Holacanthus ciliaris,* is rare along the coast of North America, even in the most southern parts, but is common in the coral reef areas of the West Indies. Although the queen angelfish could justifiably be referred to as tropical, such fishes may be more properly defined as "insular," in contrast to "continental" (Robins 1971). The situation is confused, however, because many of these northern gulf stragglers require shallow reef habitats, as well as warm temperatures. Possibly depth or other environmental factors prevent such species from inhabiting the natural offshore reefs of the northern gulf.

The latter point is further substantiated by the existence of apparently permanent populations of some species such as *Pomacentrus partitus, Thalassoma bifasciatum,* and *Scarus croicensis* at the Florida Middle Ground Reef (Smith *et al.* 1975; Smith 1976) located at 28°11′ to 28°45′N; 84°00′ to 84°25′W, on the West Florida shelf. Buffered environmental conditions, structural complexity of the reefs, water column productivity, benthic algal productivity, and varying depths (24-48 m) were suggested as contributing to the maintenance of the diverse and abundant Middle Ground fish fauna (Smith *et al.* 1975). A similar situation seems to exist at the Flower Garden Reefs in the western gulf (Cashman 1973). Although some strays along the northwest Florida coast could originate from reefs such as the Middle Ground, the prevailing currents of the eastern gulf (especially the Loop Current) suggest a Caribbean origin.

Successional Changes in the Fish Fauna

Discrete successional changes in community composition were not recorded during this study. There were obvious successional changes, however, in the number of species present on the jetties (Fig. 7). During the first year of the study (1968), the number of species observed on each dive increased from an initial 18 to 20 species in June to an average of about 30, and remained relatively stable between August and the first part of November. The maximum count in this period was 38 species on 6 September. Following a pronounced winter decline in species present (described in the following section), the same general pattern of increase in number of species was evident in 1969 and also in 1970, with the increase beginning in February or March, and continuing to its peak in September or October. Such increase can be attributed to the annual recruitment of species to the jetty habitat following their winter absence. The total number of species recorded during each of the three years of the study have also increased, with 74 recorded in 1968, 94 in 1969, and 110 in 1970. During successive years, the number of species recorded at any particular time of the year (except possibly the winter) has also increased, despite the marked

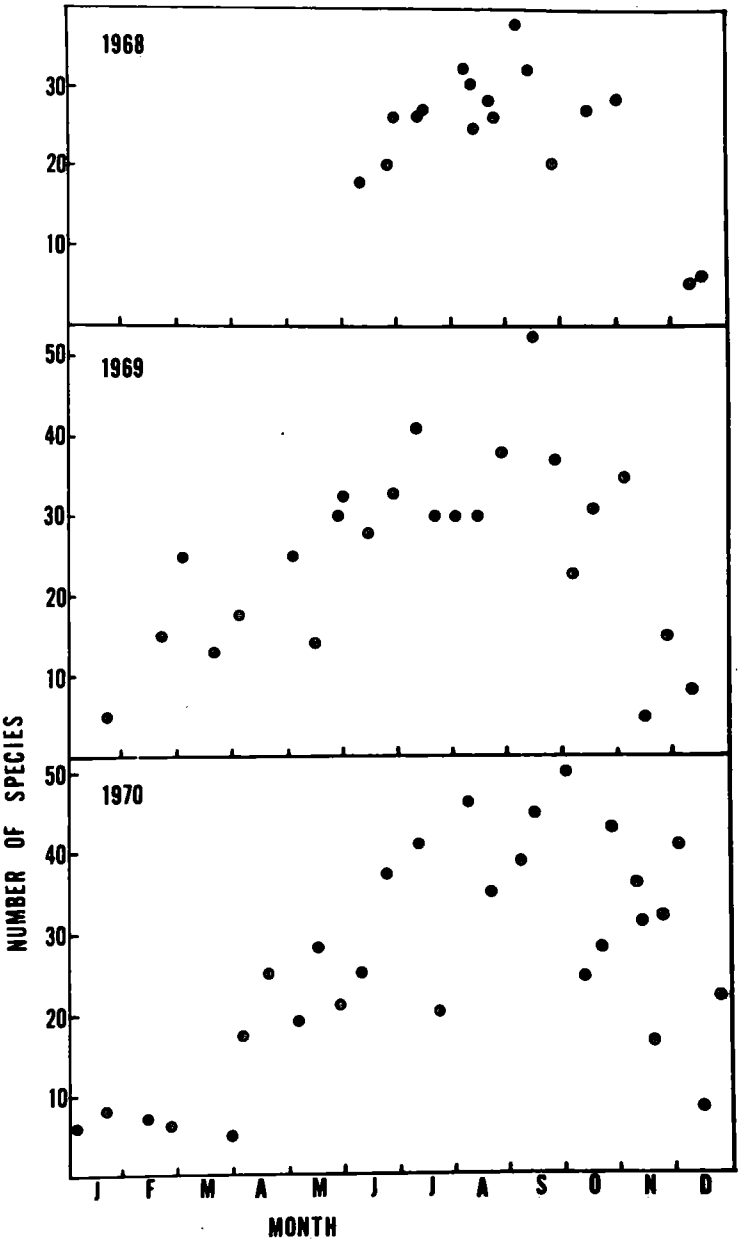

FIGURE 7.—Numbers of species of fishes recorded during observations on the East Pass jetties during 1968, 1969, and 1970.

seasonal changes. Thus, for the month of June, 18 to 20 species were recorded in 1968, 28 to 33 in 1969, and 25 to 37 in 1970. Average counts for the period from July through October are 28 species in 1968, 35 in 1969, and 37 in 1970. Excluding one very low count in 1970, which is obviously erroneous (23 July), the average number for that year is 39.

Species not recorded or rare during 1968 but which became relatively numerous during 1969 and 1970 are *Opsanus beta, Syngnathus springeri, Centropristis melana, Mycteroperca microlepis, Pomatomus saltatrix, Echeneis neucratoides, Caranx ruber, Eucinostomus* sp., *Archosargus probatocephalus, Holacanthus bermudensis, Blennius marmoreus, Bathygobius soporator,* and *Acanthurus coeruleus.* Although this phenomenon can be explained partly by the continued recruitment of new species to the jetties, the situation is somewhat more complex since the pattern was repeated annually even though most of the fishes were absent during the winter. Many species of inshore fishes move offshore to deeper water during the winter and the recruitment of fishes to habitats such as the jetties must be repeated each spring. This recruitment was more and more successful each year, indicating that niches on the habitat were becoming more numerous, and a greater variety of fishes were able to live there. This was possibly because of changes in the diversity and quantity of food sources such as benthic algae and invertebrates.

At least two species (*Opsanus beta* and *Hypleurochilus geminatus*) formed permanent populations on the jetties, and therefore did not have to be recruited in subsequent years. Individuals of some species that became established in 1968, but which moved out to deeper water for the winter, might have been able to "home" back to the jetties in the spring. This is apparently the case with *Serranus subligarius* and *Halichoeres bivittatus,* since they became established late in 1968, but were common early in the spring in 1969 and 1970.

A few species that were common in 1968 were less numerous during subsequent years. This trend was most obvious in *Centropristis philadelphica* and *Balistes capriscus.* The scarcity of *C. philadelphica* in 1969 and 1970 may have resulted from a lack of recruitment from permanent spawning populations in other areas since all those present at the jetties were juveniles. The situation is more complex and difficult to explain in the case of *Balistes capriscus.* Adults of this species were present from June through October and were common in August during 1968. Only a few were seen during 1969 and none during 1970. Its absence during 1970 is especially strange since the species was abundant during August, 1970, on a reef about 6.4 km south of East Pass. This relatively active fish is typical of reef habitats but also spends much time in open water moving from reef to reef. There seems

to be no reason why it could not have reached the vicinity of the East Pass jetties during 1970. Two additional species that became less numerous at the jetties are *Antennarius ocellatus* and *Mugil curema*. Neither of these species was ever common enough at the jetties to be certain evidence of any particular trend.

Bairdiella chrysura, *Cantherhines pullus*, and *Monacanthus hispidus* displayed another unusual pattern of occurrence. Each species was present in substantial numbers during 1968 and 1970, but was scarce or absent in 1969. The same pattern was seen in *Scarus croicensis*, but this species was never common on the jetties. Such a pattern could indicate an annual difference in the number of individuals of each species recruited into the area. There are obviously yearly differences in the transport of pelagic young of some species into the area, but most are species that never become common on the jetties (including *Scarus croicensis*). Species such as *Bairdiella chrysura* and *Monacanthus hispidus*, which are usually common in inshore waters of the northern gulf, might be expected with equal frequency every year in habitats such as the jetties. Possibly there was a general decline in abundance of these two species throughout the area in 1969, but other habitats were not studied and this possibility could not be verified. Both species were common at the St. Andrew jetties during October, 1969.

Seasonal Changes in the Fish Fauna

Pronounced seasonal changes occur in the composition of fish faunas in all inshore habitats of the northern gulf. Many species begin to disappear in the fall, apparently either moving offshore into deeper water or migrating southward along the Florida coast, and are almost completely absent during the winter. This winter decline in number of species present (as well as in number of individual fishes) was especially obvious at the jetties, where only about 5 to 10 species were usually present during January and February (Figs. 7 and 8). These seasonal changes in number of species followed very closely the seasonal changes in temperature. The autumn decline began in October when the water temperature first began to drop below the summer high of 30°C, but the major decrease in number of species occurred in November when the temperature dropped below 20°C. Most species had left the area by December but a slight warming trend early in December, 1970, seemed to permit many species to remain inshore through December (Fig. 7). Most of these had disappeared by January, 1971.

The only species that were consistently present as adults throughout the year were *Opsanus beta* and *Hypleurochilus geminatus*, but

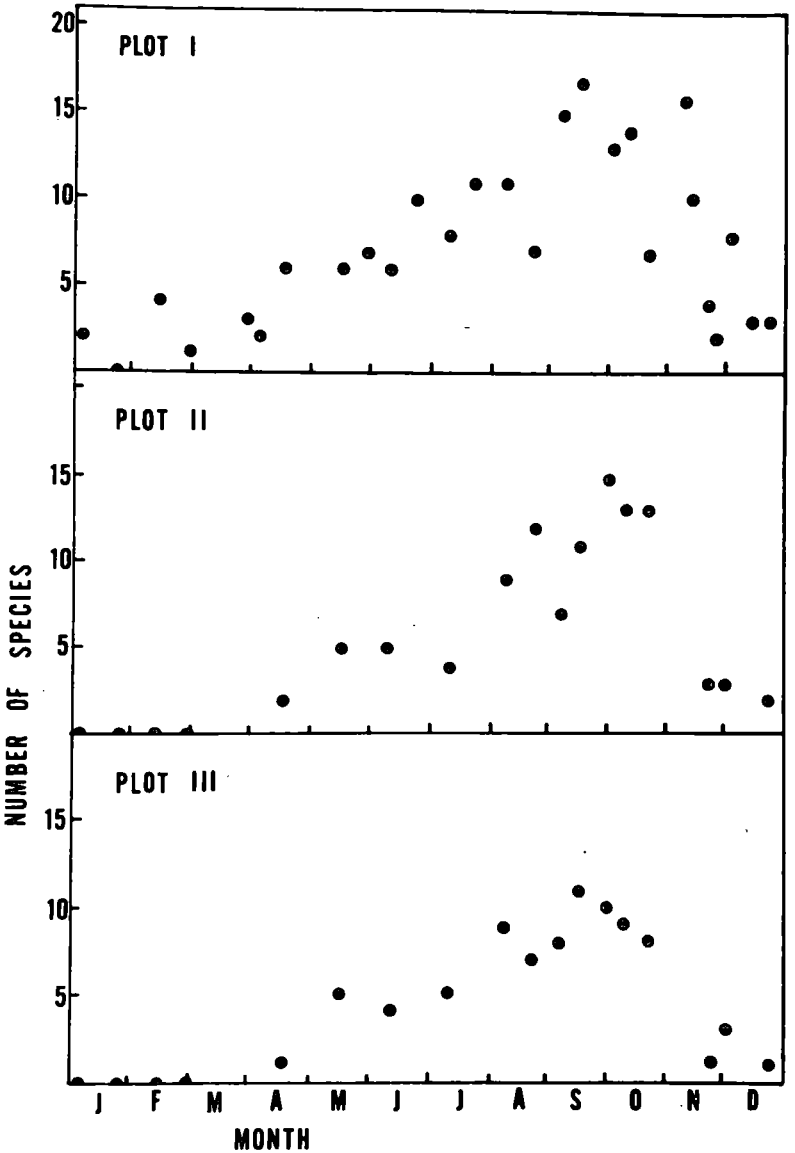

FIGURE 8.—Number of species of fishes recorded in plot counts on the East Pass jetties during 1970.

even these were less numerous in the winter. Adults of *Lagodon rhomboides* and *Leiostomus xanthurus* follow the usual pattern of moving offshore in the fall, but both species spawn after leaving the inshore waters, and large numbers of larvae and small juveniles appear inshore in November and December. The latter two species were the most numerous fishes on the jetties during the winter months but only small juveniles were present. *Mugil cephalus* has similar reproductive habits (Anderson 1958), but juveniles of this species were much less numerous at the jetties. Larvae of *Myrophis punctatus* also appeared inshore during the winter, but collections of this species were too few to allow determination of its occurrence pattern at the jetties. Other species occasionally recorded during the winter are *Dasyatis sabina, Gobiesox strumosus, Menidia beryllina, Diplectrum formosum, Serraniculus pumilio, Serranus subligarius, Archosargus probatocephalus, Halichoeres bivittatus, Gobiosoma longipala* and *Chilomycterus schoepfi.* Except for *Archosargus,* these species were considerably more numerous during the warmer months than in the winter.

The winter exodus of fishes from inshore waters is apparently in most cases a direct response to temperature changes (May *et al.* 1976). Most common species inhabiting inshore areas of the northern gulf can tolerate temperatures as low as 15°C, and some can survive at temperatures of 10°C or even lower if the decline is gradual. However, winter temperatures inshore can fluctuate considerably over short periods. Apparently, the offshore migrations serve to place the fishes in more stable, deep-water areas where temperatures are less variable and usually do not drop below 15°C. Inshore areas are certainly not devoid of food resources during the winter when some cold-adapted species such as *Urophycis* move inshore and devour large quantities of invertebrates and larval fishes that are still present (Reid 1954; Lewis and Wilkens 1971). Larval and prejuvenile stages of *Lagodon rhomboides, Leiostomus xanthurus,* and *Mugil cephalus* find adequate foods inshore and probably are at a distinct advantage in moving inshore when most of the potential predators are absent.

The spring increase in number of species inshore begins in February or March when the water temperature is still between 15 and 20°C. The severity of winter temperatures may affect the distance that some species move offshore, and thus affects the date at which those species again appear inshore. The rather mild temperatures of the winter of 1968-1969 not only allowed several species to remain inshore, but also accelerated the influx of some speices in the spring. Examples of such arrivals were *Orthopristis chrysoptera, Lagodon rhomboides* (adult), *Acanthurus chirurgus,* and *Acanthurus randalli.*

Possibly the fishes move to various depths offshore, depending upon the temperature. During colder winters they may move farther offshore and thus require more time in the spring to move back inshore. The winter habitats of such species are still not known, and much additional research is required before such problems can be adequately explained.

Seasonal changes occurring in the fish fauna are well illustrated by the counts of numbers of species and individual fishes made in 1970 on the three plots marked off on the jetties (Tables 2-5; Fig. 2). Species are arranged in the tables to show the general pattern of recruitment of new species into the area during the spring and summer. The plots represent only small postions of the jetties, however, and most species listed were present at earlier dates on other parts of the jetty.

These plot counts also illustrate the numerical importance of the various species on the jetties. *Hypleurochilus geminatus* was the most common species during the winter, except for larval and prejuveniles of *Lagodon rhomboides* and *Leiostomus xanthurus,* and remained one of the dominant members of the fauna throughout the year. It was probably more numerous than these counts indicate. In April *Halichoeres bivittatus* first appeared in the plot counts and immediately became the most numerous member of the fauna. In July there was a major increase in the counts of *Halichoeres,* apparently resulting from spawning in May and June, since many seen subsequently were small juveniles. This species was abundant through the middle of November and was far more numerous than any other species. Even so, its numbers began to decline in November and it was absent in the plots by January. The third dominant member of the jetty fauna was *Lagodon rhomboides.* Adults first appeared in May and remained in the plots through the middle of November. These three species, *Halichoeres bivittatus, Hypleurochilus geminatus,* and *Lagodon rhomboides,* constituted about 84 percent of all the fishes counted on the jetties.

Most major species in the plots had been recorded by September, although a few did not appear until November, when most species had begun to disappear from the area. Again it should be emphasized that most of these species had already been observed on other parts of the jetty. As noted above, the major decline in both number of species and number of individuals occurred about the middle of November. The slight increase in counts following the major reduction on November 21 occurred at the time of a slight temperature rise in early December. Many fishes (especially *Halichoeres bivittatus, Orthopristis chrysoptera,* and the scarids) had moved out to deeper water at the

south end of the jetty late in November, and many moved back along the jetties as the temperature rose in December.

Effects of Chemical and Physical Factors

Variations in salinity, water clarity, currents, surge and depth (in addition to temperature) have affected the fish fauna on the jetties. Salinity, water clarity, and currents fluctuated with the tidal cycle. Tidal ranges in the area are generally less than about 36 cm, so water depths were not significantly altered by tidal shifts.

The salinity at the jetties was high during flood tides, usually about 28-35 o/oo and was often slightly higher on the channel side, apparently because the lower salinity bay water was trapped to a certain extent on the gulf side of the jetty. By the end of the flood tide, however, the salinity on each side of the jetty was about equal. As the tide began to ebb, the low salinity bay water was carried for the most part along the channel side of the jetty, and salinity in this area was reduced considerably. Early in the tidal cycle the less dense, low salinity water was carried along the jetty at the surface, forming a sharp isocline at a depth of about one meter. Salinity differentials across this isocline were occasionally as high as 15 o/oo. Toward the end of an ebb tide the salinity of the water along the channel side of the jetty was low; the lowest recorded was 7.3 o/oo. Thus, the fishes living on this part of the jetty were subjected to a wide range of salinities daily.

Water clarity also tended to follow the tidal cycle since the ebbing bay water was generally more discolored than the high salinity gulf water. Consequently, the water on the channel side was generally less clear and also varied to a greater extent than that on the gulf side.

Tidal flow along the jetty often created rather strong currents on the channel side but rarely on the gulf side. During such periods most of the fishes remained near the bottom, either under rocks or in crevices where they could avoid being swept away.

As might be expected considering the differences on the two sides of the jetties, some species were restricted to one side or the other, and some that were present on both sides were not equally common on the two sides. Fishes living on the channel side (Plot I) had to withstand considerable fluctuations in the environment, including periods of low salinity, decreased water clarity, and rather strong currents. The gulf side (Plots II and III) was characterized by generally more stable conditions, but this area was subjected to the almost continual stress of surge breaking against the jetty. *Kyphosus sectatrix* was almost never seen on the channel side of the jetty, but seemed to prefer areas where surge was the greatest. Species such as *Hypleurochilus geminatus, Lagodon rhomboides, Orthopristis chrysoptera, Acan-*

thurus chirurgus, and *Acanthurus randalli* were also more common on the gulf side based upon the mean number counted per square meter of bottom area (Tables 2-4). However, *Hypleurochilus geminatus,* one of the few species present during the winter, was recorded only on the channel side during the winter. Its absence on the gulf side may result from the increased surge during the winter. Species often recorded on the channel side but rare on the gulf side were *Leiostomus xanthurus, Serranus subligarius, Diplectrum formosum, Opsanus beta, Blennius marmoreus, Serraniculus pumilio,* and *Bathygobius soporator. Halichoeres bivittatus* was about equally common on both sides.

Another factor affecting the distribution of fishes on the jetties was water depth. Deeper areas on the jetties typically had considerably more species, as well as more individual fish, than the shallow areas. In the deeper regions more surface area of the jetty rocks was usually exposed; hence, both water depth and available cover served to increase the number of fish present. The deeper areas at the seaward ends of the jetties always harbored more fishes than other parts of the jetties, and the fishes remained in such areas late in the fall after they had disappeared from the shallower depths. The high number of species (25) recorded on 1 March 1969 resulted from the poisoning of a deep area (5.7 m deep, but subsequently shoaled over) on the gulf side of the west jetty at the seaward end of the weir portion. Many species not usually present at that time of year had apparently remained in the area or possibly moved inshore early because of the moderate temperatures of that winter, and had congregated in the deeper water where temperatures might have been more stable.

Trophic Structure of the Fish Fauna

No detailed study of energy flow on the jetties was attempted in this study, but a few generalizations are possible (based upon stomach analyses reported in Hastings 1972). The primary producers on the jetties were the numerous species of benthic algae that cover most of the rocks, but apparently only a few of the common fishes on the jetties fed directly upon these plants. Some which did consume large quantities of plant material were *Archosargus probatocephalus, Lagodon rhomboides, Kyphosus sectatrix, Chaetodipterus faber, Pomacentrus variabilis, Nicholsina usta* and other scarids, *Blennius marmoreus, Hypleurochilus geminatus, Acanthurus chirurgus,* and *Acanthurus randalli.* Of these, *Archosargus, Lagodon, Chaetodipterus, Pomacentrus, Blennius,* and *Hypleurochilus* also fed to some extent upon various invertebrates. At times large quantities of sea grass fragments (mostly *Diplanthera*) accumulated at the base of the jetties, but the energy flow from this material to the fish fauna is unknown.

No grass beds occurred in the immediate vicinity of the jetties, and such plants do not play a major role in the economy of the jetty fishes in this area. The importance of planktonic material in the economy of the jetties is not known, but some species were occasionally seen feeding in midwater or at the surface near the jetties. Examples are *Lagodon rhomboides* and *Chaetodipterus faber*. Phytoplankton was probably consumed by few fishes but may have been important to some invertebrates which served as food for fishes.

Some energy flow into the system came by way of the numerous pelagic fishes that congregated near the jetties. Such fishes fed primarily in the open areas surrounding the jetties. This pelagic group included planktonic feeders (*Harengula pensacolae, Sardinella anchovia,* and *Decapterus punctatus*), which may have provided food for the few large predators (*Mycteroperca microlepis* and *Lutjanus griseus*) that resided on the jetties as well as for species of pelagic predators (*Pomatomus saltatrix, Caranx crysos,* and *Scomberomorus maculatus*) which also congregated about the jetties. Some species such as *Lutjanus griseus, Leiostomus xanthurus,* and *Bairdiella chrysura* may have fed predominantly on invertebrates over the sand flats surrounding the jetties and thus incorporated some energy into the jetty food web. These fishes may play a role comparable to the numerous lutjanids and pomadasyids of coral reef areas that use the reefs only as shelter and feed in surrounding areas during the night (Starck and Davis 1966). However, the sand flats around the East Pass jetties seem rather barren when compared with the grass flats of coral reef lagoons and back reef areas, so these fishes may remain near the jetties to feed. Since no night studies on the jetties were attempted, the nocturnal activities of these fishes are not known. Nocturnal studies at the Stage II platform off Panama City Beach (Hastings *et al.* 1976) indicate that *Harengula pensacolae, Caranx crysos, Haemulon aurolineatum* and *Orthopristis chrysoptera* are nocturnal feeders that disperse into open water areas at night.

Most fishes inhabiting the jetties fed upon small invertebrates or small fishes that lived among the rocks or in dense algal mats covering these rocks (Hastings 1972). Thus, most fishes were secondary consumers, and the various crustaceans, polychaetes, mollusks, and other small invetebrates were the primary consumers that fed upon the benthic plant material. *Hypleurochilus geminatus,* one of the most numerous resident fishes, was an important food item for many species, since it was commonly found in the stomachs of specimens collected on the jetties.

Comparasion of East Pass and St. Andrew Jetties

Of the 204 species that have been recorded in the immediate vicinities of these two habitats, 61 species were recorded at the St. Andrew jetties but not at the East Pass jetties, and 23 were recorded only at the East Pass jetties (Table 1). It should be noted that a few of these were recorded in both areas but not actually on both jetties. Fishes of the families Exocoetidae and Belonidae were seen at the East Pass jetties, but none was collected and consequently none could be identified to species. Excluding these two groups, 44 species were recorded in the St. Andrew area only, and 8 in the East Pass area only. Thus, at least 150 species were common to both habitats.

In comparing the fish faunas listed for these two jetties, the amount of study given to each habitat must be considered. Although the East Pass jetties have been studied much more extensively during the two and one-half year period from June, 1968, to January, 1971, the records for the St. Andrew jetties cover a longer time period (1958-1972) and include the results of several collectors in the area. In addition the fishes of St. Andrew Bay have been studied during this period whereas comparable records were not available for Choctawhatchee Bay. The collections of Allison (1961) spanned a two-year period during 1958 and 1959, and several other biologists from Florida State University, including myself, have collected extensively at the St. Andrew jetties since 1967, frequently using rotenone.

During most observations at the St. Andrew jetties, more species were recorded than for comparable periods at the East Pass jetties. From July through October in 1970 and 1971, the average number recorded per observation day was about 47, compared to about 38 at East Pass in 1970. The same general seasonal pattern was observed at the St. Andrew jetties, however, with only about 10 species recorded in February.

Of the 23 species recorded at the East Pass jetties only (Table 1), most are rather common in the northern gulf but exhibit almost no attraction to reef structures. These might be expected to occur at times near the St. Andrew jetties. Rare species such as *Engraulis eurystole, Trachinotus goodei, Erotelis smaragdus,* and *Dactylopterus volitans* should occur at the St. Andrew jetties with about the same frequency as at East Pass, but to date have not been recorded there. All but one of the typical reef species included in this list (*Lutjanus campechanus, Ocyurus chrysurus, Mulloidichthys martinicus,* and *Balistes vetula*) are also rare inshore in the northern gulf, and consequently were rare at the East Pass jetties. *Bathygobius soporator* was never common at East Pass but was seen rather frequently during 1970. Why it should be absent at the St. Andrew jetties is not known, but it is apparently

not common anywhere in the northern gulf. *Gobiesox strumosus* seems to be a similar example, since it was recorded considerably more often at East Pass than at the St. Andrew jetties. The last two species seem to have similar ecological requirements and the scarcity of the two at the St. Andrew jetties may be related.

The list of fishes recorded only at the St. Andrew jetties (Table 1) includes numerous strays from more tropical areas that occur sporadically in the northern gulf. Examples of these are *Holocentrus rufus, Holocentrus vexillarius, Centropomus undecimalis, Kyphosus incisor, Abudefduf taurus, Pomacentrus fuscus, Lachnolaimus maximus, Scarus coelestinus, Sparisoma aurofrenatum, Sparisoma viride,* and *Hypleurochilus bermudensis.* Such species were never common at the St. Andrew jetties and should be expected to appear occasionally at East Pass. Another large portion of this list includes common estuarine inhabitants of the northern gulf that are usually not attracted to reef structures. Most were not common at the St. Andrew jetties, but some might be expected there more often than at East Pass because of the protected habitat available in the adjacent lagoons. Most probably occur in Choctawhatchee Bay. Examples are *Lepisosteus osseus, Bascanichthys scuticaris, B. teres, Anchoa mitchilli, Pogonias cromis, Polydactylus octonemus, Citharichthys macrops, Achirus lineatus,* and *Monacanthus ciliatus.* Several species recorded only at the St. Andrew jetties are strays from the natural reefs in deeper water offshore and may be more frequently encountered at the St. Andrew jetties because of the greater depths there. Examples of these are *Conger oceanicus, Gymnothorax saxicola, Apogon pseudomaculatus, Astrapogon alutus, Lutjanus analis, Lutjanus apodus, Equetus lanceolatus, Chaetodon sedentarius, Halichoeres caudalis* and *Coryphopterus punctipectophorus.* Other deep water species not necessarily characteristic of reef habitats are *Seriola dumerili, Stenotomus caprinus* and *Scorpaena calcarata.* Again, these species might be expected to occur occasionally inshore at East Pass. This is the case with *Apogon pseudomaculatus* and *Stenotomus caprinus* for which there are literature records of their collection at East Pass in 1956 and 1954, respectively (Caldwell 1955; Caldwell and Briggs 1957).

Although actual comparative counts of numbers of individuals on the St. Andrew jetties were not made, several species were obviously more numerous there than at East Pass. Such differences, as well as the absence of some species at East Pass, may be attributable in some way to the greater size or length of the St. Andrew jetties, the greater depths on the channel side, or to the protected habitat available in the lagoons. Several species from the offshore reefs including *Epinephelus*

morio, Rypticus maculatus, Haemulon aurolineatum, Haemulon plumieri and *Equetus umbrosus* were considerably more numerous at the St. Andrew jetties, probably because of the greater depths there. The lagoons also provide a limited amount of sandy mud substrate and also extensive grass beds in close proximity to the jetties; several species associated with such habitats were more numerous at the St. Andrew jetties. Possibly of only minor importance is the greater diversity of attached benthic algae and invertebrates attributable to the greater age of the habitat. Although additional species will undoubtedly be added to the faunal list for this habitat, the East Pass jetties have apparently reached a stable condition as far as common fishes are concerned. In spite of the differences observed between the two areas, the fish fauna of the East Pass jetties in general is quite similar to that of the St. Andrew jetties.

Comparison of the Jetties and Offshore Reefs

A few obvious differences have been noted between the fish fauna of the natural reefs at depths of 18-30 m off northwest Florida and that of the rocky habitats inshore, even though only a limited number of observations have been made in this study on the offshore reefs. Some of the typical inshore species recorded at the jetties never occur offshore. Likewise, the abundant estuarine species that move offshore to spend the winter were not seen near the reefs. If they congregate near such bottom irregularities, they must move out to depths greater than about 30 m. The typical reef species (such as *Serranus subligarius, Pomacentrus variabilis,* and *Halichoeres bivittatus*) that are common inshore in the warmer months must move out to these reefs during the winter, but the number of observations was too limited to indicate any seasonal changes in abundance of these species. Many of the dominant reef species recorded inshore were at least present on these offshore reefs during the winter. There is apparently some seasonal change in the reef fauna at depths up to 30 m, and many of the species (such as *Lutjanus campechanus*) move farther offshore to deeper reefs during the winter.

However, the reefs at depths of 18-30 m support an interesting assortment of typical reef residents that are present throughout the year. These offshore reefs, with their year-round residents, are undoubtedly the original habitat of many of the common species found inshore during the warmer months. Examples of fishes in this category are *Diplectrum formosum, Mycteroperca microlepis, Serraniculus pumilio, Serranus subligarius, Rypticus maculatus, Lutjanus griseus, Diplodus holbrooki, Chaetodipterus faber, Chaetodon ocellatus, Pomacentrus variabilis, Halichoeres bivittatus, Nicholsina*

TABLE 6.—SPECIES RECORDED ON THE OFFSHORE REEFS (DEPTHS OF 18-30 M) OFF NORTHWEST FLORIDA, BUT NOT INSHORE AT THE JETTIES.[1]

Species	Common Name	Estimated Abundance
Opsanus pardus	Leopard toadfish	common
Epinephelus drummondhayi	Speckled hind	occasional
Epinephelus nigritus	Warsaw grouper	common
Pristigenys alta	Short bigeye	occasional
Seriola rivoliana	Almaco jack	occasional
Rhomboplites aurorubens	Vermilion snapper	common
Calamus leucosteus	Whitehead porgy	common
Pagrus sedecim	Red porgy	common
Equetus (*Pareques*) sp. nov.	Black-bar drum	occasional
Chromis enchrysurus	Yellowtail reeffish	common
Chromis scotti	Purple reeffish	common
Ioglossus calliurus	Blue goby	common
Microgobius carri	Seminole goby	occasional

[1]Additional species collected at these reefs are listed by Jordan (1885, 1887); Jordan and Evermann (1887, 1896-1900); Jordan and Gilbert (1883, 1884); Jordan and Swain (1885); Goode and Bean (1883); Springer and Bullis (1956); Bullis and Thompson (1965); Böhlke and Robins (1969); Caldwell (1959, 1963); Randall and Caldwell (1966); and Vick (1964).

usta, Blennius marmoreus, Acanthurus chirurgus, Acanthurus randalli, Scorpaena brasiliensis, and *Balistes capriscus.* In contrast, other species are common on the offshore reefs but only occasionally or rarely appear inshore. Examples are *Gymnothorax nigromarginatus, G. saxicola, Centropristis ocyurus, Apogon pseudomaculatus, Lutjanus campechanus, Equetus lanceolatus, Holacanthus bermudensis, Halichoeres caudalis,* and *Coryphopterus punctipectophorus.* Some species occurring on these reefs may never move into depths less than about 12 m (Table 6). Apparently other environmental factors such as depth are important in restricting the distribution of such obligate reef residents.

The numerous species of reef fishes regarded here as strays from tropical waters were rarely or never seen on the offshore reefs. A few of these (such as *Chaetodon capistratus, Abudefduf saxatilis, Thalassoma bifasciatum,* and *Sparisoma radians*) appeared nearly every summer inshore at the jetties but for some reason have not become established as permanent residents in the northern gulf. Either the low winter temperatures on the offshore reefs (about 15°C) are below their tolerance level or else they cannot take refuge on these offshore reefs because of some other factors. Some such as *Abudefduf saxatilis* and *Pomacentrus fuscus* are restricted to depths less than about 18 m, and consequently are excluded from the offshore reefs. A

few tropical species might be able to survive inshore during mild winters, but usually only juveniles appear each spring or summer.

Recommendations

Structures such as rock jetties function as artificial reef habitats and greatly affect the occurrence of various species of fishes in areas such as East Pass where natural reef habitats are lacking. Thus it seems that engineers involved in the design and construction of such structures should give some consideration to designs that would maximize the benefit and minimize the adverse effects that such projects might have on the biota of an area.

The study of East Pass was concerned primarily with species that were attracted to the new habitat and that consequently increased in numbers at East Pass. Conceivably, the jetties could have had a detrimental effect upon some species. The jetties have changed circulation patterns in the pass and could impede the movement of fishes into and out of the bay or along the gulf beach. It any such detrimental changes have occurred at East Pass, they were not evident.

The jetties have had advantageous effects on many species of fishes and some have increased their numbers considerably at East Pass. However, there are certain aspects of the design of the East Pass jetties that have limited their effectiveness as an artificial reef. Criteria suggested for consideration in the construction of artificial reefs (Unger 1966; Woodburn 1966; Turner *et al.* 1969) are generally not applicable to jetties since the location and design of such structures are usually determined by their intended purpose. However, a few modifications in the construction of the East Pass jetties could have made them more attractive to food and game fishes, as well as to anglers and divers.

Depths along most of the jetties are too shallow to support large quantities of fishes, and in addition there is only a limited amount of rocky substrate available underwater. A design that would have allowed greater depths along the jetties would have then allowed greater quantities of game and food fishes to remain near the jetties.

An attribute of the St. Andrew jetties that makes them more productive from both a biological and a recreational point of view is the presence of protected coves on the shoreward ends of these jetties. These coves provide quiet water areas for swimming and boating and also support seagrass beds and a variety of quiet water organisms not common at East Pass. The greater depths along most of the jetties and the presence of protected lagoonal areas are probably the two most important factors contributing to the greater diversity of fishes present at the St. Andrew jetties.

Angling pressure on the East Pass jetties is limited to some extent by their inaccessibility. The irregular placement and looseness of the jetty rocks causes some difficulty and danger to those who would walk on the jetties. Much of the west jetty is accessible only by boat since the weir portion separates it from the beach. However, boat owners in the area prefer locations other than the jetties, so that area is usually not fished. During a short period when the weir portion was shoaled over by dredge spoil, fishing pressure on the west jetty increased considerably. Designs more advantageous for fishermen could result in a more desirable cost-benefit ratio for projects such as jetty construction.

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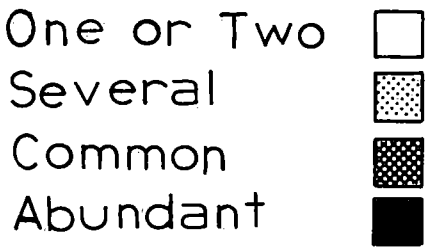
Appendix

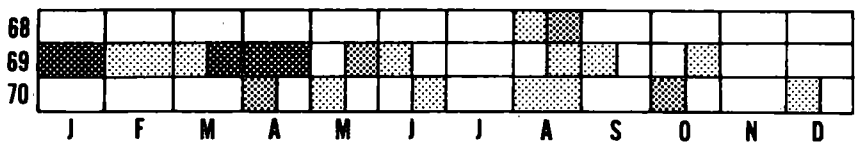
Occurrence Charts

Charts 1-78 illustrate the seasonal occurrence patterns of the major fish species recorded at the East Pass jetties in 1968, 1969, and 1970. Legend for these charts is as follows:

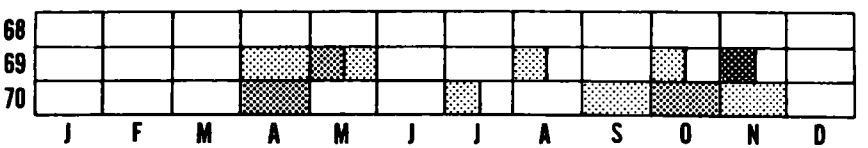


1. Sharks

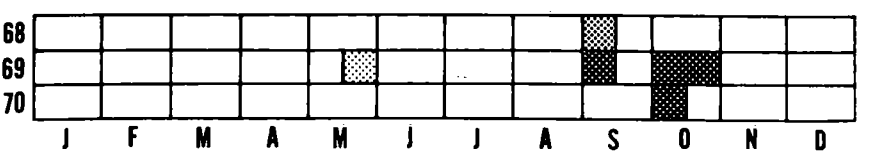
2. Dasyatis sabina



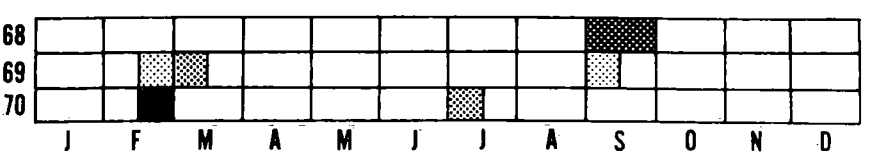
3. Dasyatis sayi



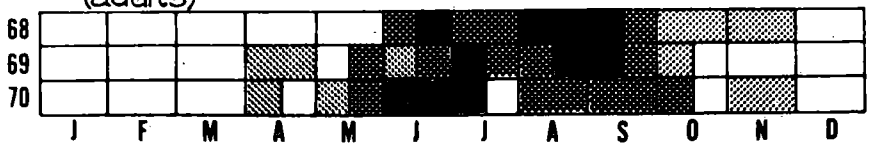
4. Elops saurus



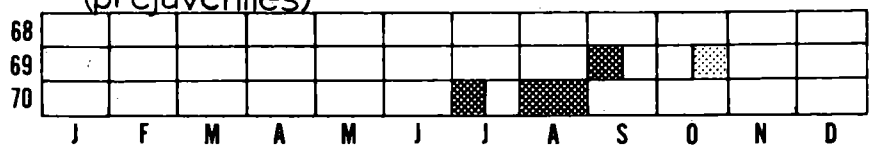
5. Myrophis punctatus



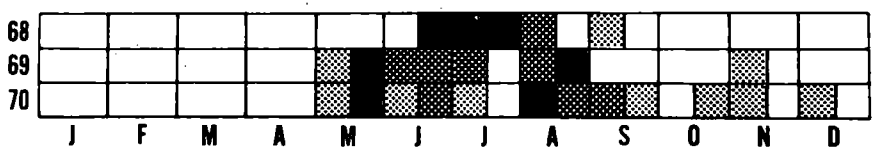
6. Harengula pensacolae (adults)



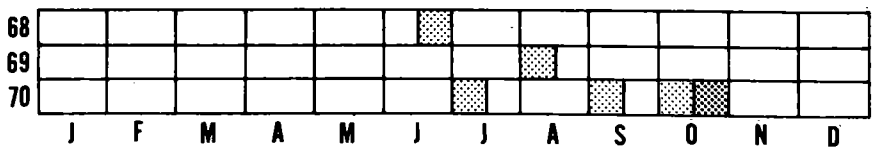
7. Harengula pensacolae (prejuveniles)



8. Sardinella anchovia



9. Synodus foetens



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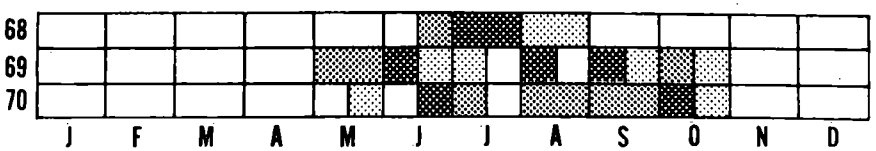
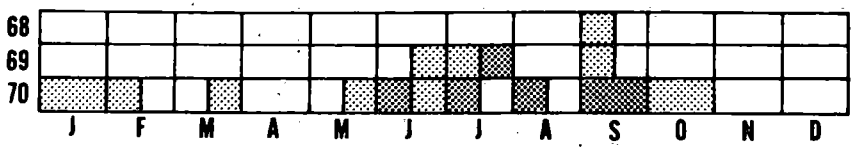
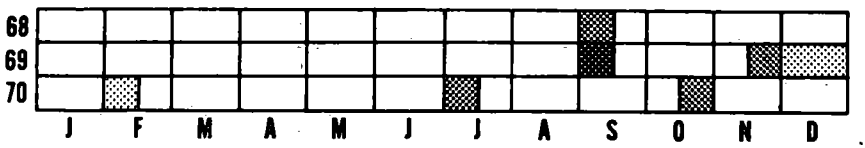


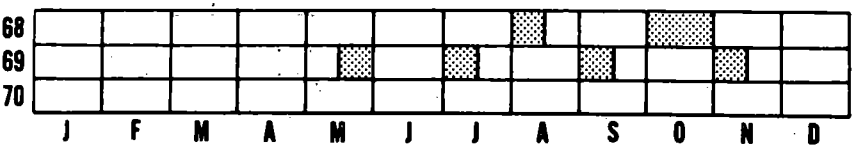
11. Opsanus beta



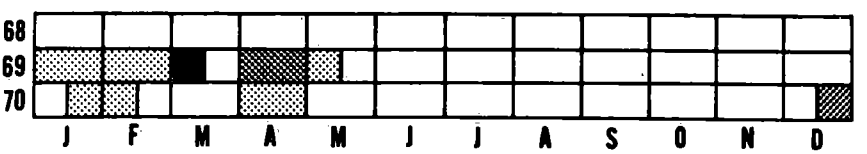
12. Gobiesox strumosus



13. Antennarius ocellatus



14. Urophycis floridanus



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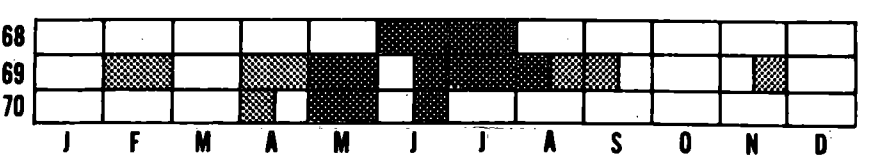
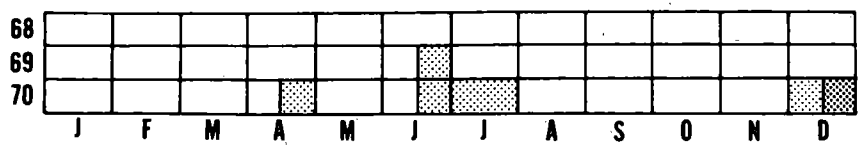
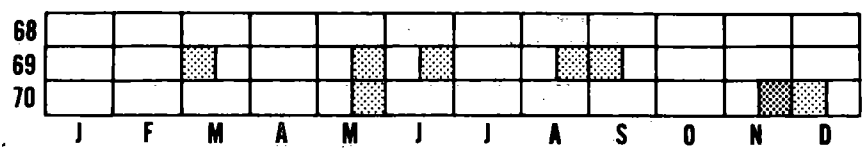


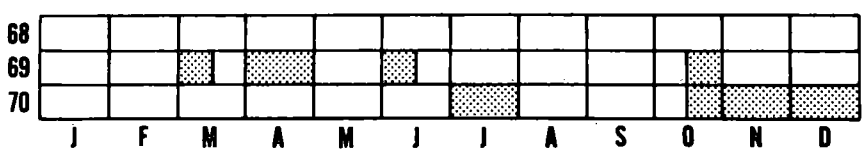
16. Syngnathus scovelli



17. Syngnathus springeri



18. Centropristis melana



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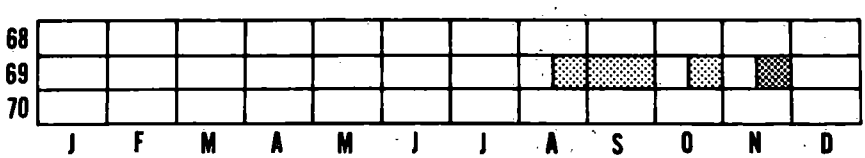
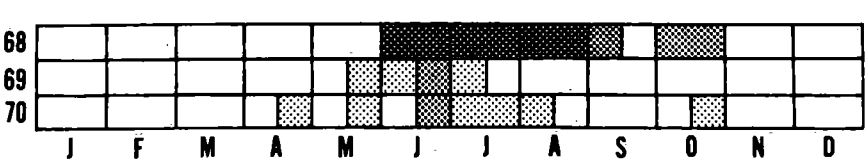
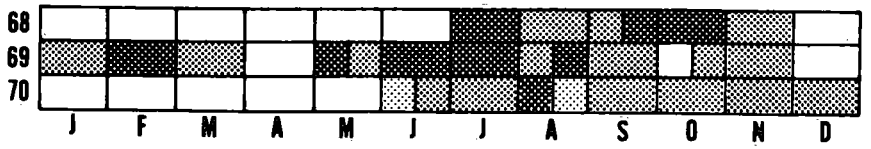


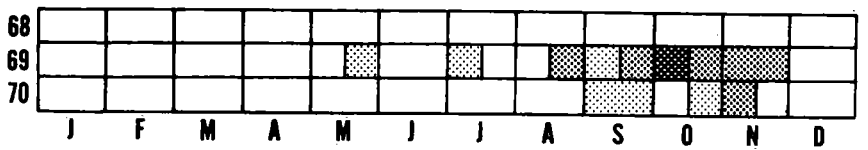
20. Centropristis philadelphica



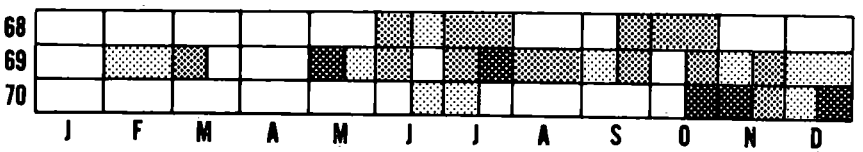
21. Diplectrum formosum



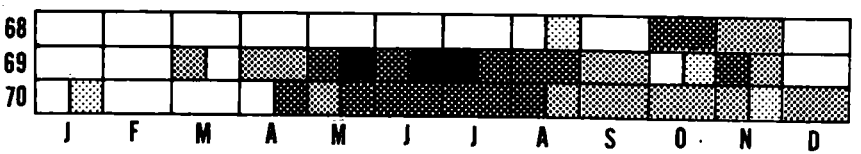
22. Mycteroperca microlepis



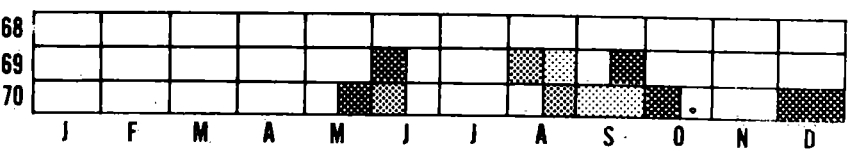
23. Serraniculus pumilio



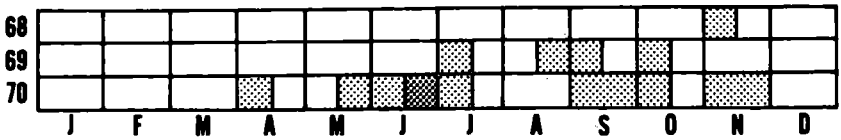
24. Serranus subligarius



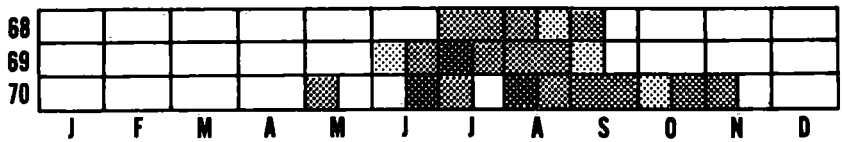
25. Pomatomus saltatrix



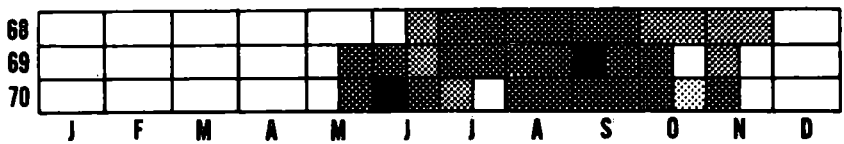
26. Echeneis neucratoides



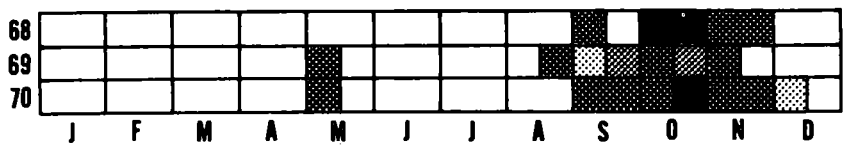
27. Caranx bartholomaei



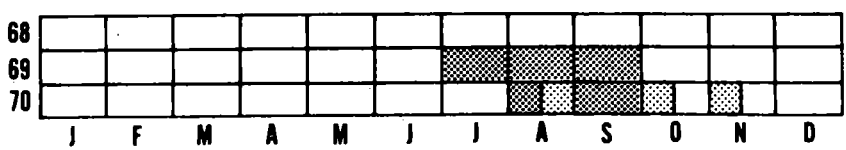
28. Caranx crysos



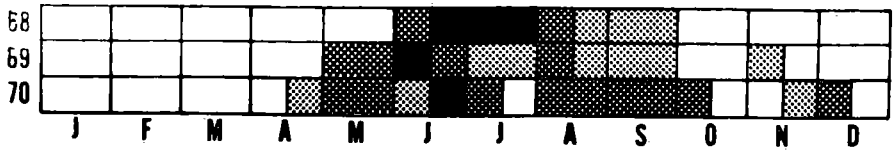
29. Caranx hippos



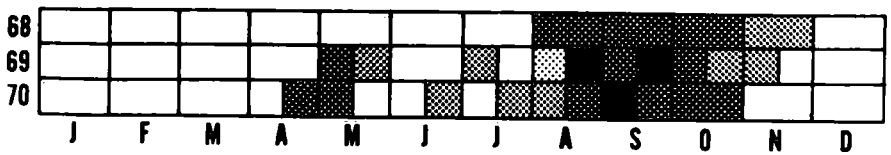
30. Caranx ruber



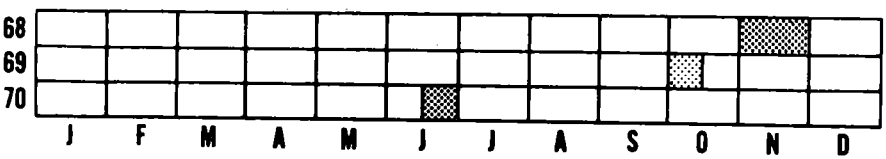
31. Decapterus punctatus



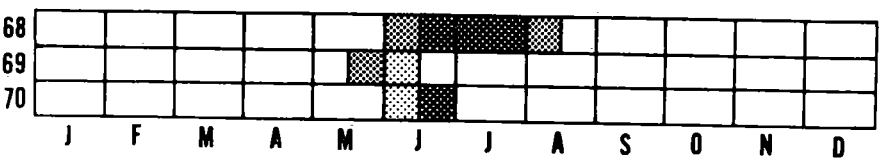
32. Oligoplites saurus



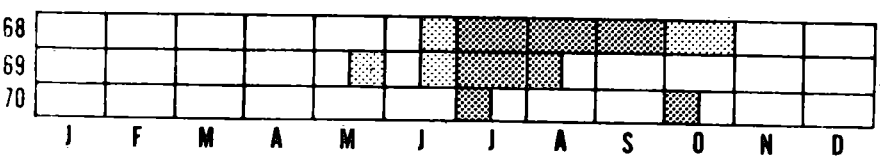
33. Selene vomer



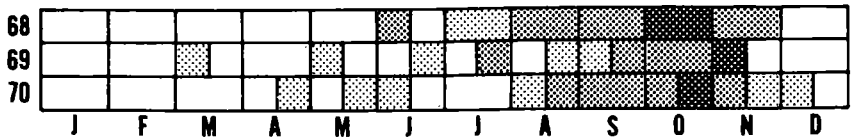
34. Seriola zonata



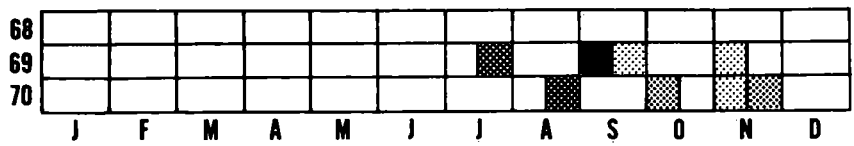
35. Trachinotus carolinus



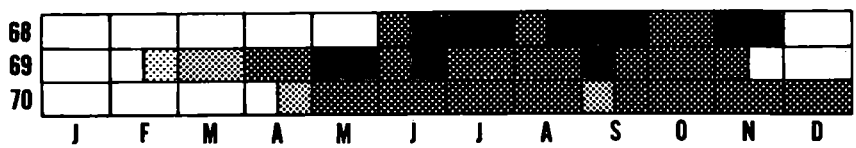
36. Lutjanus griseus



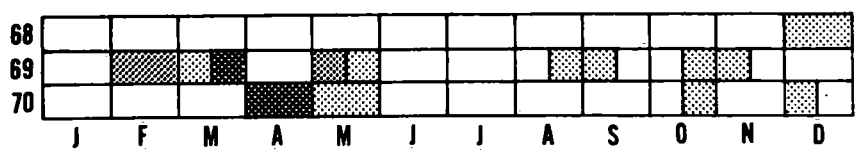
37. Eucinostomus



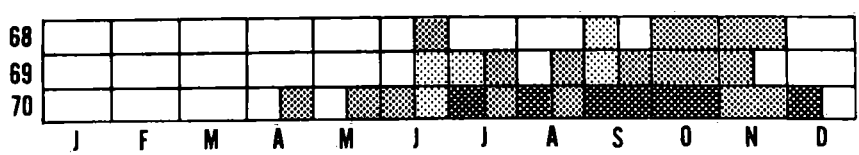
38. Orthopristis chrysoptera



39. Archosargus probatocephalus

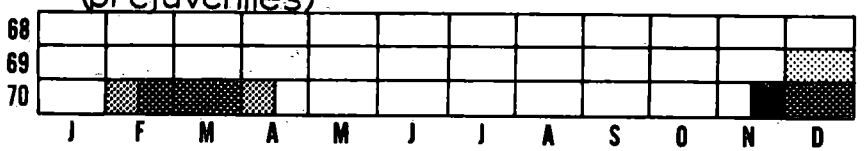


40. Diplodus holbrooki

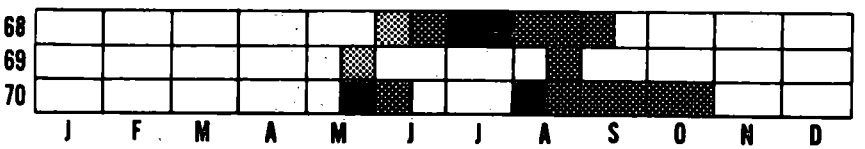


41. Lagodon rhomboides (adults)

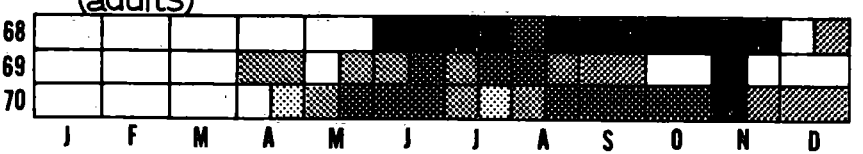
42. Lagodon rhomboides (prejuveniles)



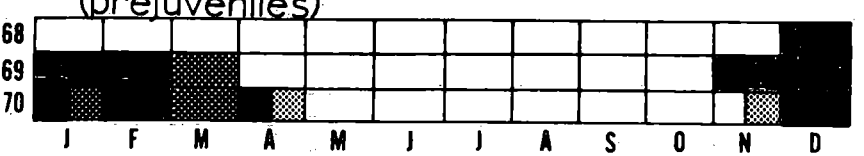
43. Bairdiella chrysura



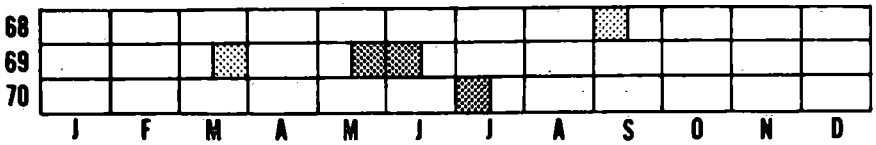
44. Leiostomus xanthurus (adults)



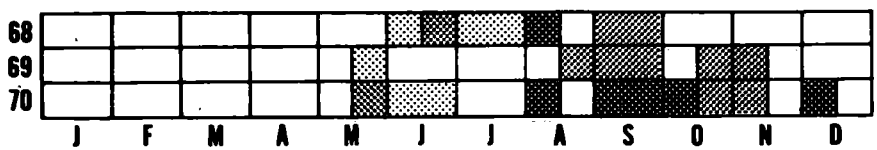
45. Leiostomus xanthurus (prejuveniles)



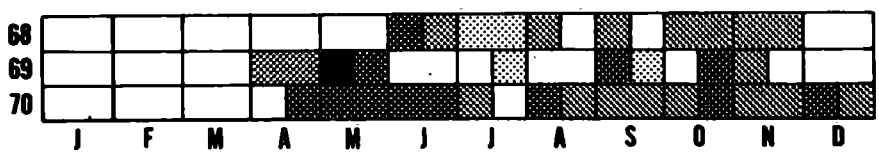
46. Menticirrhus focaliger



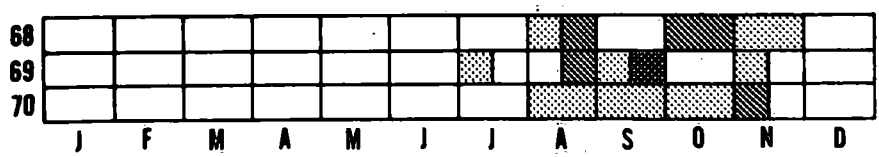
47. Kyphosus sectatrix



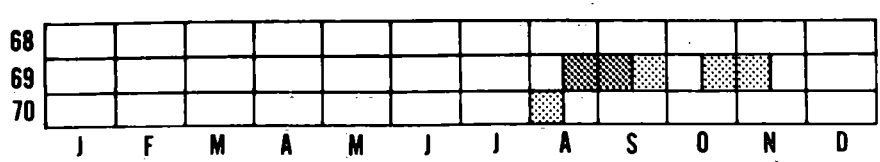
48. Chaetodipterus faber



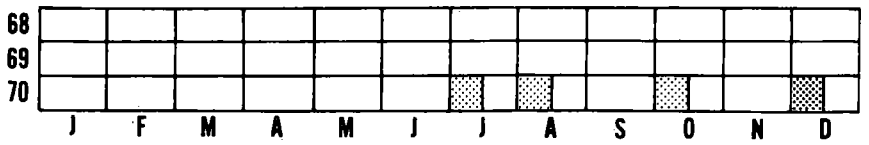
49. Chaetodon ocellatus



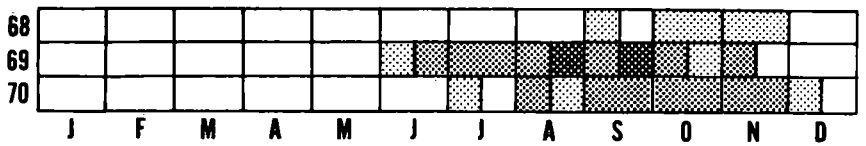
50. Holacanthus bermudensis



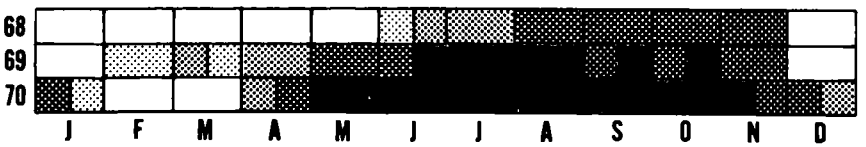
51. Abudefduf saxatilis



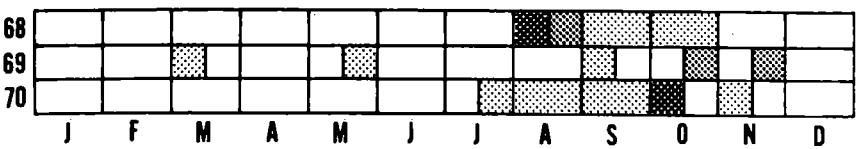
52. Pomacentrus variabilis



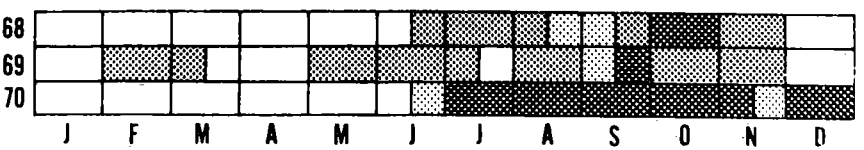
53. Halichoeres bivittatus



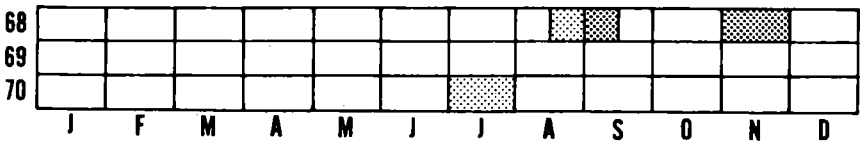
54. Hemipteronotus novacula



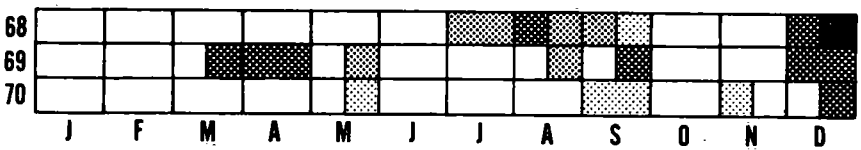
55. Nicholsina usta



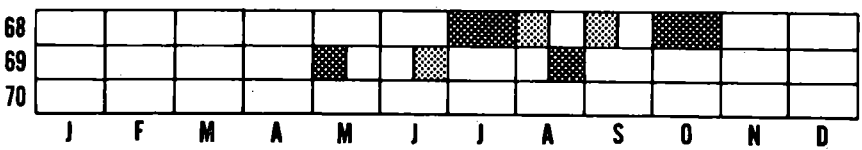
56. Scarus croicensis



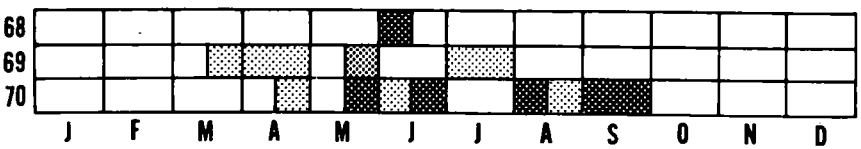
57. Mugil cephalus



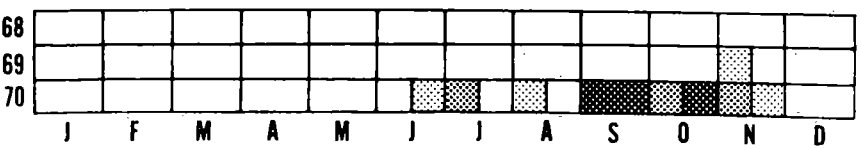
58. Mugil curema



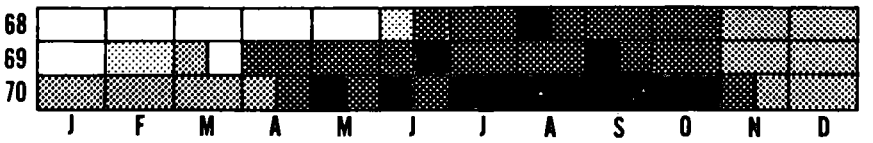
59. Sphyraena borealis



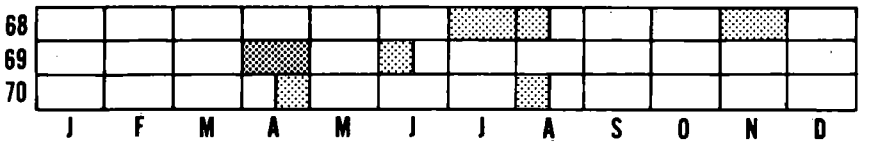
60. Blennius marmoreus



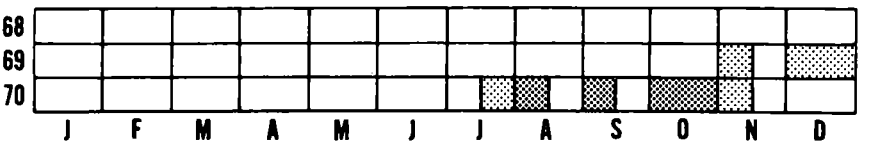
61. Hypleurochilus geminatus



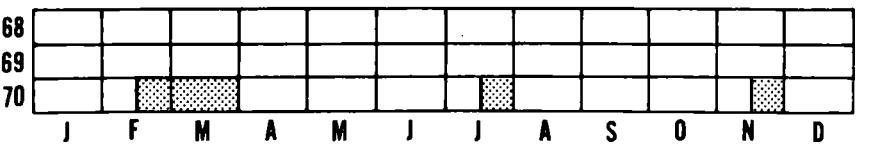
62. Hypsoblennius hentzi



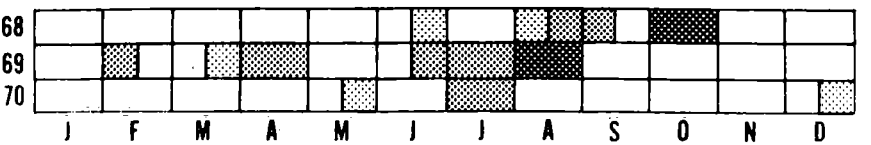
63. Bathygobius soporator



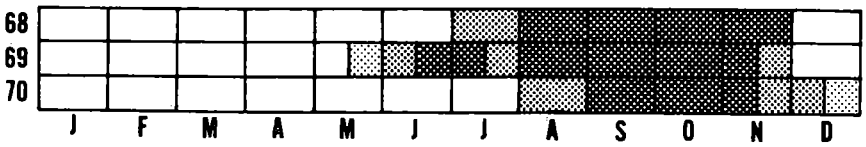
64. Gobionellus boleosoma



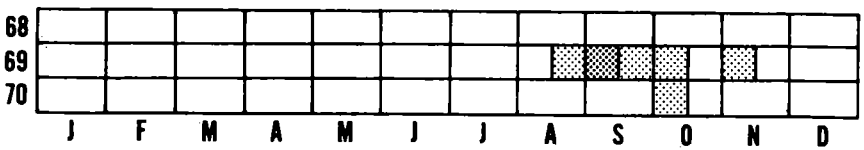
65. Gobiosoma longipala



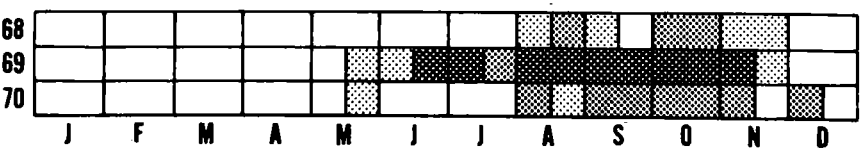
66. Acanthurus chirurgus



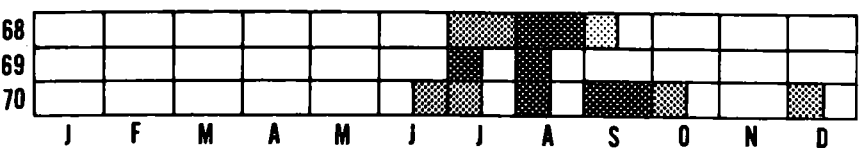
67. Acanthurus coeruleus



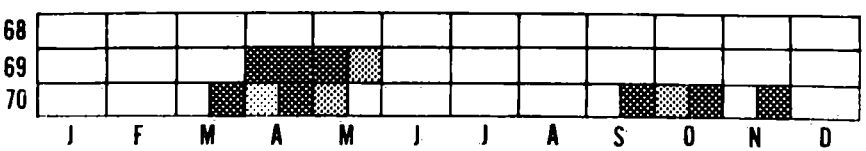
68. Acanthurus randalli



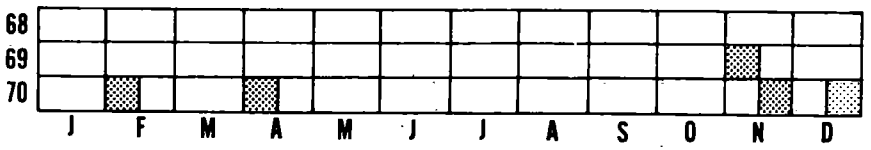
69. Euthynnus alletteratus



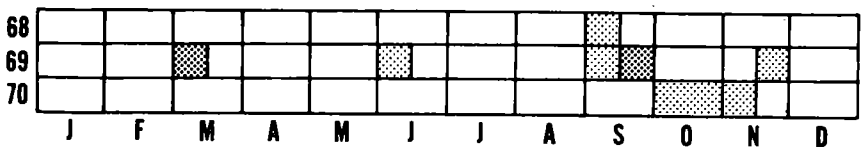
70. Scomberomorus maculatus



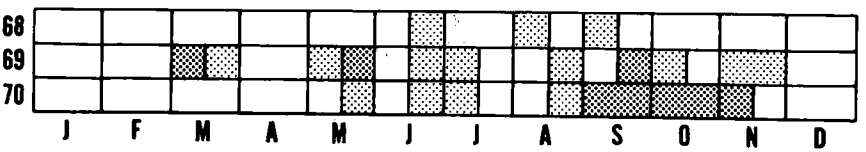
71. Peprilus burti



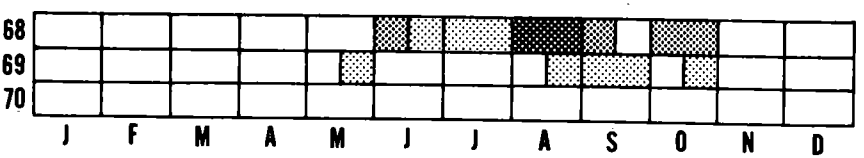
72. Scorpaena brasiliensis



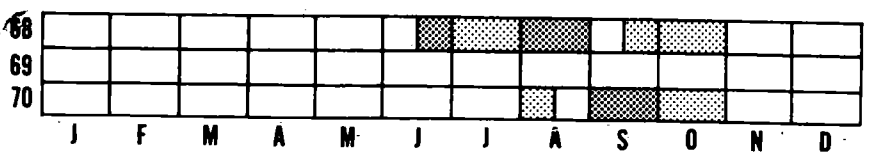
73. Paralichthys albigutta



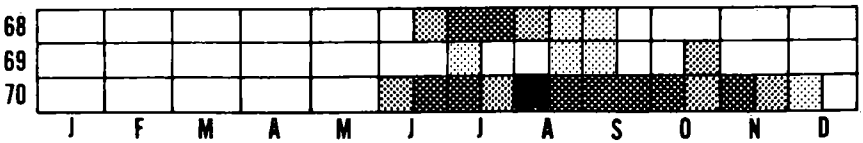
74. Balistes capriscus



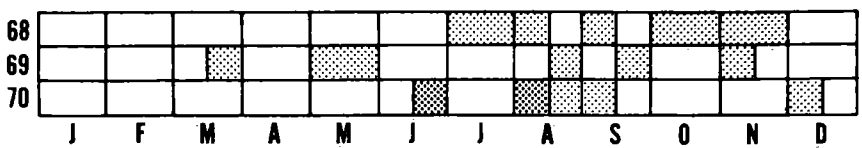
75. Cantherhines pullus



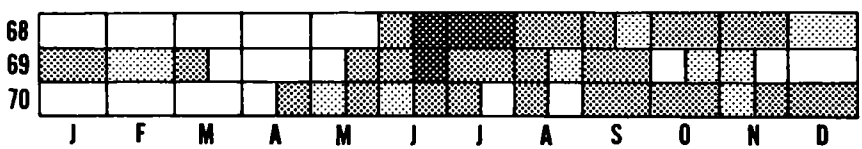
76. Monacanthus hispidus



77. Lactophrys quadricornis



78. Chilomycterus schoepfi



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