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DIEL AND SEASONAL OCCURRENCE OF IMMATURE FISHES IN A LOUISIANA TIDAL PASS[1]

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ABSTRACT

A 15-month study of a natural tidal pass on the southeastern Louisiana coast revealed that the pass and adjacent inshore waters are utilized by a variety of immature fishes as immigration pathway and/or nursery. Eighty species representing 39 families were found to occur in the pass area, including young of several commercial and sport fishes. Two seasonal assemblages of immature fishes were identified, cold- and warmwater. Coldwater species were mostly immigrating young of offshore spawners, while warmwater species were mostly young of inshore spawners. The catch of coldwater species was influenced more by tidal stages than light periods; warmwater species exhibited varied diel catch patterns but the catch of predominant warmwater species was more closely associated with light periods than tidal stages. The similarity in diel patterns exhibited by some of the coldwater assemblage indicates that this group may react similarly to the problem of inshore transport (immigration).

INTRODUCTION

Barrier islands border more than half the shoreline of the northern Gulf of Mexico (Kwon, 1969). West of the present bird-foot delta of the Mississippi, barrier islands around the abandoned Mississippi-LaFourche delta enclose one of the most productive estuarine areas in North America (Gunter, 1967). These barrier islands are interspersed by relatively narrow openings, the tidal passes, which allow organismal, nutrient and tidal exchange between the Gulf and estuarine bays and marshes. Most commercial and sports fishes of the Gulf of Mexico spawn in the Gulf and their postlarval and juvenile stages enter the estuaries through the tidal passes. The early life history stages are the most critical part of a fish's life cycle (Gunter, 1967; Fore, 1970a) and many estuarine dependent marine species spend a portion of this critical period in tidal passes. Some fishes spawn in the immediate vicinity of tidal passes and a few complete their entire life cycles there.

There are few published studies directed specifically to investigations of the ichthyofauna of Louisiana's tidal passes or to the state's coastal-marine immature fishes. Moreover, there is a paucity of information on the diel occurrence of marine immature fishes in general. This paper presents some of the findings of a 15-month diel study of immature fishes associated with Caminada Pass, Grand Isle, Louisiana.

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MATERIALS AND METHODS

Caminada Pass is located on the southeastern Louisiana coast, west of the Mississippi River delta (Figure 1), and serves as a major route of communication between the Gulf and the southwestern portion of the Barataria Bay estuarine system. It is oriented northwest-southwest and separates the western end of Grand Isle from an adjacent barrier sandspit known locally as Goat Island (Figure 2). The pass is approximately 0.5 km long and 0.8 km wide; average depth is 2.7 meters, but occasional depressions of 12 meters or more occur along the western side.

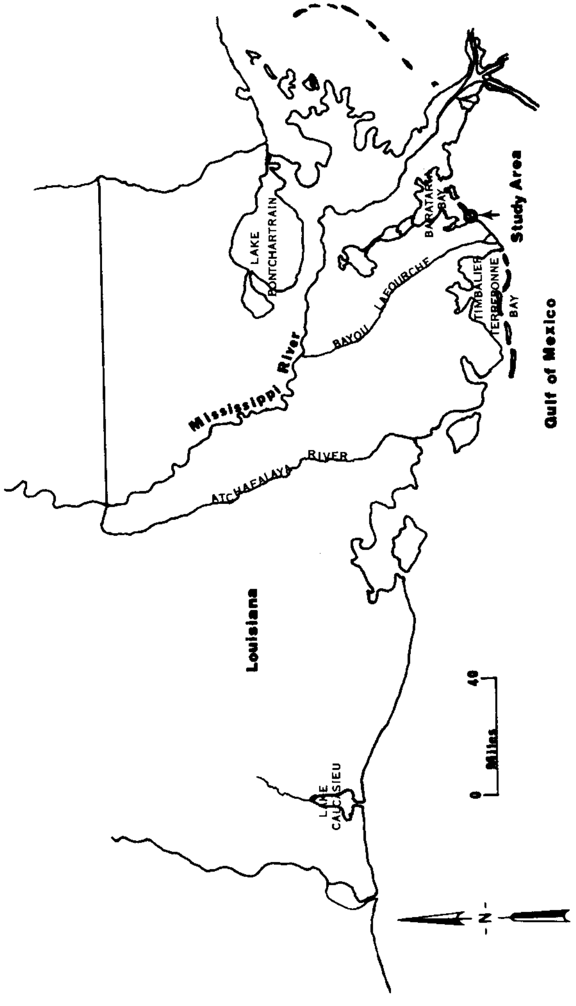

Figure 1. Map of coastal Louisiana showing location of study area.

Two sampling stations were established on the western shore of Caminada Pass, one on the pass itself, the other on a small bay just inside the pass (Figure 2). All fishes were collected with a small hand-pulled trawl originally designed to catch postlarval penaeid shrimp (Renfro, 1963). The Renfro beam trawl has been used to sample larval and juvenile fishes by other investigators (Dawson, 1966; Norden, 1966; Fore, 1970a,b; Fore and Baxter, 1972). By maintaining full extension of an anchored 15.2-meter tether, we hauled the net through a semicircle of constant area at each station. Using this procedure the volume of water filtered was approximately the same for each sample. We feel that this beam trawl adequately sampled immature fishes in a standardized manner not possible in such an environment with any other collecting gear.

From June, 1971, through August, 1972, samples were usually collected at four hour intervals over at least one 24-hour period per month. Generally, a clockwise and a counter-clockwise tow of the beam trawl were made at both stations during each collecting period. With each collection, data were taken on air and water temperature, salinity and on tidal and general meteorological conditions. All fishes collected were preserved in the field with a 10% solution of buffered formalin and returned to the laboratory for identification and processing. Total numbers and standard lengths in millimeters were recorded for each species. In collections of more than 200 individuals of a species, 200 randomly sampled individuals were measured but all were counted. Differences in the catch of 11 major species between stations (Station 1, pass vs. Station 2, bay), light periods (day vs. night), tidal stages (flood vs. ebb), light period-tidal stage interactions and direction of tow (clockwise vs. counter clockwise) were evaluated using a least squares analysis of variance for disproportionate numbers.

Figure 2. Aerial photo of Caminada Pass Area. Numbers indicate location of sampling stations. Photo by National Aeronautics and Space Administration.

We assumed that immature fishes in the pass vicinity would show distributional-abundance patterns relative to such diel factors as tidal stage and day-night phase. Even if this assumption were not borne out in our sampling results, frequent sampling over a 24-hour period would none the less provide a more accurate inventory of the fishes present on a particular date than would the all too usual "one-shot" collection methods.

RESULTS AND DISCUSSION

Physical Parameters

Air temperatures recorded during the study ranged from 32°C (1600 hrs, 11 Aug., 1972) to 8.5°C (2058 hrs, 4 Dec., 1971); the overall average air temperature was 22.5°C. Water temperatures ranged from 32°C (1620 hrs, 4 Aug., 1971) to 8.5°C (0930 hrs, 5 Feb., 1972); overall average water temperature was 23.1°C. Salinities recorded during the study ranged from 35.5 ppt (16 June, 1971) to 8.5 ppt (6 Feb., 1972); overall average salinity was 23.4 ppt. Salinities in the pass area are influenced mainly by the introduction of saline waters from the Gulf of Mexico and local freshwater runoff. But during periods of high Mississippi River discharge, salinities in the pass area are appreciably reduced by river water entering the pass from the Gulf. On four occasions (June, July, 1971; March, July, 1972) flooding tides from the Gulf were associated with decreasing pass salinities, probably reflecting the movement of Mississippi River water into the pass area.

Tides along the southeastern Louisiana coast are normally diurnal (one maximum and one minimum each tidal day, 24 hrs 50 mn); semi-diurnal tides (two maximums and two minimums each day) occur infrequently (Marmer, 1954). Tropic and equatorial tides occur semi-monthly at intervals of about 8 days. Maximum vertical range averages 0.67 meters for tropic tides and 0.1 meters for equatorial tides (Marmer, 1954). Average annual tidal range is 0.34 meters (Barrett, 1971). The basic tidal patterns were modified by various meteorological phenomena, especially wind. Strong northerly winds dampened tidal fluctuations by lengthening the duration of ebbing tides and reducing the range of flooding tides. Periods of strong southerly winds had the opposite effect.

All collections for the study were made during periods of diurnal tides; no semi-diurnal tides were sampled. Normal tropic tides had a marked effect on the study area, especially at Station 2. During tropic floods water moved well into the marsh grass and on following ebbs fell 15 or more horizontal meters, leaving a broad exposed flat. Tidal levels in the pass area were lowest during times of prevailing northerly winds (November, 1971 - April, 1972) and highest during times of prevailing southerly winds (June - October, 1971 and May - August, 1972).

Species Composition

Eighty species of fishes representing 39 families and one species of lancelet were collected from the Caminada Pass area (Table 1). A comparison of these results with a previous checklist of fishes taken in this area with many gears (Wagner, 1973) indicates that immature individuals of most of the ichthyofauna are present in the pass area. Of our 80 species, 14 were collected as postlarvae only, 37 as juveniles only, 16 as postlarvae and juveniles only, 10 as postlarvae, juveniles and adults and 3 as juveniles and adults only. A summary of the catch by trip is given in Table 2.

Table 1. List of fishes collected by beam trawl from Caminada Pass, Louisiana, June, 1971 - August, 1972.

Scientific Name	Common Name	Number	Type Indiv.*
Branchiostoma sp.	Lancelet	3	Juv-Ad
Elops saurus	Ladyfish	9	Le
Anguilla rostrata	American eel	2	El
Paraconger caudilimbatus	Margintail conger	1	El
Myrophis punctatus	Speckled worm eel	139	Le-El-Ad
Ophichthus gomesi	Shrimp eel	1	El
Brevoortia patronus	Gulf menhaden	4,819	Pl-Juv
Harengula pensacolae	Scaled sardine	5,339	Pl-Juv
Anchoa cubana	Cuban anchovy	10	Juv
A. hepsetus	Striped anchovy	2,596	Pl-Juv
A. lyolepis	Dusky anchovy	970	Pl-Juv
A. mitchilli	Bay anchovy	20,946	Pl-Juv-Ad
Synodus foetens	Inshore lizardfish	29	Pl-Juv
Arius felis	Sea catfish	10	Juv
Gobiesox strumosus	Skilletfish	544	Pl-Juv
Histrio histrio	Sargassumfish	4	Juv
Urophycis regius	Spotted hake	1	Juv
Ophidion welshi	Crested cusk-eel	3	Juv
(unidentified)	Flyingfish	6	Juv
Hyporhamphs unifasciatus	Halfbeak	1	Juv
Adinia xenica	Diamond killifish	3	Ad
Cyprinodon variegatus	Sheepshead minnow	6	Ad
Fundulus grandis	Gulf killifish	3	Ad
F. similis	Longnose killifish	431	Pl-Juv-Ad
Membras martinica	Rough silverside	254	Pl-Juv-Ad
Menidia beryllina	Tidewater silverside	8,792	Pl-Juv-Ad
Syngnathus floridae	Dusky pipefish	2	Juv
S. louisiana	Chain pipefish	183	Juv-Ad
S. scovelli	Gulf pipefish	1	Juv
Caranx hippos	Crevalle jack	6	Juv
Chloroscombrus chrysurus	Atlantic bumper	147	Juv
Oligoplites saurus	Leatherjacket	14	Juv
Selene vomer	Lookdown	1	Juv
Trachinotus carolinus	Florida pompano	90	Juv
T. falcatus	Permit	2	Juv
Corphaena hippurus	Dolphin	7	Juv
Lutjanus griseus	Gray snapper	2	Juv
L. synagris	Lane snapper	3	Juv
Lobotes surinamensis	tripletail	1	Juv
Eucinostomus argenteus	Spotfin mojarra	751	Pl-Juv
Orthopristis crysoptera	Pigfish	3	Pl
Archosargus probatocephalus	Sheepshead	13	Pl
Lagodon rhomboides	Pinfish	1,020	Pl-Juv
Bairdiella chrysura	Silver perch	1,005	Pl-Juv
Cynoscion arenarius	Sand seatrout	36	Pl-Juv
C. nebulosus	Speckled trout	748	Pl
Larimus fasciatus	Banded drum	22	Pl
Leiostomus xanthurus	Spot	45,707	Pl-Juv
Menticirrhus americanus	Southern whiting	273	Pl-Juv
M. focaliger	Minkfish	2	Juv
M. littoralis	Gulf whiting	28	Juv
Micropogon undulatus	Atlantic croaker	2,603	Pl-Juv

Pogonias cromis	Black drum	33	Pl
Sciaenops ocellata	Redfish	269	Pl
Stellifer lanceolatus	Star drum	1	Pl
Chaetodipterus faber	Atlantic spadefish	709	Pl-Juv
Mugil cephalus	Striped mullet	373	Juv
M. curema	White mullet	59	Juv
Sphyraena barracuda	Great barracuda	1	Juv
Polydactylus octonemus	Atlantic threadfin	3	Juv
Astroscopus y-graecum	Southern stargazer	4	Juv
Hypsoblennius sp.	Blenny	24	Pl
Dormitator maculatus	Fat sleeper	10	Pl
Erotelis smaragdus	Emerald sleeper	11	Pl
Evorthodus lyricus	Lyre goby	13	Pl
Gobionellus boleosoma	Darter goby	806	Pl-Juv-Ad
G. hastatus	Sharptail goby	10	Pl
Gobiosoma bosci	Naked goby	8	Pl
Microgobius gulosus	Clown goby	508	Pl
Scomberomorus maculatus	Spanish mackeral	15	Juv
Prionotus scitulus	Leopard searobin	4	Juv
P. tribulus	Bighead searobin	4	Juv
Citharichthys spilopterus	Bay whiff	93	Juv-Ad
Etropus crossotus	Fringed flounder	51	Juv-Ad
Paralichthys albigutta	Gulf Flounder	11	Pl-Juv
P. lethostigma	Southern flounder	225	Pl-Juv
Archirus lineatus	Lined sole	9	Pl
Symphurus plagiusa	Blackcheek tonguefish	75	Pl-Juv-Ad
Canthidermis sufflamen	Ocean triggerfish	1	Juv
Monacanthus hispidus	Planehead filefish	7	Juv
Sphoeroides parvus	Least puffer	314	Juv

*Le=Leptocephalus; El=Elver; Pl=Postlarvae; Juv=Juvenile; Ad=Adult.

Two seasonal assemblages of immature fishes were recognized in the Caminada Pass area: 1) a coldwater assemblage and 2) a warmwater assemblage. (These categories correspond generally to the "cold water" and "warm water" seasonal groupings of fish larvae used by Hoese, 1965, in the Aransas Pass, Texas area.) In our study, the coldwater assemblage occurred primarily from November through April when water temperatures in the pass were usually less than 20°C (Table 3). The warmwater assemblage occurred primarily from May through October when water temperatures in the pass were usually greater than 20°C (Table 3).

Table 2. Number of species and predominant species in beam trawl collections, Caminada Pass, Louisiana. June, 1971 - August, 1972.

Trip	No. Species	Predominant Species	Type Indiv.*
2-3 Jun, 1971	30	*Menidia beryllina*	Pl-Juv-Ad
9-10 Jun, 1971	32	*Anchoa hepsetus, Anchoa mitchilli*	Juv-Ad
16-17 Jun, 1971	25	*Anchoa mitchilli*	Juv-Ad
23-24 Jun, 1971	29	*Anchoa mitchilli, Chaetodipterus faber*	Juv
1-2 Jul, 1971	28	*Bairdiella chyrsura, Anchoa mitchilli*	Pl-Juv
7-8 Jul, 1971	29	*Harengula pensacolae, Sphoeroides parvus*	Pl-Juv
4-5 Aug, 1971	25	*Harengula pnsacolae*	Pl
11-12 Aug, 1971	29	*Anchoa mitchilli, Harengula pensacolae, Cynoscion nebulosus*	Pl-Juv
11-12 Sep, 1971	19	*Eucinostomus argenteus*	Pl-Juv
9-10 Oct, 1971	26	*Anchoa mitchilli, Sciaenops ocellata*	Pl-Juv
6-7 Nov, 1971	18	*Micropogon undulatus*	Pl
4-7 Dec, 1971	13	*Leiostomus xanthurus, Micropogon undulatus*	Pl
8-9 Jan, 1972	16	*Leiostomus xanthurus, Brevoortia patronus, Lagodon rhomboides*	Pl-Juv
5-6 Feb, 1972	21	*Leiostomus xanthurus*	Pl-Juv
4-5 Mar, 1972	18	*Brevoortia patronus, Leiostomus xanthurus*	Pl-Juv
8-9 Apr, 1972	31	*Brevoortia patronus, Gobiesox strumosus, Mugil cephalus*	Pl-Juv
13-14 May, 1972	28	*Gobionellus boleosoma, Bairdiella chrysura*	Pl
7-8 Jun, 1972	24	*Anchoa mitchilli, Menidia beryllina*	Pl-Juv
6-7 Jul, 1972	25	*Anchoa mitchilli, Menidia beryllina*	Pl-Juv
15-16 Aug, 1972	17	*Cynoscion nebulosus, Microgobius gulosus*	Pl

*Pl=Postlarvae; Juv=Juvenile; Ad=Adult.

Coldwater Species. The predominant coldwater species in terms of numbers collected was the spot *(Leiostomus xanthurus).* Spot postlarvae were common in Caminada Pass from early December, 1971, through early February, 1972; peak catches occurred in December. Postlarvae of the Gulf menhaden *(Brevoortia patronus)* Atlantic croaker *(Micropogon undulatus)* and pinfish *(Lagodon rhomboides)* were also common in winter collections. Postlarvae of the Atlantic croaker and Gulf menhaden were collected from October through April but peak catches of croaker postlarvae occurred in December and the peak catches of menhaden in April. Pinfish postlarvae were collected from December to March with peak collections occurring in January. Juveniles of the striped mullet *(Mugil cephalus)* postlarvae of the southern flounder *(Paralichthys lethostigma)* and leptocephali and elvers of the speckled worm eel *(Myrophis punctatus)* were other important members of the coldwater assemblage. Young-of-the-year of all 7 coldwater species were collected from December through March.

Young of five minor species were collected only during the coldwater period. These included two elvers of the American eel and one juvenile of the spotted hake collected in January, 1972; two juveniles of the crested cusk-eel taken in November and January; one juvenile of the Gulf pipefish collected in February, 1972; and 11 postlarvae and juveniles of the Gulf flounder collected from December through April.

Table 3. Seasonal assemblages of major fishes in beam trawl collections, Caminada Pass, Louisiana. June, 1971 - August, 1972.

Species	Peak Occurrence	Type Indiv.*	Place of Spawning	Peak Time of Spawning
Coldwater Assemblage (Nov-Apr; Mean water temperature below 20° C)				
1. *Leiostomus xanthurus*	Dec	Pl	Gulf	Nov-Mar
2. *Micropogon undulatus*	Dec	Pl	Gulf	Sep-Mar
3. *Lagodon rhomboides*	Jan	Pl	Gulf	Nov-Feb
4. *Paralichthys lethostigma*	Jan	Pl	Gulf	Nov-Feb
5. *Myrophis punctatus*	Feb	Le	Gulf	Oct-Feb
6. *Brevoortia patronus*	Apr	Pl	Gulf	Oct-Mar
7. *Mugil cephalus*	Apr	Juv	Gulf	Oct-Feb
Warmwater Assemblage (May-Oct; Mean water temperature above 20° C)				
1. *Anchoa mitchilli*	Jun	Pl-Juv	Pass	Mar-Oct
2. *Anchoa hepsetus*	Jun	Pl-Juv	Pass	Mar-Aug
3. *Anchoa lyolepis*	Jul	Pl-Juv	Gulf	Mar-Aug
4. *Menidia beryllina*	Jun	Juv	Pass	Apr-Aug
5. *Fundulus similis*	Jun-Jul	Pl-Juv	Pass	Mar-Aug
6. *Harengula pensacolae*	Jul	Pl	Gulf	Apr-Aug
7. *Bairdiella chrysura*	Jul-Aug	Pl	Pass	Mar-Aug
8. *Cynoscion nebulosus*	Aug	Pl	Pass	Apr-Sep
9. *Microgobius gulosus*	Aug	Pl	Pass	Apr-Aug
10. *Menticirrhus americanus*	Aug	Pl-Juv	Pass	Apr-Sep
11. *Eucinostomus argenteus*	Jul	Pl-Juv	Gulf	Mar-Sep
12. *Symphurus plagiusa*	Jul	Pl-Juv	Pass	Apr-Aug
13. *Chaetodipterus faber*	Jun-Jul	Juv	Gulf	May-Aug
14. *Sphoeroides parvus*	Jul	Juv	Gulf	Apr-Aug
15. *Syngnathus louisianae*	Jul	Juv	Gulf	Feb-Oct
16. *Choloroscombrus chrysurus*	Jul	Juv	Gulf	Apr-Aug
17. *Trachinotus carolinus*	Jun-Jul	Juv	Gulf	Mar-Aug
18. *Mugil curema*	Jun	Juv	Gulf	Apr-Jun
19. *Membrus martinica*	Oct	Juv	Pass	Apr-Sep
Intermediate				
1. *Gobiesox strumosus*	Apr	Pl-Juv	Pass	Mar-Jun
2. *Sciaenops ocellata*	Oct	Pl	Gulf	Aug-Nov
Extended				
1. *Gobionellus bolesoma*	Jul-Jan	Pl-Juv	Pass	All Year
2. *Citharichthys spilopterus*	Jul-Feb	Pl-Juv	–	–
3. *Etropus crossotus*	Jul-Feb	Pl-Juv	–	–

*Pl=Postlarvae; Juv=Juvenile; Le=Leptocephalus

Warmwater Assemblage. In terms of numbers and frequency of occurrence, the bay anchovy *(Anchoa mitchilli)* and tidewater silverside *(Menidia beryllina)* were the predomianant members of the warmwater assemblage. Catches of these species consisted mainly of postlarvae and juveniles and both, while common throughout the summer, were most abundant during June. Postlarvae and juveniles of the striped and dusky anchovies *(A. hepsetus* and *A. lyolepis);* postlarvae of the scaled sardine *(Harengula pensacolae);* and postlarvae of the silver perch *(Bairdiella chrysura)* were also common during summer and outnumbered the bay anchovy and tidewater silverside in certain months. Other prominent warmwater species were juveniles of the Atlantic spadefish *(Chaetodipterus faber)* and longnose killifish *(Fundulus similis)* and postlarvae of the spotfin mojarra *(Eucinostomus argenteus),* clown goby *(Microgobius gulosus)* and speckled trout *(Cynoscion nebulosus).*

We consider the presence and abundance of speckled trout postlarvae in the warm water assemblage of the pass especially noteworthy. (During the study, we collected 748 postlarvae ranging in size from 2-14 mmSL with a mean length of 4.5 mmSL.) Published information on speckled trout in the Gulf, mostly from Texas and Florida (Pearson, 1929; Guest and Gunter, 1958; Tabb, 1966; King, 1971), indicates that most spawning of speckled trout occurs in high salinity ($>$30 ppt) areas of interior bays and estuaries, usually in association with beds of submerged vegetation. Frequent occurrence of newly-hatched larvae and repeated local observations of adults in spawning condition led us to conclude that speckled trout spawn in the immediate vicinity of Caminada Pass, an area of low to medium salinities and lacking in submerged vegetation. The majority of our speckled trout postlarvae were collected in patches of fine to medium "coffee-ground" detritus, suggesting that such material may, in the absence of submerged vegetation, offer suitable cover.

Among minor fishes, eight species were collected only in association with drifting sargassum weed which occurred in the pass area during June and October of 1971. These included: juveniles of the dolphin, plainhead filefish, sargassumfish, rough triggerfish, tripletail, margintail conger and flyingfish. Notable among other minor species collected during summer were: postlarvae of the emerald sleeper and blenny *(Hypsoblennius sp.)* and juveniles of the lane snapper, grey snapper, permit, spanish mackeral and great barracuda.

Extended-Intermediate Species. Five major species collected during the study could not be classified exclusively with either warm- or coldwater assemblage. Two species, skilletfish *(Gobiesox strumosus)* and redfish *(Sciaenops ocellata)* occurred intermediate to the seasonal assemblages and three species, darter goby *(Gobionellus bolesoma)* bay whiff *(Citharichthys spilopterus)* and fringed flounder *(Etropus crossotus)* were collected in almost equal numbers during both seasonal periods (Table 3).

Assemblage Relationships. Overall, the warmwater assemblage was considerably more diverse than the cold (19 major species to 7 respectively, Table 3). In terms of numbers of individuals, however, there was little difference between assemblages. The six most abundant species consisted of an equal number of cold- and warmwater forms. A significant difference between assemblages was noted among the life histories of the individual species. The coldwater group consisted primarily of young-of-the-year that were moving from spawning grounds in the Gulf of Mexico to nursery grounds in nearby bays and marshes. For coldwater species, the Caminada Pass area was essentially a pathway and secondarily a nursery ground. The warmwater assemblage consisted primarily of young-of-the-year of inshore spawners and were not moving through the pass from the Gulf. For warmwater species, the pass area served both as spawning ground for adults and nursery for developing young.

Diel Patterns in Catch

Results of statistical analyses of 11 major species and observations on 20 others revealed useful information on the effects of light and tide on the distribution and abundance of each species. In general, the catch of coldwater species was affected more by tidal stages than light periods and the opposite appeared true for warmwater species.

Warmwater Assemblage. As a whole, diel patterns in catch varied among warmwater species. Of the four species statistically analyzed (scaled sardine, bay anchovy, tidewater silverside and speckled trout), the only significant difference in catch at the pass station was between light periods for scaled sardine. Catch of scaled sardine was greater during day than night. Though not statistically significant, bay anchovy and speckled trout catches were greater during day while tidewater silversides were more abundant at night. Among other warmwater species, the catch of striped and dusky anchovy, Atlantic bumper and least puffer were greater during day while the darter goby and longnose killifish were more abundant at night. Although lacking significant statistical support it appeared that catch per tow among warmwater species varied more with light-dark periods than tidal stage.

Coldwater Assemblage. Strong similarities in diel catch patterns were noted among coldwater species analyzed. The catch of four species (Atlantic croaker, pinfish, striped mullet and southern flounder) showed significant statistical differences between tidal stages and the catch of menhaden approached significance with regard to tidal stage. Only the catches of striped mullet and pinfish showed statistical differences between light periods. Croaker, pinfish, striped mullet and menhaden were more abundant at the pass station during ebb tides; southern flounder were more abundant at the bay station during ebb tides. Striped mullet were more abundant during dark periods and pinfish were more abundant during days. (Due to net avoidance, the trawl was probably more effective for mullet of the size ranges encountered during dark periods than during day.) Though not statistically significant, catches of spot and southern flounder were greater during ebb at the pass station while catches of the speckled worm eel (letocephali) were greater during flood.

The similarity in diel patterns exhibited by some of the coldwater assemblage indicates that this group react similarly to the problem of inshore transport. The literature (Pearson, 1929; Hoese, 1965; Fore and Baxter, 1972) and our local observations lead us to suspect that this shoreward movement is at least partly active and perhaps in phase with tidal flow. The young-of-the-year of the coldwater assemblage are large enough at the time of reaching the tidal passes to swim actively; in fact, large schools of spot postlarvae have been observed swimming bayward along the shore with flooding tides.

That large catches of some coldwater species were made on ebbing tides may have several explanations. Immigrating postlarvae may seek out the quieter waters near shore (and in range of the beam trawl) during ebb tide. Or, perhaps, the ebbing tide concentrated the postlarvae onshore as it does detritus such as water hyacinth and mangrove seeds. The hydrography of the Barataria Bay system and Caminada Pass is such that ebb flows are stronger than floods and that flows are greater on the western side. Perhaps confinement of sampling to the western shore of the pass explains higher catches of some species on ebb tides. At any rate, we believe that on flooding tides the postlarvae are dispersed and swim and/or are carried inland.

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DESCRIPTION AND EVALUATION OF A LONG-HAUL SEINE FOR SAMPLING FISH POPULATIONS IN OFFSHORE ESTUARINE HABITATS

by

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ABSTRACT

A long-haul seine was designed to sample 10,000 m^2 of open water less than 3.5 m deep for both pelagic and semi-demersal fish populations. The net, 354 m long constructed of 20 and 25 mm bar mesh, was used to encircle the area, and by a simple method to concentrate and purse the catch in open water. Atlantic menhaden, *Brevoortia tyrannus*; Atlantic thread herring, *Opisthonema oglinum*; pinfish, *Lagodon rhomboides*; and striped mullet, *Mugil cephalus* were the most abundant species collected from 60 samples taken during 1973 in the Newport River estuary (Carteret County, North Carolina). Sample to sample variation for individual species was high, with coefficients of variation usually about 100%. Mark-recapture experiments using a total of 232 marked fish indicated that 31 to 54% (95% confidence limits) of the marked pelagic and semi-demersal fish released in the sampled water mass were recovered.