SEASONAL ABUNDANCE AND DISTRIBUTION OF MARINE ORGANISMS IN A SEMI-IMPOUNDED LOUISIANA WILDLIFE MANAGEMENT AREA

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Abstract—*Data presented describe seasonal abundance and distribution of finfish and shrimp in an area on Rockefeller Refuge semi-impounded by Wakefield weirs. Eight stations in the 3,565 ha southwest Louisiana coastal wildlife management area were trawled twice a month from 2 March 1974 to 5 March 1975 utilizing an airboat. Numerically,* Menidia beryllina *was most abundant followed by* Penaeus setiferus, Micropogonias undulatus, *and* Brevoortia patronus. *Stations near the weirs experienced considerable diversity of species and largest samples.*

Water level stabilization resulting from the placement of weirs in the watershed enabled samples to be obtained at all stations during the one year study. Evidence of the migratory nature of many of the species is presented in this report.

Key words: Coastal semi-impoundment, weir, marine organisms.

Introduction

The Louisiana Department of Wildlife and Fisheries through its Fur and Refuge Division owns and manages over 202,000 ha of coastal wetlands. Active management programs utilized on these areas by the department include: forced drainage, gravity drainage, controlled estuarine, and passive estuarine management. The last two programs, controlled and passive estuarine management, are practiced in areas near the coast which are subjected to tidal fluctuations, contain brackish-to-saline vegetative communities, and are frequented by estuarine dependent fishes (Wicker et al. 1983). These management programs have evolved through years of trial and error.

Wakefield-type weirs have been popular with coastal land managers since the early 1940's. These pioneers, recognizing a need for water control, began constructing primitive structures which evolved into the modern weirs of today. Without question, these people must be recognized as being directly responsible for the salvation of thousands of hectares in coastal Louisiana from degradational processes.

Weirs were originally constructed with the idea that the structures would reduce salinities, stabilize water levels, minimize turbidity, and restrict the rate of tidal exchange. However, detailed studies by Chabreck and Hoffpauer (1962) revealed that salinity and turbidity were only slightly affected. These authors found the greatest effect obtained through the use of weirs was water level stabilization. Nevertheless, marshes affected by weirs were far more productive than natural marshes. In many cases, Chabreck (1968) found aquatic production to be up to four times more abundant behind weirs.

The first weirs were usually constructed of wood and placed several centimeters below the surrounding marsh; they moderated tidal interchange

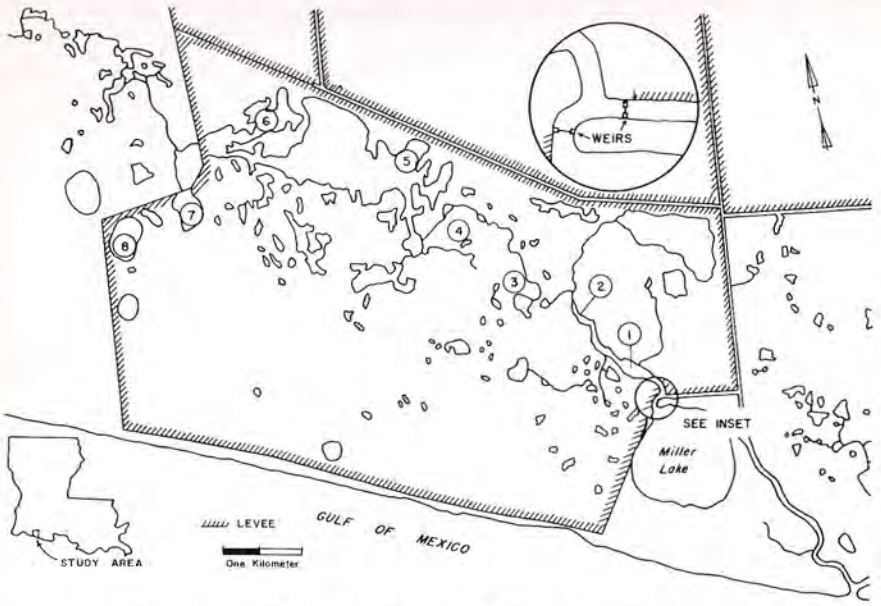

FIGURE 1. Location of sampling stations in the semi-impounded Price Lake area at Rockefeller Wildlife Refuge, 1974–1975.

on most incoming and outgoing tides. Size, shape, and materials varied considerably depending upon the situation. Usually weirs were placed in the smaller water sheds when landowners needed control of water levels without eliminating access to the systems by the estuarine-dependent species of the marine community. Weirs were also used in areas of relatively unstable marsh which could not support continuous levees. The controlled areas were therefore considered semi-impounded.

Popularity of weirs increased in the 1960's and 1970's when over 100,000 ha of wetlands were managed under this system (Herke 1978). Construction techniques were improved by using steel interlocking sheet

TABLE 1. Sample station description, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana, 1974–1975. Stations 1–3 were in the weir zone, 4–6 the mid zone, and 7 and 8 the far zone.

Station no.	Habitat type	Average depth (m)	Average salinity (ppt)	Average secchi (cm)	Average oxygen (ppm)
1	Lake	0.2 (0.1–0.5)	9.2 (3.5–15.9)	10 (5–15)	5 (3–11)
2	Canal	0.6 (0.2–0.8)	9.4 (4.1–21.5)	12 (5–15)	5 (1–10)
3	Lake	0.2 (0.1–0.7)	9.7 (3.7–23.3)	13 (2–28)	6 (2–10)
4	Lake	0.4 (0.2–0.6)	9.0 (3.6–15.6)	15 (8–25)	6 (1–13)
5	Lake	0.5 (0.4–0.6)	7.9 (3.5–14.0)	12 (5–18)	6 (1–12)
6	Lake	0.6 (0.2–0.8)	6.9 (3.6–14.8)	13 (8–23)	5 (1–11)
7	Lake	0.6 (0.4–0.8)	6.4 (3.5–11.0)	13 (8–25)	6 (1–10)
8	Lake	0.6 (0.3–0.8)	6.4 (3.4–13.0)	12 (5–23)	5 (1–10)

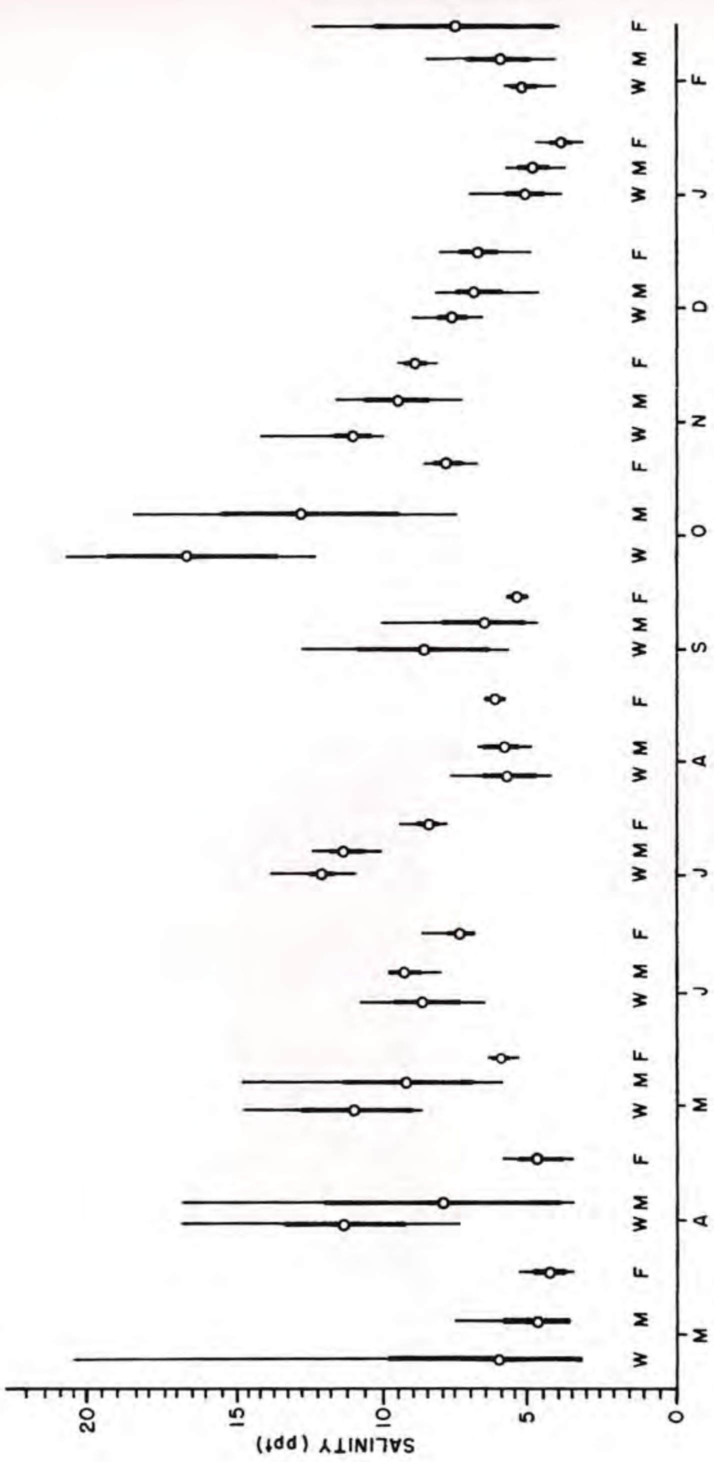

FIGURE 2. Seasonal salinity of the zones sampled twice a month at Rockefeller Wildlife Refuge, 1974–1975. The weir zone (W) included stations 1, 2, and 3, N=72; the mid zone (M) stations were 4, 5, and 6, N=72; and the far zone (F) stations were 7 and 8, N=48. The thin line represents the range, the dark line represents the standard deviation, and the circle represents the mean.

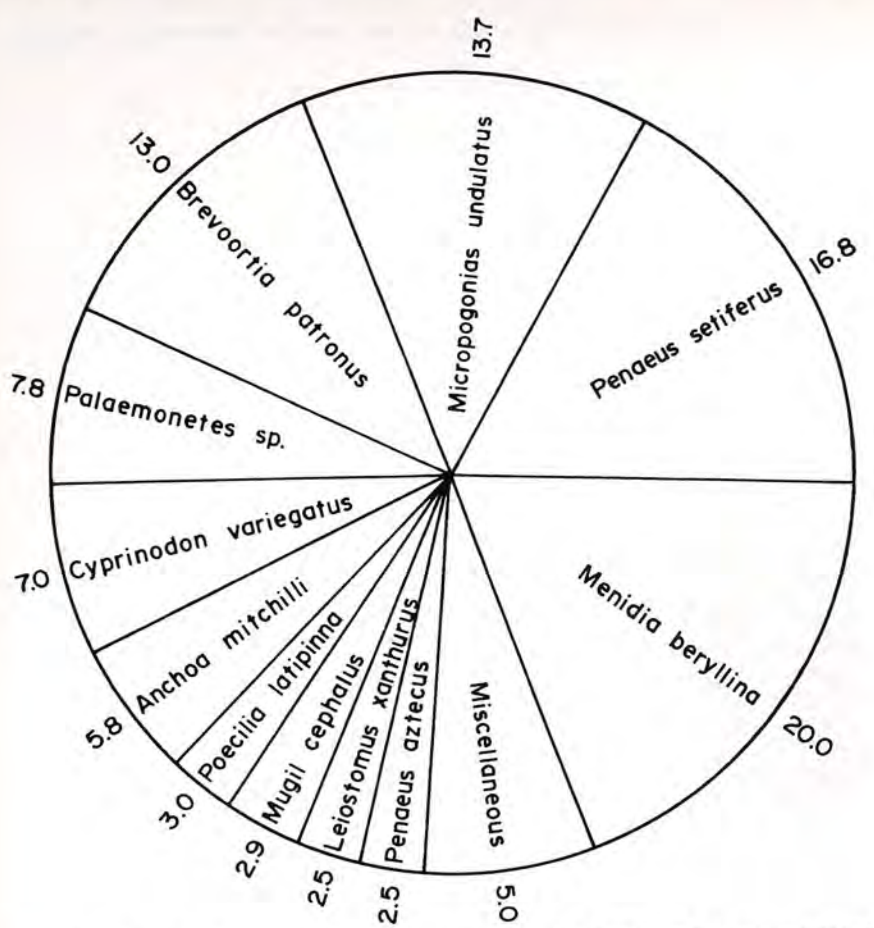

FIGURE 3. Species composition of organisms collected in Price Lake, Rockefeller Wildlife Refuge, 1974–1975.

piling capable of withstanding increased tidal surges. Subsequently, stronger structures were built. Coastal marsh managers realizing the negative impacts that were taking place with the increased canal dredging made every attempt to keep pace with the expanding oil and gas programs. In many cases oil companies were requested by the landowners to install weirs, or rebuild levees as mitigation. As a result, surface activities such as duck hunting, fur trapping, crabbing, and shrimping were maintained in conjunction with intensive mineral development programs.

Presently, due to a sagging economy, accompanied by reduced petroleum revenue, increased material costs, and increased governmental involvement, vast areas of prime wetlands are being neglected. Consequently, proper management techniques of productive wetlands are again lacking in many areas.

The objective of this study was to identify marine organisms, and to

TABLE 2. Species collected by trawl in the Price Lake semi-impoundment, Rockefeller Refuge, 1974–1975.

Species	Percent by zone			Total number
	Weir	Mid	Far	
Adinia xenica	100	0	0	4
Anchoa mitchilli	70	30	0	12,073
Anguilla rostrata	0	100	0	951
Archosargus probatocephalus	7	89	4	27
Arius felis	100	0	0	2
Bairdiella chrysura	100	0	0	2
Brevoortia patronus	72	27	1	26,449
Caranx hippos	82	18	0	34
Chaetodipterus faber	89	11	0	9
Chloroscombrus chrysurus	0	100	0	2
Cynoscion arenarius	89	11	0	486
Cynoscion nebulosus	100	0	0	1
Cyprinodon variegatus	18	80	2	14,952
Dormitator maculatus	86	14	0	14
Dorosoma cepedianum	77	9	14	1,108
Dorosoma petenense	78	22	0	1,306
Elops saurus	85	12	43	46
Eucinostomus argenteus	51	49	0	35
Fundulus confluentus	64	36	0	50
Fundulus grandis	52	47	1	479
Fundulus jenkinsi	25	25	50	4
Fundulus pulvereus	50	50	0	197
Fundulus similis	92	8	0	24
Gambusia affinis	45	55	0	160
Gobioides broussonneti	100	0	0	1
Gobionellus boleosoma	87	7	6	575
Gobionellus hastatus	91	3	6	115
Gobionellus shufeldti	52	39	9	69
Gobiosoma bosci	19	74	7	78
Ictalurus furcatus	0	0	100	1
Lagodon rhomboides	52	48	0	44
Larimus fasciatus	97	3	0	31
Leiostomus xanthurus	29	67	4	5,234
Lepisosteus oculatus	11	35	54	37
Lepisosteus spatula	53	30	17	71
Lucania parva	6	84	10	1,366
Lutjanus synagris	100	0	0	1
Menidia beryllina	6	51	43	41,055
Microgobius gulosus	20	80	0	35
Micropogonias undulatus	71	20	9	28,409
Mugil cephalus	43	42	11	5,991
Myrophis punctatus	0	0	100	2
Opisthonema oglinum	100	0	0	255
Palaemonetes sp.	36	60	4	16,094
Paralichthys lethostigma	65	20	15	504
Penaeus aztecus	42	38	20	5,219
Penaeus setiferus	54	25	21	34,843
Poecilia latipinna	11	89	0	6,997

TABLE 2. Continued.

Species	Percent by zone			Total number
	Weir	Mid	Far	
Pogonias cromis	47	6	47	43
Polydactylus octonemus	67	33	0	214
Prionotus sp.	70	30	0	10
Sciaenops ocellata	92	5	3	379
Sphoeroides nephelus	100	0	0	1
Symphurus plagiusa	82	0	18	127
Synodus foetens	75	25	0	8
Trichiurus lepturus	70	30	0	10
Trinectes maculatus	100	0	0	1

determine their seasonal abundance and distribution, in a semi-impounded wildlife management unit at Rockefeller Wildlife Refuge.

MATERIALS AND METHODS

Located in the coastal marshes of southwest Louisiana, the 34,000 ha refuge is primarily managed for waterfowl (Chabreck 1960). Consequently, the area is highly managed utilizing a variety of water control methods unique to coastal Louisiana.

The tidal marshes of the 3,565 ha Price Lake area were semi-impounded in 1967 by the placement of two 20 m Wakefield weirs with crest of approximately 9 cm in the drainage system (Fig. 1). Cessation of water movement in this system has rarely been observed (Arnoldi 1974, Knudsen 1976, Perry 1981).

Sampling commenced on 2 March 1974 and was repeated every other week at each of eight stations through 5 March 1975 (Table 1). On each sample day, collections were made at all stations within a 12 hr period. An airboat was used to tow a 4.9 m flat otter trawl (2 cm bar mesh with a 6 mm knitted mesh lining in the tail). Each tow was 400 m long and lasted approximately 5 minutes. Dissolved oxygen, salinity, secchi disk and water depth were taken prior to the start of each sample. Organisms collected were preserved in 10% formalin solution (except for unusually large specimens which were measured in the field). The sample was later sorted by species, number, and frequency caught at each station, and measured to the nearest 5 mm standard length. Shrimp were measured as to total length. To determine and document species change in relation to distance inland from the weirs, stations were grouped in three classifications. Stations 1, 2, and 3 (stations closest to the weir) were grouped into a weir classification; stations 4, 5, and 6 were grouped as mid; and stations 7 and 8 were classed as far.

RESULTS

Twice-monthly samples illustrated a decrease in salinity with distance traveled inland from the weirs (Fig. 2). February 1985 was the only exception when the far zone salinity readings averaged 8 ppt, mid zone 5.7 ppt,

and weir zone 5.2 ppt. Table 1 indicates the lowest reading was at station 8, ranging from 3.4–13.0 ppt. Turbidity as measured with a secchi disk was similar at all stations. Small lake stations 3 and 4 were less turbid in late spring and fall due to the presence of aquatics, primarily widgeongrass, *Ruppia maritima*. Oxygen readings fluctuated considerably with lowest concentrations in July when dead fish were found in the weir zone.

Tidewater silversides, *Menidia beryllina,* contributed 20% of the total abundance followed by: white shrimp, *Penaeus setiferus,* 16.8%; Atlantic croaker, *Micropogonias undulatus,* 13.7%; gulf menhaden, *Brevoortia patronus,* 13%; grass shrimp, *Palaemonetes* sp., 7.8%; sheepshead minnow, *Cyprinodon variegatus,* 7.0%; and bay anchovy, *Anchoa mitchilli,* 5.8% (Fig. 3). A total of 57 species was identified: 206,246 specimens were measured and their distribution and abundance recorded (Table 2).

Brown shrimp appeared in April 1984 at the weir and mid zones and spread to the far zone by May (Fig. 4). Average size was consistently larger at the far zone and a bleeding off of the larger shrimp was evident beginning in September. Samples in July and August revealed declining brown shrimp catches, thus indicating their exodus.

Large numbers of juvenile white shrimp first appeared in July. A maximum average size of 90 mm was reached in the far zone in September. Their migration out of the marsh began in September. The shrimp portion of the data in this study was analyzed in detail (Perry 1981).

Atlantic croaker were collected at all stations although the stations nearest the weir yielded the most (Fig. 5). When sampling commenced in March 1974 croaker total lengths had the largest range nearest the weir and least in the far zone. Large catches of juveniles occurred in the months of March and April of 1984 and January and February 1985.

Similarly, the transient nature of spot, sand seatrout, flounder, and gulf menhaden was evident. Each species was more abundant in the habitat types of the weir zone. Of these, only sand seatrout were not collected from the far zone. Bay anchovy like shrimp also decreased in numbers and increased in average size with an increase in distance from the weirs (Fig. 5). Months of 1984 of maximum abundance for bay anchovy were April in the mid zone, September in the far zone, and October in the weir zone.

DISCUSSION

This data supported information published by Chabreck and Hoffpauer (1962), Larrick and Chabreck (1976), Herke (1977), and Wengeart (1972) on the buffering effect of weirs on salinity, turbidity, and waterlevel fluctuation. In their Marsh Island study area Chabreck and Hoffpauer (1962) determined the mean annual water level behind weirs was 0.1 m higher than natural areas. Greatest difference in water levels at one time was 0.8 m and a −0.3 m tide resulted in only 2.4% of the pond bottoms behind weirs being exposed, but with the same tide in the natural areas approximately 84% of the ponds were dry. These characteristics are tremendously important in wetland management where subsidence and erosion have resulted in consid-

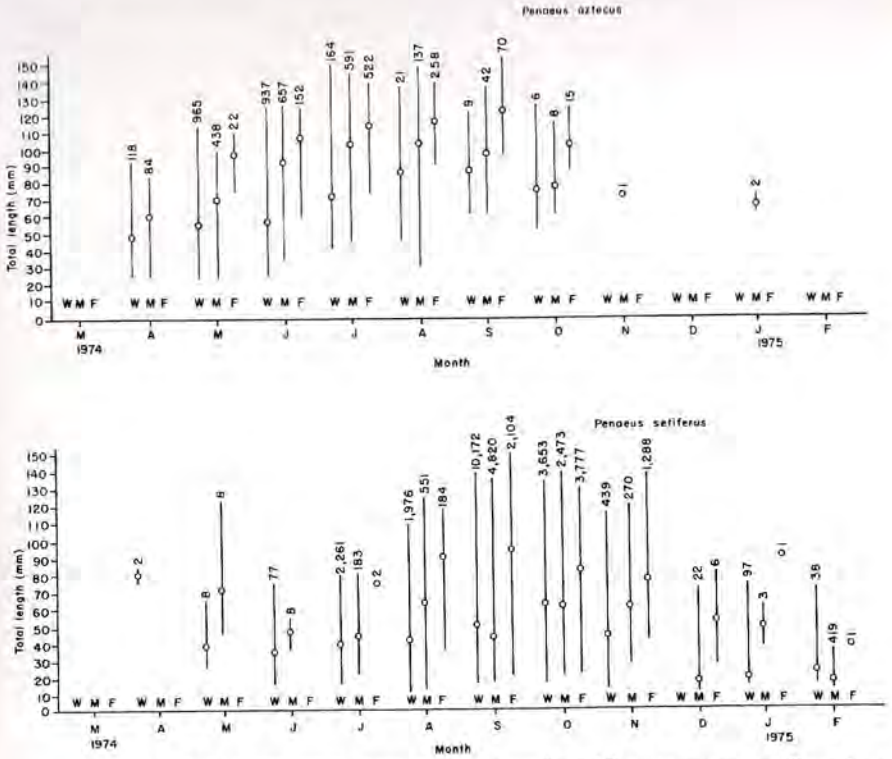

FIGURE 4. Total length range, mean, and total number of *Penaeus aztecus* and *P. setiferus* captured from the sample zones, in Price Lake, 1974–1975. The weir zone (W) included stations 1, 2, and 3; the mid zone (M) stations were 4, 5, and 6; and the far zone (F) stations were 7 and 8.

erable natural land loss, increased turbidities, and increasing salinities. This is so intense that Gagliano (1981) reported Louisiana's coastal zone which makes up over 30% of the nations coastal wetlands is losing over 10,000 ha per year. In an effort to lessen this, land owners have utilized, among other techniques, a system of weirs as a tool in the management of some of their wetlands.

In this study it has been demonstrated that marine organisms were allowed to enter the study area and distribute to the farthermost point. White shrimp catches were 7 times more numerous than brown shrimp. Catch per unit effort of larger shrimp, length over 10 cm, was greatest at stations 7 and 8, which were farthest from the weir.

Catches of shrimp in the zones nearest the weir were highest. This was due to the fact that this area experiences a greater water exchange as the channel is relatively constricted compared to the more wide open water area farther inland. Those in the farthest stations are more sedentary. Also, the average size of individual species were greatest farthest from the weir.

Better habitat conditions behind weirs may result in increased growth

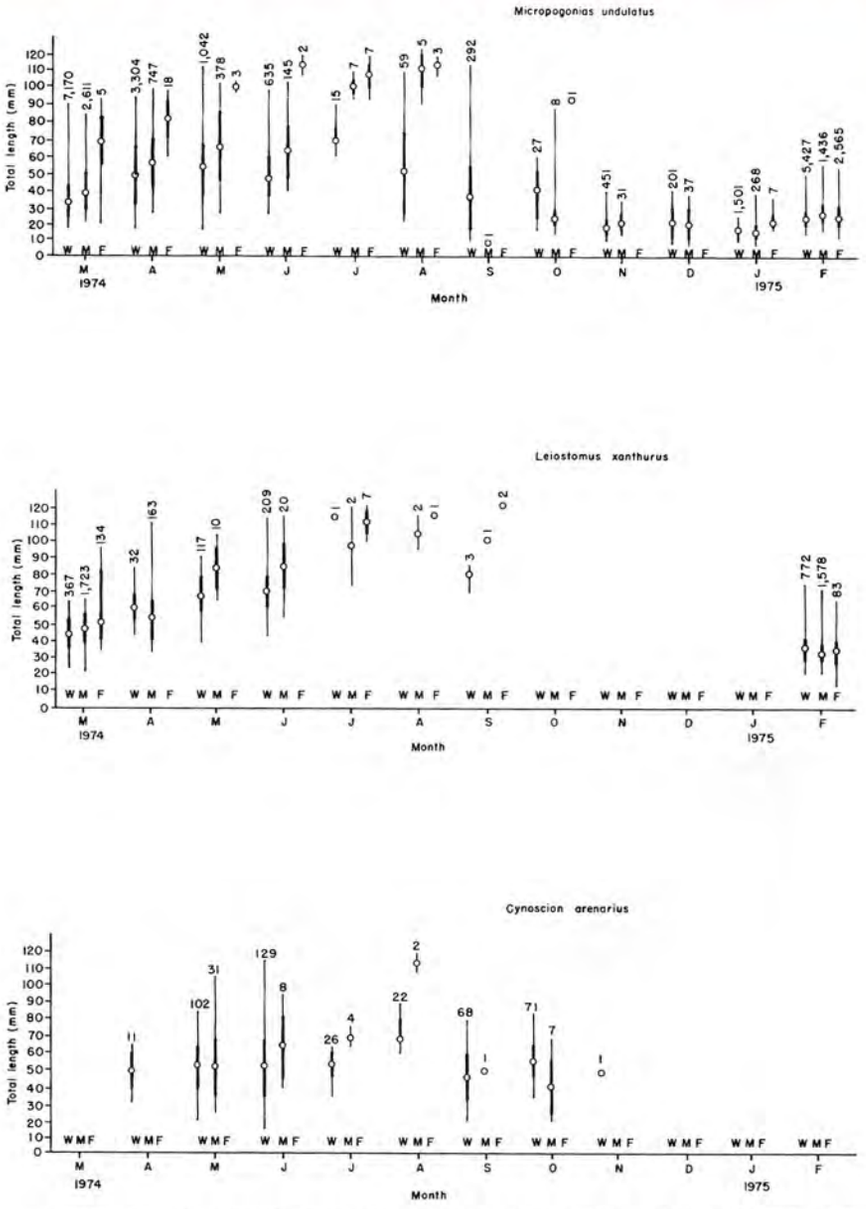

FIGURE 5a. Total length range (thin line), standard deviation (dark line), and mean (circle) of the more abundant or important fin-fish captured from the Price Lake sample zones, 1974–1975.

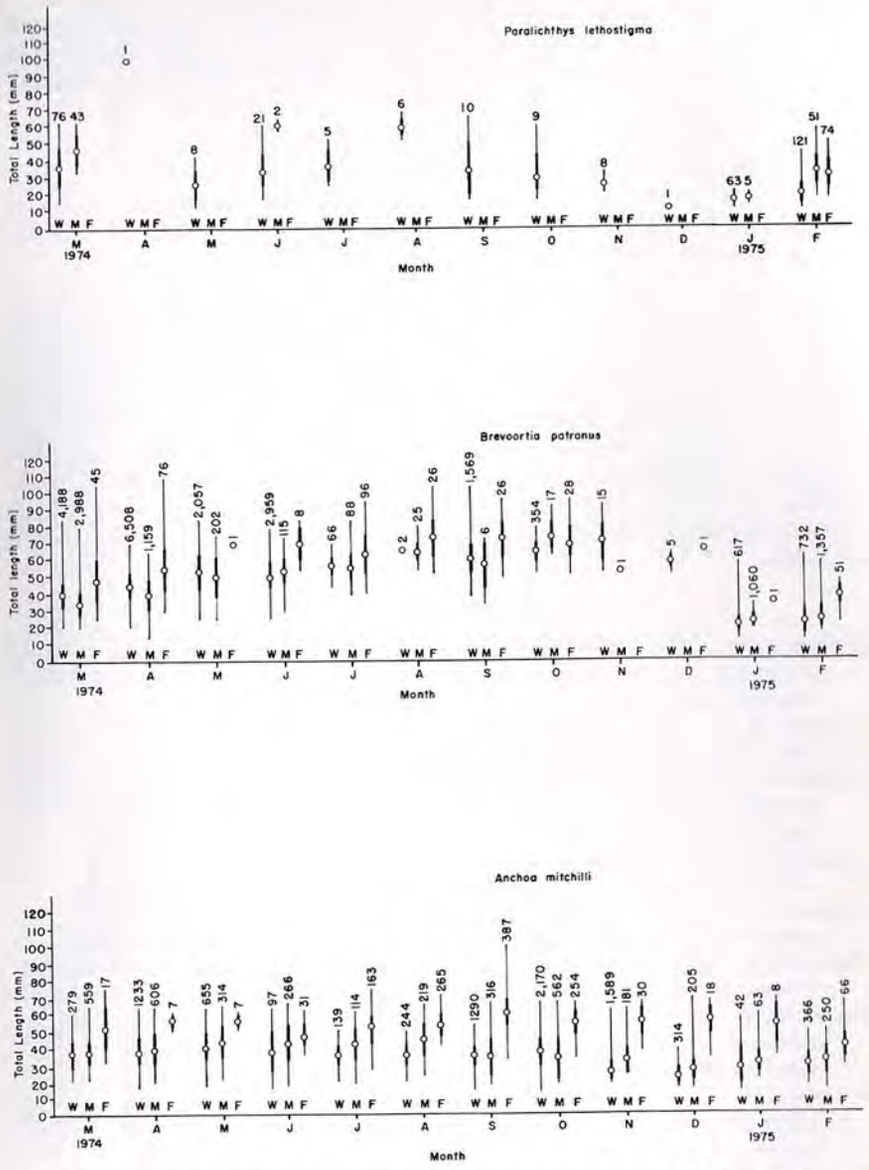

FIGURE 5b. Total length range (thin line), standard deviation (dark line), and mean (circle) of the more abundant or important fin-fish captured from the Price Lake sample zones, 1974–1975.

rates of marine organisms. Herke (1978) found some species leaving the semi-impounded marshes were larger, which poses the question "which is of the most benefit—returning a certain number of large organisms to the Gulf or returning many more small ones?"

The weirs apparently did not prohibit the exodus of organisms to the extent that they were killed due to cold weather. Samples were taken on a regular basis and the only dead organisms found were those which died from low dissolved oxygen in late summer. During the colder winter months few species were collected, indicating their departure.

In summary, previous studies demonstrated the desirable results of water management to the coastal environment. This study indicates the following: 1) the Price Lake marsh managed by weirs, a form of water management, experienced what appeared to be buffering effect on salinity and depth fluctuations and complete dewatering from low tides, northers, etc.; and 2) the structures did not prohibit ingress and egress of marine organisms. The initiation of management through placement of weirs or other structures in watersheds of deteriorating productivity should be considered as one of the alternatives to provide for the maintenance and productivity of the coastal ecosystem.

LITERATURE CITED

ARNOLDI, D. C. 1974. Use of fluorescent granule implantation to estimate growth rate and length of stay in a Louisiana coastal marsh nursery by juvenile Atlantic croaker, *Micropogon undulatus*. Thesis. Louisiana State University, Baton Rouge, Louisiana. 51 pp.

CHABRECK, R. H. 1960. Coastal marsh impoundments for ducks in Louisiana. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 14:24–29.

CHABRECK, R. H. 1968. Weirs, plugs and artificial potholes for the management of wildlife in coastal marshes. Proc. Marsh and Estuary Management Symposium. Louisiana State University. Pp. 178–192.

CHABRECK, R. H. AND C. M. HOFFPAUER. 1962. The use of weirs in coastal marsh management in Louisiana. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 16:103–112.

GAGLIANO, S. M. 1981. Special report on marsh deterioration and land-loss in the deltaic plain of coastal Louisiana. Coastal Environments, Inc., Baton Rouge, Louisiana. 12 pp.

HERKE, W. H. 1977. Life history concepts of motile estuarine-dependent species should be re-evaluated. W. H. Herke, Baton Rouge, Louisiana. 97 pp.

HERKE, W. H. 1978. Some effects of semi-impoundment on coastal Louisiana fish and crustacean nursery usage. Proc. Third Coastal Marsh and Estuary Management Symposium. Louisiana State University. 3 pp.

KNUDSEN, E. E. 1971. The growth rate of juvenile brown shrimp, *Penaeus aztecus*, in a semi-impounded Louisiana coastal marsh. Thesis. Louisiana State University, Baton Rouge, Louisiana. 50 pp.

LARRICK, W. D. AND R. H. CHABRECK. 1976. Effects of weirs on aquatic vegetation along the Louisiana coast. Proc. Ann. Conf. Southeast. Assoc. Fish Wildl. Agencies 13:581–589.

PERRY, W. G. 1981. Seasonal abundance and distribution of brown and white shrimp in a semi-impounded Louisiana coastal marsh. Proc. Louisiana Acad. Sci. 44:102–111.

WENGERT, M. W., JR. 1972. Dynamics of the brown shrimp, *Penaeus aztecus aztecus* Ives 1891, in the estuarine area of Marsh Island, Louisiana in 1971. Thesis. Louisiana State University, Baton Rouge, Louisiana. 93 pp.

WICKER, K. M., D. DAVIS, AND D. ROBERTS. 1983. Rockefeller State Wildlife Refuge and Game preserve: Evaluation of wetland management techniques. Coastal Management Section Louisiana Department of Natural Resources. 95 pp.