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SEASONAL ABUNDANCE AND DISTRIBUTION OF BROWN AND WHITE SHRIMP IN A SEMI-IMPOUNDED LOUISIANA COASTAL MARSH

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Abstract. *This paper documents brown shrimp,* Penaeus aztecus, *and white shrimp,* P. setiferus, *occurrence in a Louisiana coastal marsh semi-impounded by Wekefield weirs. Stations represented a diversity of habitat types and were sampled twice monthly in the 2,800 ha wildlife management area.*

Seasonal abundance and distribution data on 39,639 shrimp showed white shrimp to be most abundant. The only month in which no shrimp were collected was March. Brown shrimp appeared in April, dispersed throughout the study area, and by the end of August few remained. Some white shrimp which overwintered in the Gulf and returned to the marshes were collected in April; however, large catches of juveniles did not occur until July. Catch per unit effort peaked in September and October and fell considerably in November. Large white shrimp, like the brown shrimp, emigrated ahead of the smaller shrimp. Unlike brown shrimp which seemed to be stimulated to leave by increasing water temperatures, the white shrimp were influenced by decreasing temperatures.

Introduction

Louisiana's coastal marshes offer some of the most productive fisheries and wildlife habitat in the world. As evidence of this, coastal commercial fisheries including shrimp, *Penaeus aztecus* and *P. setiferus*, menhaden, *Brevoortia patronus,* oysters, *Crassostrea virginica,* and crabs, *Callinectes sapidus,* amount to an annual income of approximately $200,000,000. Mid-winter waterfowl inventories reveal from 5 to 6.5 million waterfowl annually; fur harvest peaked in 1977 with $25,000,000 being earned by trappers. When one adds the value of recreational pursuits to this an amazing sum is obtained.

There is considerable variation in the coastal marshes of Louisiana. Some areas are more conducive to particular forms of fisheries than others. Much of this variation is natural; however, some has been attributed to man's efforts to alter marshes for a particular objective. Canals have been dredged, streams deepened and areas drained. Salt water intrusion, tidal action and drainage problems confronted landowners who were not always directly responsible for the changes. As a solution early land managers plugged canals with earthen dams. In the early 1940's, Wakefield-type weirs gained popularity with fur trappers who built them to stop drainage and for access into their trapping ground. These were low level dams set in drainage areas with a crest several centimeters below marsh elevation thereby providing tidal water interchange.

In the 1950's several of the larger marsh landowners recognized the rapid deterioration of their lands. The primitive designs of the trappers were modified and they began strategically placing weirs in the numerous pipeline canals and small watersheds. Presently, over 100,000 ha of marshland in Louisiana have been semi-impounded by the weirs.

Fisheries workers have expressed concern over the placement of weirs in tidal drainage canals. Tidal flows are involved in the life history of many of our economically important fish and crustaceans. Structures which affect tidal flows, as weirs, may also affect their movement.

Overall effects of weirs on the state fisheries are not fully understood though researchers have studied the fisheries in semi-impounded and unimpounded marshes for over a decade. Fishery workers are still unable to say whether semi-impoundment is a "bad" or "good" fishery management practice (1).

The Louisiana Department of Wildlife and Fisheries has several thousand hectares of marshlands semi-impounded. As an agency responsible for all wildlife resources of our state, the Department wants to know what indirect effect may occur by various land management practices. An objective of this study was to determine and document shrimp usage of a semi-impounded marsh on Rockefeller Wildlife Refuge. It was not possible to obtain data before the weirs were constructed; however, the location and physical characteristics of this marsh historically indicate it to have been an important nursery.

Description of Study Area

The investigation was conducted on Rockefeller Wildlife Refuge which is in the coastal chenier plain marshes of southwest Louisiana. Price Lake, the study area, consists of approximately 2,800 ha of semi-impounded brackish marsh in which water depths are less than 1 m (Fig. 1).

Historically the area drained to the east through Miller's Lake and Joseph Harbor Bayou. Westward drainage was across private lands and through Hog Bayou to the Gulf. In 1967, to facilitate water management for waterfowl and fur bearing animal production, a canal was extended eastward from Joseph Bayou on the north end of Miller's Lake to Humble Canal. A weir was then placed on the canal and on Joseph Bayou below the junction (Fig. 1). The crests of the weirs were placed 15 cm below average marsh level, which allowed water to flow in and out on most tides. The management area was completed in 1969 with the extension of a levee system, 1.4 m high, southward from the

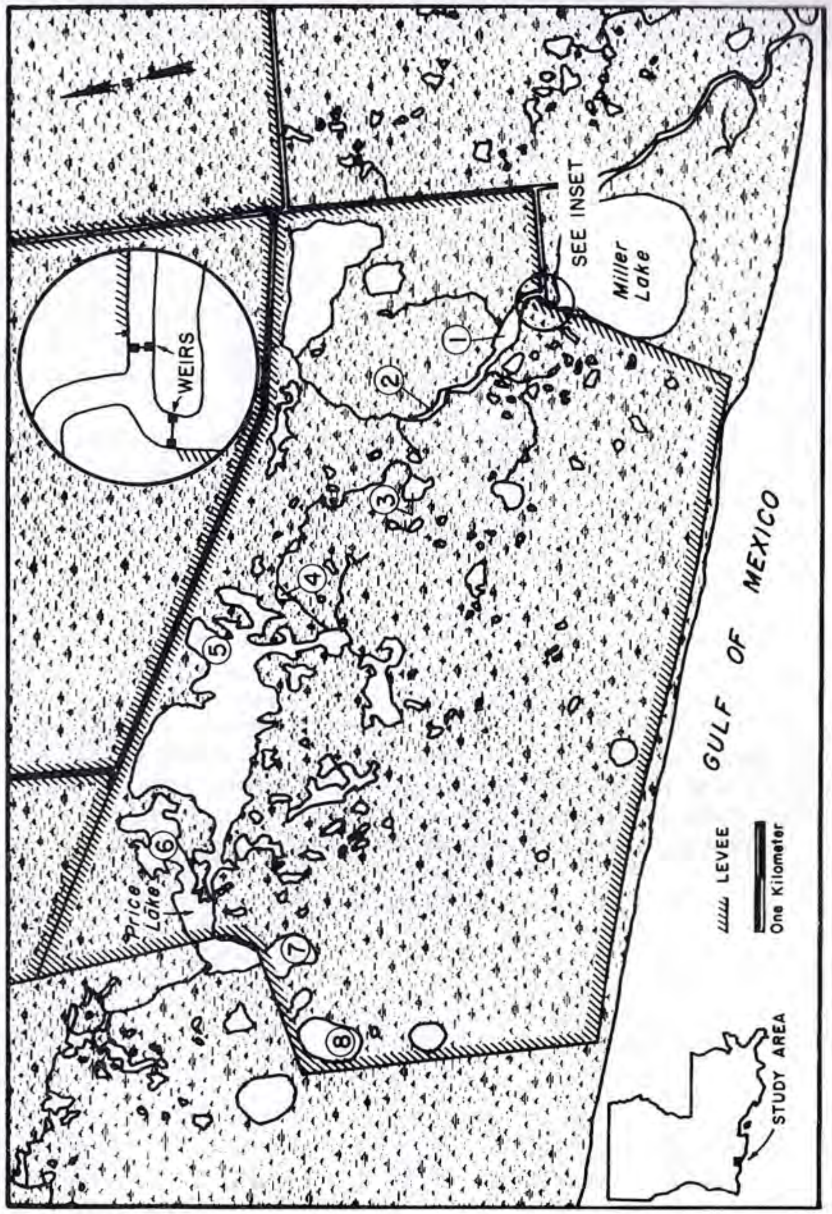

FIGURE 1. Location of sampling stations in the semi-impounded Price Lake at Rockefeller Wildlife Refuge, 1974-75.

end of Price Lake Road and along the natural beach ridge on the south. Cessation of flow over these weirs has rarely been observed (2, 3). Water movement in this system is frequently a result of wind and is also affected by lunar tides and rainfall.

MATERIALS AND METHODS

Eight stations were established and sampling commenced on March 2, 1974. As illustrated in Figure 1, station 1 was nearest the weir and the others intermittently spaced toward the western boundary of the semi-impounded management area. Sample sites were selected in shallow to moderate depth lakes and in a bayou complex transversing the study area (Table 1). On each sample day, collections were made at all stations within a 12 hr. period and were repeated every other week through March 5, 1975. Sample gear consisted of an airboat which towed a 4.9-m flat otter trawl, 2-cm bar mesh with a 6-mm knitted mesh liner in the tail, at each station. Each tow was 400 m long and lasted approximately 5 min. Dissolved oxygen, salinity, secchi and depth were taken immediately prior to the start of each sample.

TABLE 1. Sample station description, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana.

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)

RESULTS

Twice monthly trawl samples at each station revealed salinities gradually decreased with distance inland from the weirs. The lowest reading was at Station 8 where it ranged from 3.4-13.0 ppt (Table 1). Average turbidity secchi disk readings were almost similar although on a particular sample day they would sometimes vary considerably. The small lake stations of 3 and 4 were less turbid in late spring and early fall when widgeongrass, *Ruppia maritima*, was present. As in all shallow marsh systems, oxygen readings fluctuated considerably. Lows of 1 ppm were recorded for all stations except 1 and 3. Lowest readings occurred in July. Dead red drum, *Sciaenops ocellata*, black drum, *Pogonias cromis*, sheepshead, *Archosargus Probatocephalus*, and southern flounder, *Paralichthys lethostigma*, were found at stations 1, 2 and 3.

Count and measurement data were taken from samples of 39,639 shrimp during the study. White shrimp contributed 87% of this total. Shrimp were found during all months except March.

A total of 5,128 brown shrimp were collected. And with the exception of Station 2, they were evenly dispersed over the study area. Station 2, a natural bayou serving the entire semi-impoundment, yielded almost twice as many brown shrimp, 1,045, as each of the other stations.

Brown shrimp first appeared in April with juveniles collected from Stations 1-4 (Fig. 2). May and June were the months of peak catch at Station 1-3 and by this sampling period they had dispersed to all stations. Few exceeded 100 mm. July was the peak month for Stations 7 and 8 where 96% exceeded 100 mm. By the end of August, very few brown shrimp remained in the study area.

An analysis of the brown shrimp data by month with all stations combined revealed 27% of the total catch was made in May and only 4% were classed as large individuals, length over 100 mm. The catch peaked in June when 33% of the brown shrimp were collected. Sizes had increased whereby larger individuals made up 33% of the catch. The warmer months of July and August noted declining brown shrimp catches.

Brown shrimp utilized the stations furthest from the weirs. Catch per unit effort [C/E] of larger individuals, length over 100 mm, was equal to the catch of smaller shrimp at Station 5 and progressed higher through Station 8 when C/E was 23.2 for the larger individuals and 0.9 for the smaller (Fig. 3).

White shrimp like the browns demonstrated their transient nature by first appearing in small numbers, despersing over the entire study area and exiting (Fig. 2). Distribution was slightly varied with Station 2 yielding 30% of the 34,511 white shrimp collected and catch at Station 8 ranked fourth with 11%.

A few larger white shrimp first occurred in April; however, large catches of young of the year shrimp were not recorded until July. Catch per unit effort peaked in September at Stations 1-5, dropped slightly in October and fell considerably in November (Fig. 2). Stations 6-8 had large C/E beginning in August, peaked in October and dropped through November.

When data from all stations were combined by month, 49% of the white shrimp were collected during September of which 11% were 100 mm or larger. Catch in October dropped to 28%, 12% was made up of those 100 mm or larger. Larger white shrimp, like the brown shrimp described earlier, left ahead of the smaller shrimp. However, unlike brown shrimp which seemed to be influenced by increasing water tem-

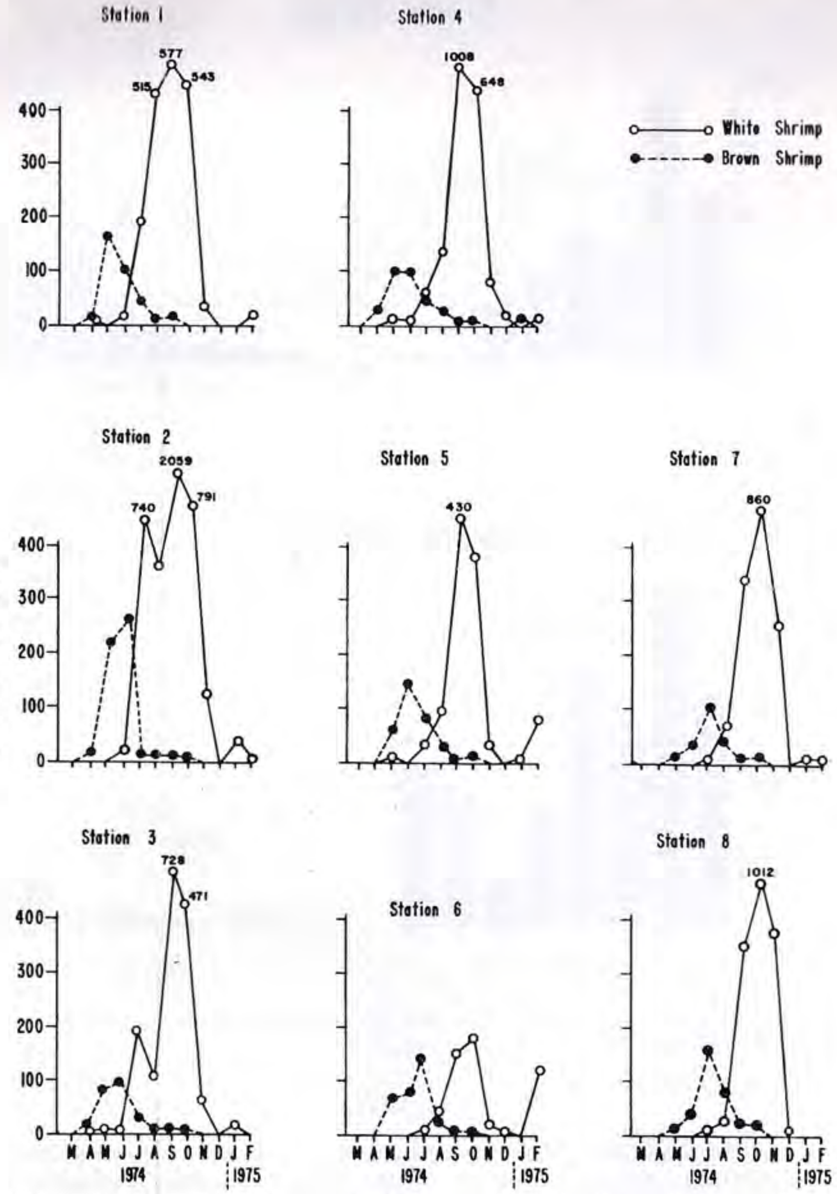

FIGURE 2. Seasonal catch per unit of brown and white shrimp from sample stations in the study area, 1974-75.

peratures, white shrimp were stimulated to leave by decreasing temperatures and accompanying cold fronts. Average monthly salinities only varied slightly, August, 6.7 ppt - October, 6.8 ppt.

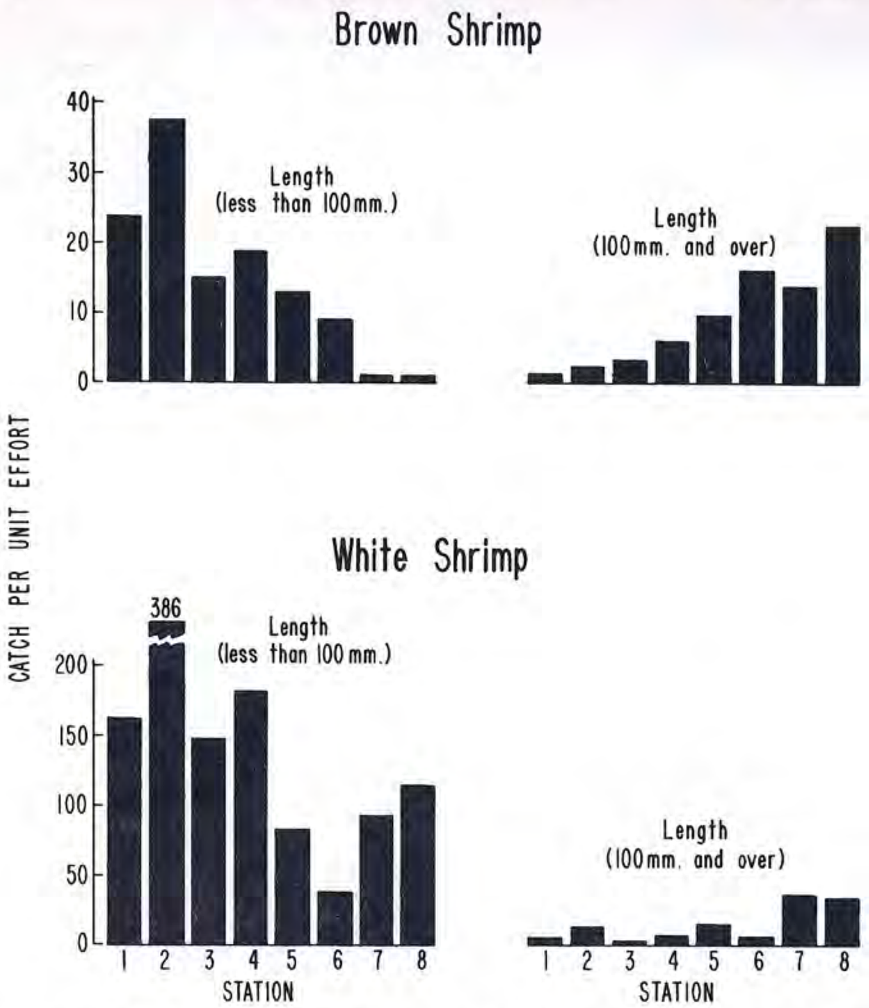

FIGURE 3. Catch per unit effort by size and by sample station of brown and white shrimp, Rockefeller Wildlife Refuge, 1974-75.

DISCUSSION

Originally, land managers constructed weirs with the concept they would lessen salinities, stabilize water levels, minimize turbidity and restrict the rate of tidal exchange (4). This has not always been the case.

Water data taken in connection with this study illustrates the stations furthest inland from the weir experienced a range in salinities of 9.6 ppt. Depth ranges at the stations of the study area fluctuated from 0.2 m o 0.6 m due to seasonal tides, winds and rainfall. And turbidity varied considerably throughout.

However, these were not sudden changes as the weirs had a buffering effect. Other studies (5, 6 and 7) indicate semi-impoundment through weir construction results in a reduction in rate of salinity change.

Water level stabilization is one of the major effects reported by the use of weirs. Mean annual water level behind weirs in one study was 0.1 m higher than in natural areas (5). Greatest difference in water levels at one time was 0.8 m and a minus 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 area approximately 84% of the ponds were dry. Chabreck and Hoffpauir (5) concluded turbidity differed less than 10% between ponds behind weirs and control areas. Later studies reported turbidities lower in semi-impounded areas, especially at vegetated sites (8, 9).

Results of the study illustrate utilization of this semi-impounded marsh as a nursery area and demonstrates the ingress and egress of brown and white shrimp. Weirs, although presenting physical barriers, do not prohibit shrimp movements.

Wengert (7) reported weirs interferred with the natural tidal processes which carry post larval shrimp at Marsh Island Wildlife Refuge. Recruitment in his semi-impounded study area was about a week behind his unimpounded area. His research also indicated brown shrimp usage was decreased by semi-impoundment. Weaver and Holloway (9) concluded from their data that brown shrimp nursery usage was increased due to a stimulation of submergent vegetation. Herke's (8) results were not clear. He had similar catch rates of brown shrimp in both marsh types but stated the turnover rate was possibly higher in the natural marsh.

Herke (1) concludes from a review of his data and literature general concensus is the growth rate of fish and shrimp in semi-impounded marshes is greater. Possibly habitat conditions are better through less intraspecific competition and less predation. He points out shrimp leaving the semi-impounded marshes are larger which brings up the question "which results is the greatest benefit to man—returning a certain number of large shrimp to the Gulf—or returning many more smaller shrimp?"

de la Bretonne and Avault (10) studied daily shrimp movements over weirs in the Terrebonne-Timberlier Bay marshes. Their data demonstrated this bleeding-off of larger brown shrimp, about 100 mm, after water temperatures reached 29-30°C. This data supports their findings in that shrimp movements from the Rockefeller study area also occurred as these temperatures were reached. Beginning in June, a steady decline was noted in largr individuals as the summer progressed.

White shrimp catches were 7 times more numerous in the study area than brown shrimp. Their exodus began in late September, water temperatures around 19-20°C, salinities only varied slightly, and continued into November. During this period, after the first cold fronts, fewer and fewer large white shrimp were captured in proportion to smaller individuals. This was particularly evident in the stations furthest from the weir.

In summary, this study indicates the following:

- Weirs have little or minimal effect on salinity and depth fluctuations although they do prevent complete dewatering from low tides, northers, etc.
- The weir did not prohibit shrimp movements, some of best catches were at stations furthest from weir.
- Brown shrimp first appeared in the April samples, despersed to all stations by May, peaked in June and very few remained by end of August. Sizes increased whereby larger shrimp, length over 100 mm, made up 33% of the catch by June.
- Catch per unit effort of larger individuals, length over 100 mm was greatest at Stations 7 and 8 which were furthest from the weir.
- Large white shrimp catches were made in July, peaked in September and dropped drastically after October.
- Distribution was varied, with 30% of the white shrimp captured at Station 2 and Station 8, furthest from the weir, yielded the fourth highest catch of 11%.
- After a brief rearing period, there was a gradual exodus of large shrimp of both species.

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