EFFECTS OF WEIRS ON AQUATIC VEGETATION ALONG THE LOUISIANA COAST

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ABSTRACT

The effects of weirs on aquatic vegetation were investigated at 3 separate areas along the Louisiana coast. In each area, aquatic vegetation was more abundant in ponds affected by weirs than in adjacent control ponds. Comparisons were also made among areas, between pond sizes, and within individual ponds relative to abundance and distribution of aquatic plants.

Weirs are constructed in tidal channels to stabilize water levels, salinity, and turbidity and improve habitat conditions for fish and wildlife. By increasing stability, environment stress is reduced and species diversity is increased. Various investigations have been conducted along the Louisiana coast to determine the environmental effects of weirs (Chabreck and Hoffpauer 1962, Burleigh 1966, Chabreck 1967, Herke 1967, Herke 1971, Hoar 1975, and Spiller 1975). The studies by Chabreck and Hoffpauer (1962) and Chabreck (1967) disclosed considerable increases in the growth of aquatic vegetation in ponds and lakes affected by weirs. The present study was undertaken to further investigate the influence of weirs on vegetation in coastal ponds and lakes.

Appreciation is extended to the Louisiana Land and Exploration Company and the Louisiana Wildlife and Fisheries Commission for assistance provided during the study.

STUDY AREA

Three separate study areas were used to investigate the influence of weirs on aquatic vegetation in the coastal ponds and lakes of Louisiana. All were located in the coastal marshes of southeast and southcentral Louisiana. Two of the areas were in the southeast section of the coastal marsh and the other was situated in the southcentral section of the coastal marsh (Figure 1).

Study Area I was in saline marsh, located in Lafourche Parish, and included portions of the 10,500-ha Wisner Wildlife Management Area, which is operated by the Louisiana Wildlife and Fisheries Commission. It is located in the southeastern portion of Lafourche Parish, approximately 8 km northwest of Grand Isle. The mean water salinity for Area I was 17.4 ppt and ranged from a high of 22.9 ppt in October, 1974, to a low of 11.9 ppt in May, 1975.

Study Area II was brackish to saline marsh and located in Jefferson and Plaquemines Parishes. It included portions of a 13,000-ha tract of private marshland, owned predominately by The Louisiana Land and Exploration Company. It is situated in the extreme southeast portion of Jefferson Parish and the extreme southwest portion of Plaquemines Parish approximately 8 km southeast of Lafitte, and 40-km north of Grand Isle. The mean water salinity was 6.5 ppt and ranged from a high of 12.0 ppt in October, 1974, to a low of 2.5 ppt in May, 1974.

Study Area III was located in Iberia Parish in intermediate to brackish marsh. It was located on the 35,000-ha Marsh Island Wildlife Refuge, which is owned by the Louisiana Wildlife and Fisheries Commission. Marsh Island lies between Vermilion Bay and the Gulf of Mexico in the extreme southern portion of Iberia Parish. It is bounded on the west by

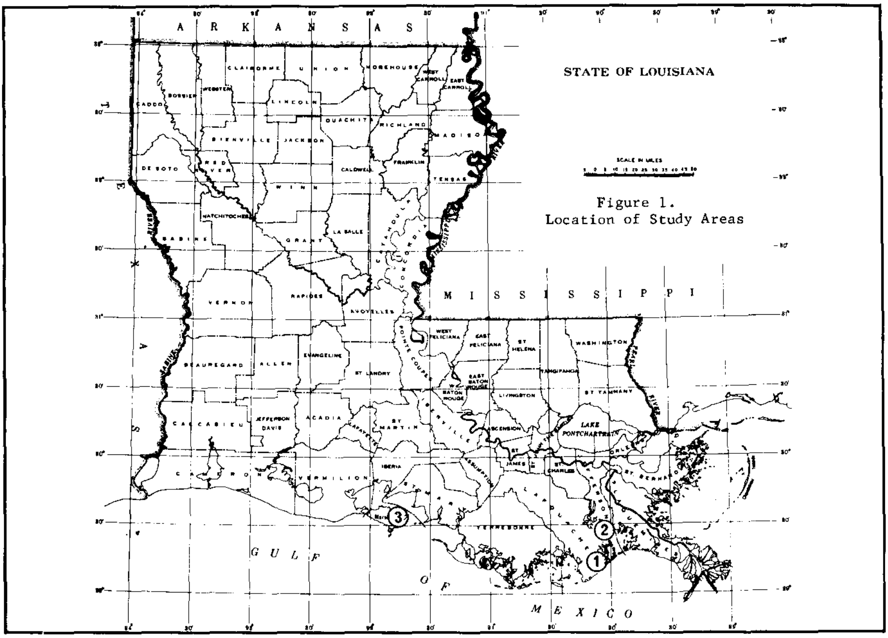

Figure 1. Location of Study Areas.

Southwest Pass and on the east by East Cote Blanche Bay. The mean water salinity in Area III was 2.0 ppt and ranged form a high of 4.9 ppt in October, 1974, to a low of 0.3 ppt in May, 1975.

Each study area consisted of 16 study sites; eight sites were behind weirs and eight sites were unweired control areas. All weirs studies had been in place between 15 and 20 years.

The coastal marsh can be subdivided into four vegetation types, based primarily on the salinity tolerance of the plant species of which they are composed. These types are: fresh, intermediate, brackish, and saline. Chabreck (1971, 1972) described the plant species which typify each vegetative type. The boundaries of these vegetative types were shown on the map by Chabreck, Joanen, and Palmisano (1968).

The most common aquatic plant associated with the brackish and saline marshes was widgeongrass (*Ruppia martima*). Widgeongrass was found on all three study areas during the course of the investigation. Other common aquatic vegetation found during the study was southern naiad (*Najas quadalupensis*), pondweed (*Potamogenton* spp.), coontail (*Ceratophyllum dmersum*), Eurasian water milfoil (*Myriophyllum spicatum*), and wild celery (*Vallisneria americana*).

In the coastal marshes of Louisiana, the tidal cycle consists of two principle types of fluctuations within the cycle, the diurnal tide and the semidiurnal tide. The extent of the rise and fall of this tidal cycle along the Louisiana coast is relatively small, averaging about 30 cm. The normal maximum tidal fluctuation is 70 cm, which occurs once a month (Marmer 1954).

The weirs were constructed of wood or steel sheet piling and resembled dams placed in tidal channels; however, the crests of the weirs were about 15 cm below the elevation of the adjacent marsh. This permitted water to flow freely in both directions over the structures, but during low tides, water behind the weirs could recede only to the elevation of the weirs' crests.

METHODS

Three separate study areas were selected in order to evaluate the effects of weirs on the vegetation under a wide range of environmental conditions. The study sites were chosen according to three criteria: area location, weired or non-weired (control), and pond size. The ponds were classified into two size categories: small, 5-ha or less, and large, greater than 5-ha. Study ponds ranged from 0.4-ha to 40-ha in size.

The aquatic vegetation was sampled by the method described by Chabreck and Hoffpauer (1962). In sampling, four parallel lines were extended across each pond and equally separated by a distance equal to about one-fifth the diameter of the pond. Twenty sampling stations were equally spaced along each of the four lines, totaling 80 stations per pond. The transect lines used to sample each pond were divided into four segments to determine where the aquatic vegetation was occuring within each pond. The four segments per line extended from one edge of the pond to the other edge with each segment having five sampling stations. The segments were numbered 1 through 4, with segments 1 and 4 being on the edges and 2 and 3 being in the interior of the pond. Sampling was done from a small boat by dragging a garden rake on the bottom at each sampling station. The plant species present and the estimated density was rated as either sparse, moderate or dense and given a number value of 1, 2, or 3 respectively. The aquatic vegetation was sampled three times; May, and October, 1974, and May, 1975, during period of vigorous growth. In total, 5,760 stations were sampled behind the weirs and an equal number were sampled in the control areas during the study.

Data collected were statistically analyzed and factorially arranged by treatments (weirs and controls), pond sizes, sampling dates, and areas using analysis of variance (Steel and Torrie 1960).

RESULTS AND DISCUSSION

Plant Abundance in Study Ponds

Differences between treatments. Throughout this study, the ponds influences by weirs contained significantly more ($P < 0.01$) aquatic vegetation than the control areas. Ponds influences by weirs had 30.2 percent occurrence of vegetation as compared to control sites, which had 14.4 percent. This indicates that weirs enhance the establishment of aquatic vegetation in marsh ponds along the Louisiana coast.

The weirs stabilize water levels, reduce the rate of tidal exchange, reduce water turbidity, and stabilize water salinities (Chabreck and Hoffpauer 1962). These factors are very important to the establishment, growth, and regeneration of aquatic vegetation.

Differences among areas. The percentage of occurrence of aquatic vegetation varied greatly among the three study areas. Area III contained a greater abundance of aquatic vegetation, when compared to the other areas, and 56.7 percent of all stations were vegetated. Area II was next with 9.3 percent of the stations vegetated, and Area I only had 0.8 percent of the stations vegetated.

The percent of plant coverage of ponds and lakes is inversely proportional to the water salinity. Chabreck (1971) found that ponds and lakes of the fresh vegetative marsh type had the greatest plant coverage, followed by the greatest plant coverage, followed by the intermediate, brackish, and saline marsh types in descending order. During his study, no vegetation was found in ponds and lakes sampled in the saline vegetative marsh type. The difference in percentage of occurrence of aquatic vegetation among areas during this study can be partly attributed to the water salinity associated with each area. Also, important is the degree of human disturbance in the area, mainly in the form of canal dredging.

Differences among treatments by areas. Although aquatic vegetation was more abundant in ponds influenced by weirs in all study areas the amount of aquatic vegetation occurring was extremely variable among the three areas. This difference in occurrence was highly significant ($P < 0.01$).

In Area II, much of the area had been modified by dredging and very little aquatic vegetation occurred in the control ponds; however, ponds in this area which were influenced by weirs contained 40 times more aquatic vegetation than control ponds. Area I is a salt marsh with some development, and during this study, no aquatic vegetation was observed at all in the control ponds. Ponds behind weirs in Area I did produce a very small amount of aquatic vegetation. Area III, which is in a semi-natural state, had a considerable amount of aquatic vegetation occuring in the control sites. The effect of weirs in Area III approximately doubled the abundance of aquatic vegetation in ponds.

Differences among sampling dates. The percentage of vegetation in ponds in each of the three areas progressively increased at each sampling period. The first sampling date was May, 1974, and 20.3 percent of the ponds were vegetated. The second sampling date was October, 1974, and 22.7 percent of the ponds were vegetated. The last or third sampling date was May, 1975, when 23.8 percent of the ponds were vegetated.

For each of the three sampling dates, sites influenced by weirs had a higher percent of aquatic vegetation than did the study sites sampled as controls (Table 1).

Table 1. Frequency of aquatic vegetation by treatments for each sampling date within each area.

	Area I			*Area II*			*Area III*		
Treatments	*May 1974*	*Oct. 1974*	*May 1975*	*May 1974*	*Oct. 1974*	*May 1975*	*May 1974*	*Oct. 1974*	*May 1975*
					Percent				
Weir	2.7	0.0	2.3	13.3	22.6	18.3	77.5	63.7	80.9
Control	0.0	0.0	0.0	0.2	1.1	0.2	38.4	48.7	40.9

Differences between line segments. A higher percentage of the aquatic vegetation was noted along the pond edges on line segments 1 and 4 in both weired ponds and control ponds. The greater abundance of aquatic vegetation along the shoreline can be attributed to the shallower water near the edges of the ponds. The difference between segments 1 and 4 and segments 2 and 3, which were in the middle of the ponds, was highly significant ($P<0.01$) for each treatment. The sites influenced by weirs not only had a higher percent of occurrence of aquatic vegetation in segments 1 and 4 along the shoreline, but segments 2 and 3 in the interior of the pond were also more vegetated than in the control sites (Figure 2). The weirs apparently created more favorable conditions for plant growth in the middle of the ponds than control sites. Aquatic vegetation was more abundant in segments 1 and 4 than in segments 2 and 3 for each treatment within each area $P<0.01$).

Differences between pond sizes. Of the 48 ponds sampled during this study, 30 were in the small class and 18 in the large class. Ponds in the large class were 24.3 percent vegetated, while ponds in the small class were 21.0 percent vegetated. This was only a 15.7 percent difference in occurrence of vegetation from the small ponds to the large ponds, yet the difference was highly significant ($P<0.01$).

Large ponds behind weirs were 34.4 percent vegetated and the small ponds were 27.6 percent vegetated. This increase from small to large ponds was a 24.6 percent difference in occurrence of aquatic vegetation ($P<0.01$). Both sizes of control ponds were very similar in the percent occurrence of aquatic vegetation, and the small control ponds were 14.5 percent vegetated and the large control ponds were 14.2 percent vegetated.

The effect of weirs on the production of aquatic vegetation was slightly greater ($P < 0.01$) in large ponds than in small ponds. The large ponds behind weirs had a 90.3 percent difference over the small ponds samples as controls (Figure 3).

Relative Abundance of Vegetation in Study Ponds.

The relative abundance of aquatic vegetation present was greater ($P < 0.01$) in ponds influenced by weirs than in control ponds (Table 2). The relative abundance was about three times greater in ponds behind weirs, and verified the findings of Chabreck and Hoffpauer (1962).

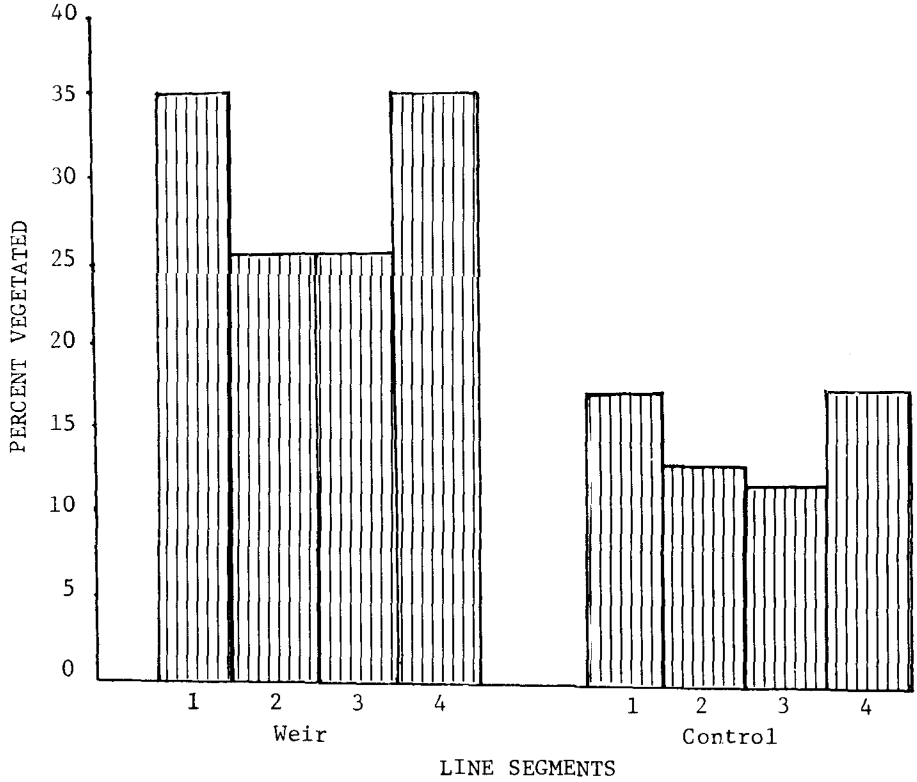

Figure 2. Percent of line segments vegetated for each treatment.

Table 2. Relative abundance[a] of aquatic vegetation in study ponds behind weirs and in control areas.

Treatment	*Area I*	*Area II*	*Area III*
Weir			
Dense	0.2	2.1	19.7
Moderate	0.1	1.6	5.4
Sparse	0.2	1.9	4.3
Total	0.5	5.6	29.4
Control			
Dense	0.0	0.03	4.5
Moderate	0.0	0.02	3.3
Sparse	0.0	0.06	5.1
Total	0.0	0.11	12.9

[a]Relative abundance was computed by multiplying frequency by density value. Plant density at each station was estimated and assigned the following density values: 0, absent; 1, sparse; 2, moderate; and 3, dense.

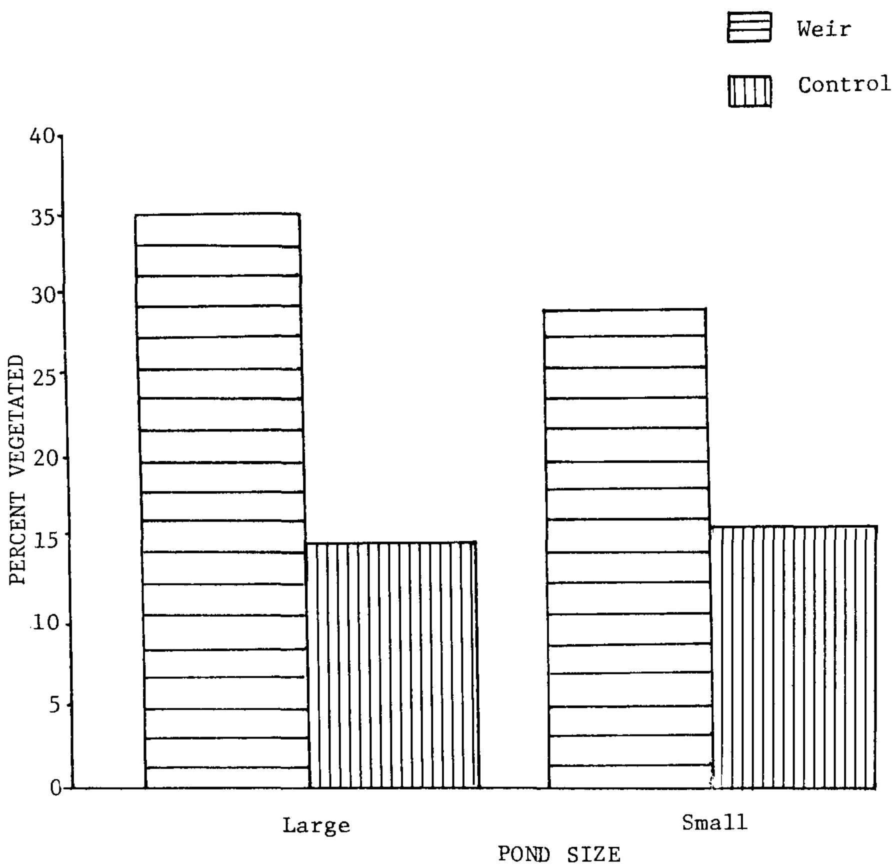

Figure 3. Percent occurrence of aquatic vegetation for pond sizes by treatments.

In each study area, there was not only more aquatic vegetation present in sites affected by weirs, but the density of that vegetation present was also greater. This difference between treatments for each area in the density of the vegetation present was highly significant ($P < 0.01$). The density of the aquatic vegetation was closely related to the percentage frequency of plants in the ponds and was inversely proportional to water occurrence of aquatic vegetation and the largest relative abundance in ponds behind weirs. Area II with the second lowest water salinities was second in occurrence and relative abundance of aquatic vegetation. Area I with the highest water salinities had the lowest abundance of aquatic vegetation.

Plant Species in Study Ponds.

During the study, 6 species of aquatic plants occurred at the sampling stations in the study ponds. These were Eurasian milfoil, coontail, widgeongrass, wild celery, southern naiad, and pondweed. Chabreck (1971) noted that not only plant coverage, but the number of species was also inversely related to water salinity. All six species were encountered in Area III, which had the lowest water salinity. Area II had 4 of the 6 species and had the second lowest water salinity. Area I, located in a saline vegetative marsh type only had one species present.

The dominant species of aquatic vegetation on the three study areas was widgeongrass. It occurred in 29.9 percent of the 144 ponds sampled. According to Chabreck (1971), widgeongrass, a brackish water species is the dominant species along the entire Louisiana coast in ponds and lakes. Martin and Uhler (1951) rated widgeongrass as an excellent waterfowl food for the Gulf coast marshes. The entire plant is consumed by waterfowl (Joanen and Glasgow 1964).

Eurasian milfoil was the second most important species in so far as distribution over the three study areas. It occurred in 26.4 percent of ponds sampled. It was the most frequent species in percent occurrence at sampling stations because it completely dominated the aquatic vegetation in Area III. Eurasian milfoil has only been in the Louisiana coastal marshes in recent years. Heavy use of Eurasian milfoil by wintering waterfowl has been observed along the Louisiana coast (pers. comm., Hugh Bateman, Louisiana Wildlife and Fisheries Commission, September, 1975). A study by Florschutz (1972) reported that this plant was an important source of food for some species of overwintering waterfowl on the Atlantic Coast. The other 4 species of aquatic plants were also rated as important waterfowl foods by Martin and Uhler (1951), but occurred in considerably lesser amounts during this study.

Differences between treatments. All 6 species of aquatic plants were encountered in sites influenced by weirs and in sites sampled as controls. A definite increase in percent frequency of occurrence of the plant species occurring in ponds behind weirs found over the same plant species occurring in natural control ponds (Table 3). A few exceptions were found in which the percent occurrence was higher in a control site, but only one species, wild celery, was in large enough amounts to be meaningful. Eurasian milfoil was the most abundant species in percent occurrence for the weired ponds and for the entire study. Area III was responsible for this because it had such a high percent occurrence of Eurasian milfoil in many of its ponds. Widgeongrass occurred in more of the ponds throughout the study, but was second in abundance. It was considered the most important aquatic species, however, because of its wider distribution.

Differences among areas. The study areas varied greatly in the species present, percent frequency of each species, and the effects weirs had on the percent frequency of species present.

Widgeongrass was the only species found in Area I. It occurred in 8.3 percent of the ponds sampled and only 0.8 percent of the stations sampled (Table 3). The widgeongrass was encountered only in weired sites.

Four species were found in Area II (Table 3). Two of the four species were found in sites influenced by weirs and all four species were found in control sites. Widgeongrass was the dominant species. The other three species, coontail, southern naiad, and Eurasian milfoil, represented such a small portion of the total vegetation present that they were considered minor species. The sites influenced by weirs produced more of the vegetation present in Area II with a few exceptions. The two species which did not occur in the weired sites, coontail and Eurasian milfoil, occurred at very low rates in the control sites.

All six species were found in both treatments in Area III. The highest percentage of occurrence of one species for the entire study occurred in Area III. Ponds in this area were 44.1 percent vegetated with Eurasian milfoil. Widgeongrass, coontail, and wild celery were also considered major species, but occurred at much lower rates (Table 3). Weired sites had a higher occurrence of each species than did the control sites with the exception of two species. Wild celery and pondweed had a higher occurrence in control ponds. The reason for this difference is not known; however, excessive competition among species behind weirs may have restricted the growth of certain species.

Differences among sampling dates. The effect of weirs, species abundance, and percent frequency of species, in relation to study areas, differed among sampling dates.

The largest number of species recorded in Area II occurred during October, 1974. Three species were encountered. With the exception of southern naiad, the highest percent of occurrence of each species occurred during October, 1974. For species occurring in both treatments, a higher percent was found in weired sites for all sampling dates (Table 3).

Table 3. Percent frequency of aquatic vegetation behind weirs and in control sites for each sampling date by study areas 1974-75.

	Area I			*Area II*			*Area III*		
Species	*May 1974*	*Oct. 1974*	*May 1975*	*May 1974*	*Oct. 1974*	*May 1975*	*May 1974*	*Oct. 1974*	*May 1975*
					Percent				
Weir									
Myriophyllum spicatum	—	—	—	—	—	—	47.5	42.0	70.0
Ceratophyllum demersum	—	—	—	—	—	—	23.1	15.0	5.5
Ruppia Maritima	2.6	—	2.3	13.3	22.6	18.3	12.8	15.0	11.2
Vallisneria americana	—	—	—	—	—	—	1.9	1.1	1.4
Najas quadalupensis	—	—	—	1.1	—	2.0	0.6	—	1.2
Potamogeton sp.	—	—	—	—	—	—	—	—	1.1
Control									
Myriophyllum spicatum	—	—	—	—	—	0.2	33.3	37.3	34.2
Ceratophyllum demersum	—	—	—	—	0.2	—	—	0.3	1.1
Ruppia maritima	—	—	—	0.2	0.8	—	1.1	8.0	2.2
Vallisneria americana	—	—	—	—	—	—	3.3	3.3	2.9
Najas quadalupensis	—	—	—	—	0.2	—	0.8	0.5	0.2
Potamogeton sp.	—	—	—	—	—	—	—	—	2.8

Widgeongrass was the only species recorded for the entire study in Area I. It was found during the May, 1974, and the May, 1975, sampling dates (Table 3). Although the occurrence was very similar, it did occur at a slightly higher rate in May, 1974. Widgeongrass was found only in weired sites during the study. The findings for Area I agree with Chabreck's 1971 study in which he found no aquatic vegetation in his samples of the saline vegetative marsh type.

In Area III, six species of aquatic plants were recorded during May, 1975. The highest percentage of total vegetation also occurred during this date. The largest difference between treatments in percent occurrence of vegetation was found in May, 1975.

LITERATURE CITED

Burleigh, J. G. 1966. The effects of wakefield weirs on the distribution of fishes in a Louisiana salt water marsh. Unpubl. M.S. thesis. La. State Univ., Baton Rouge. 59 p.

Chabreck, R. H. 1967. Weirs, plugs, and artificial potholes for the management of wildlife in coastal marshes. *In* Proc. 1st Marsh and Estuary Management Symposium. Louisiana State Univ., Baton Rouge, La. p. 178-192.

________________. 1971. Ponds and lakes of the Louisiana coastal marshes and their value to fish and wildlife. Proc. Annu. Conf. S.E. Assoc. of Game and Fish Comm. 25:206-215.

________________. 1972. Vegetation, water and soil characteristics of the Louisiana coastal region. La. Agric. Exp. Sta. Bull. 644. 72 p.

________________ and Clark M. Hoffpauer. 1962. The use of weirs in coastal marsh management in Louisiana. Proc. Annu. Conf. S.E. Assoc. of Game and Fish Comm. 16:103-112.

________________, T. Joanen, and A. W. Palmisano. 1968. Vegetative type map of the Louisiana coastal marshes. La. Wildlife and Fisheries Comm. New Orleans, La.

Florchutz, O. 1972. The importance of Eurasian milfoil (*Myriophyllum spicatum*) as a waterfowl food. Proc. Annu. Conf. S.E. Assoc. of Game and Fish Comm. 26:189-194.

Herke, W. H. 1967. Weirs, potholes and fishery management. *In* Proc. 1st Marsh and Estuary Management Symposium. Louisiana State Univ., Baton Rouge, La. p. 193-211.

________________. 1971. Uses of natural and semi-impounded Louisiana tidal nurseries for fish and crustaceans. Ph.D. dissertation. La. State Univ., Baton Rouge. 242 p.

Hoar, R. J. 1975. The influence of weirs on soil and water characteristics in the coastal marshlands of Southeastern Louisiana. Unpubl. M.S. thesis. La. State Univ., Baton Rouge. 94 p.

Joanen, T., and L. L. Glasgow. 1965. Factors influencing the establishment of widgeongrass stands in Louisiana. Proc. Annu. Conf. S.E. Assoc. of Game and Fish Comm. 19:78-92.

Marmer, H. A. 1954. Tides and sea level in the Gulf of Mexico. *In* Gulf of Mexico, its origin, waters and marine life. U.S. Fish and Wildlife Serv. Fishery Bull. No. 89, p. 101-118.
Martin, A. C., and F. M. Uhler. 1951. Food of game ducks in the United States and Canada. United States Government Printing Office, Washington, D.C. 308 p.
Spiller, S. F. 1975. A comparison of wildlife abundance between areas influenced by weirs and control areas. Unpubl. M.S. thesis. La. State Univ., Baton Rouge. 94 p.
Steel, R. D., and J. H. Torrie. 1960. Principles and procedures of statistics with special reference to biological sciences. McGraw-Hill Book Co., Inc., New York. 481 p.