UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
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A DETAILED REPORT ON HURRICANE STUDY AREA NO. 1

LAKE PONTCHARTRAIN AND VICINITY

LOUISIANA

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
REGION 4
ATLANTA, GEORGIA

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INTRODUCTION

Pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the U. S. Fish and Wildlife Service has prepared this detailed report on proposed plans for hurricane protection, Lake Pontchartrain and vicinity, Louisiana, to provide information supporting the summarized findings presented in the Service's letter report of March 13, 1962. The present report therefore is a substantiating document for informational use.

A preliminary report on this project by the Service was released in November 1957. In lieu of more definite information at that time, concern was expressed over the possible adverse effects of the low level plan, particularly the influence of the proposed barriers in the tidal passes on the hydrological regime of Lake Pontchartrain, which might result in changing salinity. The report recommended that, (1) of the two plans being considered for hurricane protection, the high level plan be adopted in the event hurricane protection was warranted and that (2) provision be made for detailed fish and wildlife studies.

The biological interpretations and conclusions presented at this time include (1) the relation of fish and wildlife to plans for hurricane protection, and (2) the probability of salt-water intrusion into Lake Pontchartrain via the Mississippi River-Gulf Outlet navigation channel now under construction by the Corps of Engineers.

Report findings are based on comprehensive fish and wildlife studies conducted in both the Lake Pontchartrain and Gulf Outlet project areas. Where appropriate, resource appraisals were related to findings of model studies conducted by the Waterways Experiment Station, Vicksburg, Mississippi.

Frequent coordination meetings between the Service, the Louisiana Wild Life and Fisheries Commission, the Corps of Engineers, New Orleans District, and the Waterways Experiment Station have been of invaluable assistance in setting the scope and approach of field investigations, as well as in consideration of model study tests. Texas A&M Research Foundation acted in consultant capacity to the Service with reference to model studies and use of model data. Summaries of the model tests pertaining to the lake system were made by the Waterways Experiment Station in response to specific requests of the Service. The Louisiana Wild Life and Fisheries Commission cooperated with the Service in the comprehensive fish and wildlife studies and in the biological interpretations and conclusions presented in this report.

DESCRIPTION OF THE AREA

The project area, located in southeast Louisiana, includes Lakes Maurepas, Pontchartrain and Borgne, Western Mississippi Sound, Northern Chandeleur Sound, the Rigolets and Chef Menteur tidal passes, and the marshes and swamps adjacent to these water areas (plate 1). Physical dimensions and other pertinent data for the primary water areas are shown in table 1.

Table 1

Description of the Water Areas

Item	Lake Maurepas	Lake Pontchartrain	Lake Borgne	Rigolets	Chef Menteur
Length (mi.)	12.0	40.0	25.0	8.6	7.1
Width (mi.)	10.0	25.0	20.0	.65 1/	.19 1/
Area (sq.mi.)	90.0	640.0	270.0	---	---
Depth, Ave. (ft. m.s.l.)	10.1	14.0	8.6	28.0 1/	43.0 1/
Depth, controlling (ft.)	---	---	---	20.0	25.0
Tide, normal (ft.)	---	0.5	1.5	---	---

1/ Vicinity Highway 90 bridge

The project area extends inland about 100 miles from the Gulf of Mexico. Western Mississippi Sound opens directly into the Gulf and Chandeleur Sound on the southeast and joins Lake Borgne on the west. The Rigolets and Chef Menteur tidal passes connect Lake Pontchartrain with Lake Borgne-Mississippi Sound, while Lake Maurepas connects with upper Lake Pontchartrain via the Pass Manchac channel.

Lake Pontchartrain is a brackish, tidal basin forming a central part of the total estuarine complex between the marine environment of the Gulf of Mexico and the nearly fresh-water conditions of Lake Maurepas. Interrelation of the fresh-water and marine systems maintains the estuarine complex, not only in Lake Pontchartrain but in the overall project area as well.

Fresh-Water System

The Pearl River system contributes more than half of the total tributary inflow to the project area. It drains about 8,000 square miles and discharges into the Rigolets tidal passage and Lake Borgne near its juncture with Mississippi Sound. Annual discharges fluctuate considerably, with more than 14 million acre-feet contributed during a wet year (1949) and less than 4 million acre-feet during a dry year (1954). Seasonal fluctuation in discharge is also great, the heaviest occuring in late winter and spring.

In addition to Pearl River, the 4,200 square-mile Lake Pontchartrain watershed is served by numerous rivers and streams, the most important being the Tangipahoa and Tchefuncte Rivers and Bayous Lacombe and Liberty, which discharge directly into Lake Pontchartrain, and the Amite, Tickfaw and Natalbany Rivers, which discharge first into Lake Maurepas, then Lake Pontchartrain through Pass Manchac. The combined discharge of these streams varies from about $7\frac{1}{2}$ million acre-feet for a wet year (1949) to less than 3 million acre-feet for a dry year (1954).

Annual precipitation contributing to the above tributary discharges varied from more than 70 inches to less than 50 inches over the Lake Pontchartrain watershed, and from about 66 inches to less than 43 inches over the Pearl River watershed.

The Bonnet Carre Floodway, at the head of Lake Pontchartrain, infrequently (3 times in 27 years) diverts Mississippi River flood waters into Lake

Pontchartrain to lower river stages at New Orleans for flood prevention. This floodway, with a design capacity of 1/2 million acre-feet per day, discharged almost 12½ million acre-feet into Lake Pontchartrain in 1937; 25½ million acre-feet in 1945, and almost 11 million acre-feet in 1950. In each instance several months were required to evacuate the diverted water from Lake Pontchartrain.

Marine System

The transport of salt water into Lake Pontchartrain is currently accomplished through the Chef Menteur and Rigolets passages by lunar and wind tides. Normal flow through these passes results from tidal head differential developed between Lake Pontchartrain and Lake Borgne-Mississippi Sound. However, wind affects normal tidal exchange considerably, and frequently wind tides are dominant. Easterly winds increase inflow through the passes, raise lake levels, and at times salinity, depending upon the brackishness of Lake Borgne-Mississippi Sound. Westerly winds cause a corresponding lowering of lake levels.

Normal tidal exchange through the passes introduces about 267,000 acre-feet of water per day into Lake Pontchartrain from Lake Borgne-Mississippi Sound. However, gulf waters do not enter Lake Pontchartrain directly, but first pass through western Mississippi Sound and Lake Borgne where they are diluted considerably by discharge from Pearl River. The resultant brackish water which enters lower Lake Pontchartrain then becomes further diluted by normal fresh-water contributions of direct rainfall and runoff drainage from the Lake Pontchartrain watershed.

Average annual salinities for the whole of Lake Pontchartrain vary between about one and three p.p.t. (parts per thousand). Under existing conditions salinity in the lower part of the lake may occasionally become as high as eight or nine p.p.t., but usually is much lower. Waters in the upper lake at times are fresh. Lake Borgne, being nearer the Gulf, has considerably higher salinity, exceeding ten p.p.t. on occasion, with annual averages ranging from five to eight p.p.t. near the south lakeshore. On the other hand, Lake Maurepas, being at the end of the complex farthest from the Gulf, has much lower salinity, with annual averages of less than one p.p.t.

The Mississippi River-Gulf Outlet navigation channel, when completed, may have equal or greater importance than the natural passes for transporting saline waters to Lake Pontchartrain. This 36-foot deep, 500-foot bottom width channel will afford a more direct connection between Lake Pontchartrain and the Gulf of Mexico. Gulf waters entering the lake from this system through the 30-foot deep Industrial Canal would be less subject to the modifying influences of Mississippi Sound, Lake Borgne and Pearl River and, therefore, could have salinities several times higher than the waters entering through the natural passes.

Physical Features

The south, west, and lower east shores of Lake Pontchartrain are composed of fine-grained alluvial deposits from the Mississippi River. The lower east shore area also contains Pearl River alluvium. The northern lake shore is composed mostly of remnant Pleistocene deposits which rise sharply about ten feet, then rise gently at about three feet per mile.

Adjacent land is marsh or swamp except on natural levees and where reclaimed for industrial, agricultural, or residential uses by levees and drainage facilities. A major part of the south shore, at or near sea level, has been reclaimed and is occupied by greater New Orleans. A large cypress swamp extends inland from the western shoreline to and beyond Lake Maurepas. The higher lands on the north shore support pine-hardwood forests, though a considerable acreage has been cleared or partially cleared for agriculture and residential development.

A large city park is located on the south lakeshore at New Orleans, and the Fontainbleau State Park is located on the north lakeshore east of Mandeville, Louisiana. The State maintains the St. Tammany Wildlife Refuge along about eight miles of the north lakeshore and adjacent uplands. The Bonnet Carre Spillway area on the southwest lakeshore is a Federal ownership and a portion has been leased by the State for public hunting.

The 1960 population of the six parishes bordering Lake Pontchartrain was about one million people, with most of them living in the New Orleans metropolitan area on the south lakeshore. New Orleans is a major seaport serving marine shipping from throughout the world, and is one of our major inland ports serving both coastal shipping via the Gulf Intracoastal Waterway and inland shipping via the Mississippi River system. The area has a well developed system of highways, rail and air transportation.

DESCRIPTION OF THE PROJECT

Two basic plans of hurricane protection have been studied (plate 1). Both plans are designed to prevent hurricane tides from flooding the New Orleans metropolitan area. This would be accomplished, basically, by improving the present physical protective system. Hurricanes strike the Louisiana coast an average of 1.6 times a year between spring and fall.

Low Level Plan

The first, or low level plan, provides for (1) enlarging existing levees and building new levees to form a continuous levee system 9 to 13 feet high along the south lakeshore between Bonnet Carre Floodway and vicinity of the Highway 11 bridge; (2) a system of levees 14 feet high from the south lakeshore extending to the vicinity of Chalmette, and (3) a 9-foot barrier levee along the eastern lake boundary with a water-control structure in each of the tidal passes. A lock or control structure also would be installed in the Gulf Outlet connection at the junction of Lake Pontchartrain and the Industrial Canal. This system of levees and closure of structures is designed to prevent wind-driven gulf tides from entering the lake.

Openings in control structures in each of the tidal passes would be of a dimension to reduce the cross-section of each pass by 75 percent. Structure sills would be at the controlling depths of the passes, minus 25 feet in Chef Menteur and minus 20 feet in the Rigolets. Closure would be accomplished with tainter gates. The structures' gates would be closed only

when a hurricane was approaching the Louisiana coast, and reopened when danger was past. Structure openings would be adequate to evacuate discharge from Bonnet Carre Floodway. It has not been determined if boat traffic through the structure opening will be permitted; in any event, navigation locks will be provided.

The control structure or lock in the Gulf Outlet connection would remain open at all times except for hurricane closure, perhaps for short periods during severe "northers" and for fish and wildlife purposes as required.

High Level Plan

The high level plan does not include the barrier along the eastern lakeshore which incorporates control structures in the tidal passes, or the structure in the Gulf Outlet connection. In most other respects, the two plans are similar except that levees along the south lakeshore would be 2 to 6 feet higher than with the low level plan.

Under either plan, necessary drainage facilities would be included in the levee system. Control gates in the drainage facility for the marshes and swamp immediately east of Bonnet Carre Floodway would remain open at all times except when closure would be required to prevent hurricane flooding.

The levee portion of either plan may not be constructed, necessarily, over the entire project area, but could be adopted in separate units, protecting those parishes which would provide the required local project assurances and participation.

PROJECT INVESTIGATIONS

Fish and Wildlife Studies

The detailed fish and wildlife field study was combined with this Service's study of the Mississippi River-Gulf Outlet project and the Lake Pontchartrain Hurricane project area is now considered to be a part of the overall Gulf-Outlet project area. However, for evaluation and reporting purposes, each area has been treated separately. Evaluation included determination of total sport-fishing and hunting participation and harvest. The commercial fishery was evaluated to determine yield and value, as were the bait fishery and fur harvest.

Fish and wildlife values of the overall hurricane project study area were obtained on a sub-unit basis, each unit generally representing a different hydrological or environmental type. Ecological requirements of the more valuable fish and wildlife species, as well as their response to salinity change, were also studied.

Fish and wildlife statistics were obtained during a one-year survey period from April 1959 through March 1960. The sport-fishery and hunting data were obtained by interviews with fishermen and hunters and expanded on the basis of direct systematic aerial counts. The commercial statistics are based on the Service's Bureau of Commercial Fisheries regular and continuing program. Fur statistics were obtained from records of the Louisiana Wild Life and Fisheries Commission, fur buyers and by interviewing trappers.

The survey period was marked by below average salinities in the lake. Fishery harvest is reportedly better during higher salinity years; however, since lake salinities fluctuate considerably from year to year and have been low periodically in the past, sport-fishing utilization and harvest as determined for the survey period were used directly to establish existing levels of use. The data consequently are considered to represent a conservative estimate of average annual participation and harvest.

Model Studies

Principal objective of the model program was to determine the influence of proposed structures in the tidal passes (low level plan) on existing hydraulic and salinity conditions in Lake Pontchartrain and the general area. Model verification was based on prototype data collected over a one-year period from March 1958 through February 1959. The model was then used to establish base salinity levels in the project area for a low inflow year, 1954, and a high inflow year, 1949. Thus, the range of existing salinities from a dry to a wet year and the seasonal fluctuations in each of the years were established. The effect on salinity of hurricane control structures in the tidal passes was then tested in the model for the high inflow (low salinity) year.

For certain tests the Gulf Outlet channel was added to the model. Thus, the salinity for the base condition years of 1949 and 1954 was obtained with the Gulf Outlet project in place and connected with Lake Pontchartrain via the Industrial Canal. The model indicated that a much higher level of

salinity would prevail in the lake system as a result of salt-water intrusion through Gulf Outlet channel. The effect of hurricane control structures in the tidal passes on this new and higher base salinity was then tested for both the low and high inflow years.

The model was also used to test the effects of a control structure in the Gulf Outlet connection. Capacity flows in the connection were reduced by one-third and two-thirds, respectively, for the high inflow year to determine the practicability of controlling salt-water intrusion. In addition, tests were run in the model to determine the size structures needed to evacuate Bonnet Carre Spillway discharge from Lake Pontchartrain, as well as to determine the effect of a hurricane closure procedure on the established salinity regime.

The results of each test run in the model were made available to the Service in the form of preliminary salinity data plotted for each station in the lake system. For several of the tests, similar data were provided for stations in the Gulf Outlet channel. The Service was later provided a summary of these data for the lake system (Appendix A).

FISH AND WILDLIFE RESOURCES

Fish and wildlife habitat of the project area is extremely important. The area provides valuable sport and commercial fishery harvest of both fresh-water and marine species, valuable nursery areas for marine fish and shellfish, waterfowl harvest, resting and feeding areas, and fur-animal producing and harvest areas.

Generally, the marine fishery occupies the lake proper and immediate contiguous waters, while the fresh-water fishery is restricted to adjacent marshes, swamps and tributary streams.

Valuable fur-animal habitat is present in the adjacent marshes, while waterfowl utilize both these marshes and the open lake for feeding and resting. Waterfowl hunting is generally restricted to the adjacent marshes and ponds.

Fishery Resources

During the one-year evaluation period more than three million pounds of fish and shellfish were harvested from Lake Pontchartrain (table 2). Commercial fishermen harvested almost 2 million pounds of fish and shellfish with a landed value of $258,000, while 247,000 man-days of sport fishing yielded over one million pounds of fish and shellfish. This sport-fishing take included 72 percent of the total finfish harvest, 19 percent of the crab harvest, and 7 percent of the shrimp harvest.

Table 2

Lake Pontchartrain Fishery Harvest, April 1959-March 1960
(In Thousands)

	Total		Fish		Crabs		Shrimp	
Fishery	Pounds	Value or Man Days	Pounds	Value or Man Days	Pounds	Value or Man Days	Pounds	Value or Man Days
Commercial	1,965	$258	272	$ 44	1,461	$133	232	$81
Sport	1,049	247 1/	700	227	332	30	17	3
Total Lbs.	3,014		972		1,793		249	

1/ Total man-days of sport fishing is less than combined subtotals because some fishermen engaged in more than one kind of fishing on same day.

Marine species are far more important than fresh-water species to both the sport and commercial fisheries. Marine species made up 95 percent of the sport-fishery harvest and 90 percent of the commercial harvest. Only 7 percent of the anglers were fresh-water fishermen. Of the marine fish caught, salt-water sheephead and speckled trout made up almost 80 percent of the sport-fishing catch, while speckled trout and redfish comprised 70 percent of the commercial marine finfish harvested. About 88 percent of the sport-fishing effort was for finfishes, and crabbing accounted for about 11 percent. Shrimping was a minor effort.

In addition to the sport and commercial-food fishery, a sizable commercial bait industry has developed on Lake Pontchartrain to supply the sport fisherman. During the one-year evaluation period bait dealers harvested and sold more than 2½ million live shrimp; 360,000 pounds of dead shrimp; 150,000 live small fish; 140,000 crabs, and 7,000 gallons of clams, for which they received more than one-quarter million dollars. While this bait was harvested from the entire study area, it was used only by sport fishermen in Lake Pontchartrain and the tidal passes.

With maintenance of existing salinities, a projected use of 800,000 man-days of sport fishing, and sport- and commercial-fishery harvest of 5¼ million pounds of fish and shellfish are assignable to the lake annually. Projections were based on Bureau of the Census population figures and data included in this Service's 1960 National Survey of Fishing and Hunting.

There is considerable gradation in fishing success and total harvest from one end of Lake Pontchartrain to the other. Of particular significance is the relation of harvest success and fishing effort to the salinity gradient (table 3 and figure 1). The highest rate of sport-fishing success occurred in the extreme lower lake from the vicinity of the Highway 11 bridge to the tidal passes where the highest salinity also occurred. The lowest rate of fishing success occured in the upper half of the lake above the New Orleans causeway where salinity was lowest. The commercial-fishery harvest was similar except for shrimp, the lower lake being closed to commercial trawling so that the entire shrimp catch came from the upper lake.

Table 3

Relation of Lake Pontchartrain Fishing to Salinity 1/
April 1959-March 1960

	Upper Lake	Lower Lake	Extreme Lower Lake
Salinity spread p.p.t. (ave.)	0.3-1.4	1.4-2.3	2.3-2.7
Sport Fishery			
No. fishermen (percent)	3.0	44.0	53.0
Fish caught/man-days (lbs)	0.5	3.1	5.1
Fish caught/acre (lbs)	0.01	2,5	14.4
No. crab fishermen (percent)	1.0	32.0	67.0
Commercial Fishery Harvest			
Marine fish (percent)	None	100.0	
Crabs (percent)	35.0	65.0	
Shrimp (percent)	100.0	Closed to harvest	

1/ Salinities in parts per thousand as established from Corps of Engineers' sampling stations.

Differences in the fishery harvest between the upper and lower lake can be expected to continue with maintenance of the salinity gradient and comparable salinity values. While the relationship between fishery harvest and salinity was based upon only one year's evaluation, the salinity differential (gradient) between the upper and lower lake is consistent as evidenced by data in table 4.

Table 4

Variations in Lake Pontchartrain Salinity (Parts Per Thousand) for Existing Conditions

	Entire Lake		Upper Lake		Lower Lake	
Model Data	Average	Range	Average	Range	Average	Range
1949 wet year	1.1	0.6-2.0	1.0	0.6-1.9	1.2	0.6-2.1
1954 dry year	2.3	1.6-3.6	2.1	1.2-3.3	2.8	1.8-4.9
Prototype Data						
1949 wet year	1.0	0.3-2.7	0.7	0.2-2.5	1.3	0.4-2.9
1954 dry year	3.1	0.9-6.8	1.8	0.3-3.8	4.5	1.5-9.8

Note: Prototype data from Corps of Engineers' sampling stations.

The relationship between salinity and the fishery demonstrates that the upper half of Lake Pontchartrain, with its low salinity level, is not conducive to either a large marine-fishery harvest or a fresh-water fishery. The lower and extreme lower lake with higher salinities, even though differences were slight, contribute a correspondingly higher rate of fishing success. However, during prolonged periods of excessive rainfall which lowers salinity, harvest of important marine species such as speckled trout and salt-water sheephead is probably temporarily reduced in the lower lake. These species evidently prefer a higher salinity than occurs in the lower lake under these conditions, or as prevails in the upper lake under most conditions.

Lake Pontchartrain is also an important nursery area for marine fish and shellfish which contribute to the harvest, not only within the lake, but also in other more saline areas of the estuarine complex and in the Gulf. These nursery stocks also provide forage (food) for the desirable sport and commercial fish which are caught in the lower lake. It is entirely possible that the abundant food supply afforded by these nursery stocks is one of the contributing factors that induce harvestable game and food fish to enter and concentrate in the lower lake.

Because fewer large predatory fish are found in the upper lake, its nursery area value is probably equal or greater than the lower lake for such species as menhaden and white shrimp.

Wildlife Resources

Since the project probably would influence only the lake proper and the adjacent marshes and swamps, effects on wildlife would be principally limited to waterfowl and fur animals.

There are approximately 70,000 acres of marshland (not including swamp) adjacent to Lake Pontchartrain. About half of this marsh area has protection in the form of levees and is either undergoing residential and industrial development, or will be in the foreseeable future. The other half has no protection.

During the one-year evaluation period, 2,100 waterfowl hunters in the area of Lake Pontchartrain and the tidal passes bagged 9,200 birds, of

which blue geese made up 65 percent of the bag, the rest being ducks and coots. Scaup was the duck bagged most frequently and at times several hundred thousand used Lake Pontchartrain as a resting and feeding area.

It is estimated, conservatively, that the Lake Pontchartrain marshes would provide 3,500 man-days of waterfowl hunting annually over the project life.

Over 100,000 fur animals, of which 88 percent were muskrats, were harvested from the marshes and swamps immediately adjacent to Lake Pontchartrain during the one-year evaluation period. Net value of this harvest was $66,000. Valuable marsh habitat is being lost to urbanization and industrial development, and this trend is expected to continue so that the average annual fur production over the life of the project is anticipated to be about 75,000 pelts, with a net value of $50,000.

EFFECTS OF THE PROJECT

Levees (Both Plans for Hurricane Protection)

Raising the grade of the present levee system would not affect fish and wildlife resources appreciably. Furthermore, construction of new levees would not significantly affect fish and wildlife resources directly, providing the existing water regime is not modified within the leveed area. Each of the plans for hurricane protection provides the necessary drainage facilities to prevent this, although a small narrow strip of wooded swamp along Highway 61 east of Bonnet Carre Spillway probably would be converted to industrial and residential sites. Indirectly, new levees would result in loss of fish and wildlife habitat by providing the basic flood protection

features necessary for future reclamation and conversion of marshes to residential and industrial development. This applies especially to the entire area of unprotected marsh and swamp east of Bonnet Carre Spillway between Highway 61 and the lake.

Since the high level plan is essentially that of levee construction, it is expected that direct effects on fish and wildlife would not be extreme. The low level plan, however, contains additional features that must be considered; namely, structures in the tidal passes and in the Gulf Outlet connection.

Hurricane Control Structures (Low Level Plan Only)

The principal factor oonsidered in project investigations was the possible adverse effects of reducing the volume of tidal exchange between Lake Pontchartrain and the brackish waters of Mississippi Sound-Lake Borgne by restricting the tidal passes with control structures. Of particular concern was the relation of tidal volume exchange to salinity, inasmuch as the salinity gradient in Lake Pontchartrain is dependent upon tidal introduction of brackish waters. Effect of project structures in the passes on velocity of flow and as physical obstructions was also considered.

The salinity levels for wet and dry years developed in the model for Lake Pontchartrain provided the base for testing the effect of hurricane control structures in the two tidal passes. For this range of existing salinity conditions, the model showed that hurricane control structures in the tidal passes which reduced their respective cross-sectional areas by

75 percent did not alter significantly existing salinities in Lakes Maurepas, Pontchartrain, and Borgne (figure 2). Tidal exchange through the passes was reduced about 15 percent by the structures.

The model also indicated that upon completion of the Gulf Outlet project, salt-water intrusion via this channel would raise salinities in the lake system. Salinities in Lake Maurepas would be increased 4.5-5.6 times over the existing wet and dry year averages; Lake Pontchartrain salinities would be 3.4-4.8 times greater, and Lake Borgne salinities 1.2-1.6 times greater (figure 3).

While this severe increase in salinity was not attributable to the hurricane plan, it resulted in such a marked change in base conditions that a determination of the effects of the hurricane control structures in the tidal passes on this new and higher level of salinity became necessary.

Model tests showed that structures in the tidal passes did not change significantly this new and higher level of salinity in Lake Pontchartrain, or Lake Borgne (figure 4). The salinity in Lake Maurepas was not changed for the high inflow year but was reduced for low inflow year conditions (figure 4); not as low, however, as the existing level.

Model tests were run also to determine the effect of a hurricane closure operation in which all structures, including the Gulf Outlet connection, were closed for a two-week period, with hurricane rainfall occurring over the watershed. There was no significant change in Lake Pontchartrain bottom salinities (figure 5) (surface salinity samples were not taken). No significant effect was shown for Lakes Borgne and Maurepas. During the closure operation salinity in the Gulf Outlet channel increased significantly, but upon reopening, salinity was lowered beyond the level of the base test. Figure 6 shows this effect for one surface location in the Gulf Outlet channel. A similar effect was noticeable over the entire channel.

In addition to the aforementioned model test results, tests were run to determine the practicability of controlling salt-water intrusion into Lake Pontchartrain from the Gulf Outlet channel. The model showed that a full range of control could be accomplished by regulating the flow at the junction of Lake Pontchartrain and Industrial Canal (figure 7). The hurricane control structures in the tidal passes did not influence this control.

Figure 8 summarizes model test results to show effects on Lake Pontchartrain of hurricane control structures in the tidal passes, effects of salt-water intrusion via Gulf Outlet channel, and salt-water intrusion control.

Model test data established that project structures in the natural tidal passes did not significantly alter Lake Pontchartrain salinities. While it must be pointed out that model findings were based upon salinity values that did not totally reflect prototype conditions, the findings offer reasonable evidence that fish and wildlife resources in the lake would be relatively unaffected as far as salinity is concerned.

In addition to concern with salinities, the effects of structures on current velocities and volume of tidal exchange must be considered. Reduction in tidal exchange of about 15 percent, caused by the structures, would reduce the back flow of nutrient-rich Pearl River waters which enter the lake and this, in turn, would lower the fertility of the lake. The effects of reduced tidal exchange and the physical interference of the structures on the movement of fish and shellfish in and out of the lake is conjectural. Since normal tidal volume exchange would remain very large with the structures in place, and since structure sills would be located at the controlling depths of the passes, these problems are seemingly not significant.

Increased velocities at the structure sites could very well present a hazard to small boats. Locking, when required, would delay boat passage. This delay may be a problem for boats entering the lake ahead of an approaching hurricane.

DISCUSSION

Hurricane Control Structures

Model studies indicate that hurricane control structures in the tidal passes, as presently planned, would have little appreciable effect on salinities in Lakes Maurepas, Pontchartrain and Borgne. Evidently, volume exchange through the passes would not be affected sufficiently to modify salinity values. Reduction of normal tidal exchange only by about 15 percent is accounted for by increased efficiency of flow at the structures. Higher flow velocities would compensate for reduction in cross-sectional area.

Model data indicate that with proper control facilities included at Gulf Outlet connection the risk of detrimental effects of the low level plan to fish and wildlife in Lake Pontchartrain is within reason. It is recognized, however, that annual salinity ranges as developed by the model for the test years did not reflect the same salinity gradient between the upper and the lower lake as shown by prototype sampling for the same period. Also, maximum salinity levels in the prototype were not attained in the model (table 4).

To emphasize that only a small reduction in salinity in lower Lake Pontchartrain could result in a large loss of fishery resources, the projected fishery values under existing conditions were compared to those with an assumed condition in which salinities in the lower lake would be reduced to the values now obtaining in the upper part of the lake. Under these assumed conditions it was estimated that annual fishery resources would be reduced by 220,000 man-days of sport fishing and that the annual sport and commercial harvest of fish and shellfish would be reduced by one and one-half million pounds. Consequently, any plan developed for hurricane protection by structures in the passes should recognize the importance of the salinity gradient in the project area. Further safeguards should be included in any request for authorization to permit project adjustment as needed to maintain the salinity values basic to fish and wildlife resources.

Problems Associated with Gulf Outlet Channel

Model test of a two-week hurricane closure operation of all structures causing, first, an increase in Gulf Outlet salinities, then a reduction upon reopening, has important implications. It indicates that prolonged or permanent closure of the Gulf Outlet connection would result in very high salinities throughout the navigation channel from surface to bottom. The reduction in salinity after reopening the structures resulted from the outflow of more than one foot of hurricane rainfall which had accumulated in the lake. A two-week closure of the structures without hurricane rainfall, on the other hand, could very well result in excessively high salinities in the channel which could persist for several months.

Model tests indicated that an intermediate type salt-water intrusion would occur in the Gulf Outlet channel. That is, a salt wedge would intrude over the entire length of the channel but would become progressively deeper toward Lake Pontchartrain, with a mixing layer above the salt wedge. Some variation in the salinity of the mixing layer was evidenced between the various tests; however, the depth of the interface and salinity below the interface did not show significant variation.

Of related significance were test results which indicated that successful control of salt-water intrusion into Lake Pontchartrain, by controlling flow at the Industrial Canal connection with the lake, would modify salinity in the surface mixing layer in the Gulf Outlet channel (figure 9). It therefore becomes very important that the structure in the Gulf Outlet-Industrial Canal connection with Lake Pontchartrain be designed and operated to afford not only proper control of lake salinities, but also provide maximum utilization of outflowing lake water to depress excessively high saline concentrations in the channel proper which could adversely affect marsh habitat associated with the Gulf Outlet.

The model did not provide the detailed data necessary either to design such a structure or develop an operational procedure. It was originally designed to test the effects of hurricane control structures and not intended to define Gulf Outlet conditions. It must be recognized, therefore, that channel salinities, as indicated by the model, probably do not reflect the exact conditions which will eventually occur, nor

will the degree of salt-water intrusion into Lake Pontchartrain necessarily be of the magnitude indicated. While the model results pertaining to Gulf Outlet channel show a relationship between the various tests, the exact type of intrusion, level of salinity, and dispersion, could vary considerably from that indicated. Disparities could result from differences between model and prototype features, such as variations in source water, vertical mixing in channel, effects of wind tides, channel depth variations and eventual modification of the channel or major connecting waterways. One or all of these could alter values indicated by the model study.

The model study represents but one approach to determining the eventual effects of Gulf Outlet channel, and, as indicated above, may have serious limitations. Much more information is needed to confirm the type and severity of salt-water intrusion which will actually occur upon completion of the Gulf Outlet channel. Probably this can be determined best by sampling in the channel or sampling in combination with a model designed specifically to provide this information.

SUMMARY

The Service's appraisal of the hurricane barrier project has been based primarily on model studies and data obtained from investigations conducted on both the Lake Pontchartrain and Mississippi River-Gulf Outlet project areas. The findings are summarized as follows:

A. Lake Pontchartrain is a large, brackish tidal basin forming a mid-part of an estuarine system located between the marine environment of the Gulf of Mexico and the nearly fresh-water environment of Lake Maurepas. The salinity gradient within this complex is maintained by contributions from both the marine system at one end and the fresh-water system on the other end. Alteration within any particular segment of the complex would result in change over the entire estuarine zone.

B. Lake Pontchartrain supports a large valuable marine-fishery harvest. Generally, the fishery harvest from the lower, more saline portion of Lake Pontchartrain is much greater than from the upper, less saline area.

C. The entire lake is considered a valuable nursery area for marine fish and shellfish which are harvested throughout the estuarine complex and from the Gulf of Mexico. For some species the upper, less saline portion of the lake is probably of equal or greater importance as nursery area than the lower lake.

D. Wildlife of moderate value exists in Lake Pontchartrain and adjacent marshes. Waterfowl and fur animals are the most important.

E. Levee construction included in both plans for hurricane protection is not expected to have a direct, significant effect on fish and

wildlife resources. Indirectly, both plans would hasten urbanization and industrialization of adjacent marshlands by providing basic features for flood protection and reclamation.

F. Model tests indicate that the proposed control structures in the tidal passes would not adversely alter existing salinity in the project area, nor would the structures greatly alter salinities which may occur with the Gulf Outlet project completed.

G. Model tests also indicate that with hurricane-associated rainfall occurring over the watershed, a short hurricane closure operation of the proposed control structures would not affect Lake Pontchartrain salinities significantly. Salinity in Gulf Outlet channel would increase severely during closure but would be reduced upon reopening the structures. Closure operation without a hurricane-associated rainfall would produce excessively high salinities in the channel for an extended period. Prolonged or permanent closure of this structure would result in continuous high salinities in the Gulf Outlet channel.

H. Proposed control structures and associated higher flow velocities in the tidal passes would present a navigation problem locally. Required locking time also could be a problem for boats entering the lake ahead of an approaching hurricane.

I. Model studies indicate that highly saline waters from the Gulf would intrude through Gulf Outlet channel and into Lake Pontchartrain. This intrusion would raise salinities significantly in Lake Pontchartrain and would cause changes throughout the entire estuarine complex from Lake Maurepas to the Gulf.

J. Model tests indicate that salt-water intrusion into Lake Pontchartrain could be effectively controlled by a structure in the connecting channel between Gulf Outlet and the Lake. Proper design and operation of this structure would likely provide some degree of control over high salinities in Gulf Outlet channel.

K. Results of model tests which indicated that salt water would intrude through the Gulf Outlet channel into the Lake system are not considered adequate for final determination of structural requirements. The model was designed to test control structures in the Lake Pontchartrain tidal passes and not intended to precisely measure Gulf Outlet effects.

L. The model did not provide the detailed data necessary either to design the most efficient type control structure in the Gulf Outlet connection or to develop an operational procedure.

CONCLUSIONS

1. Because of the high value of the fishery and critical nature of the salinity complex supporting the fishery, adequate provision should be included with any plan recommended for hurricane protection to permit rectification of adverse changes that may occur in the salinity gradient.

2. Hurricane protection essentially by means of levee protection (the high level plan) would not have a significant direct effect on fish and wildlife resources.

3. The risk of possible detrimental effects of the proposed structures (low level plan) is within reason, provided the model study findings are representative of with-project conditions and proper facilities are provided to control salt-water intrusion.

4. Should salt-water intrusion be severe from the Gulf Outlet project, as the model indicated, control would be required.

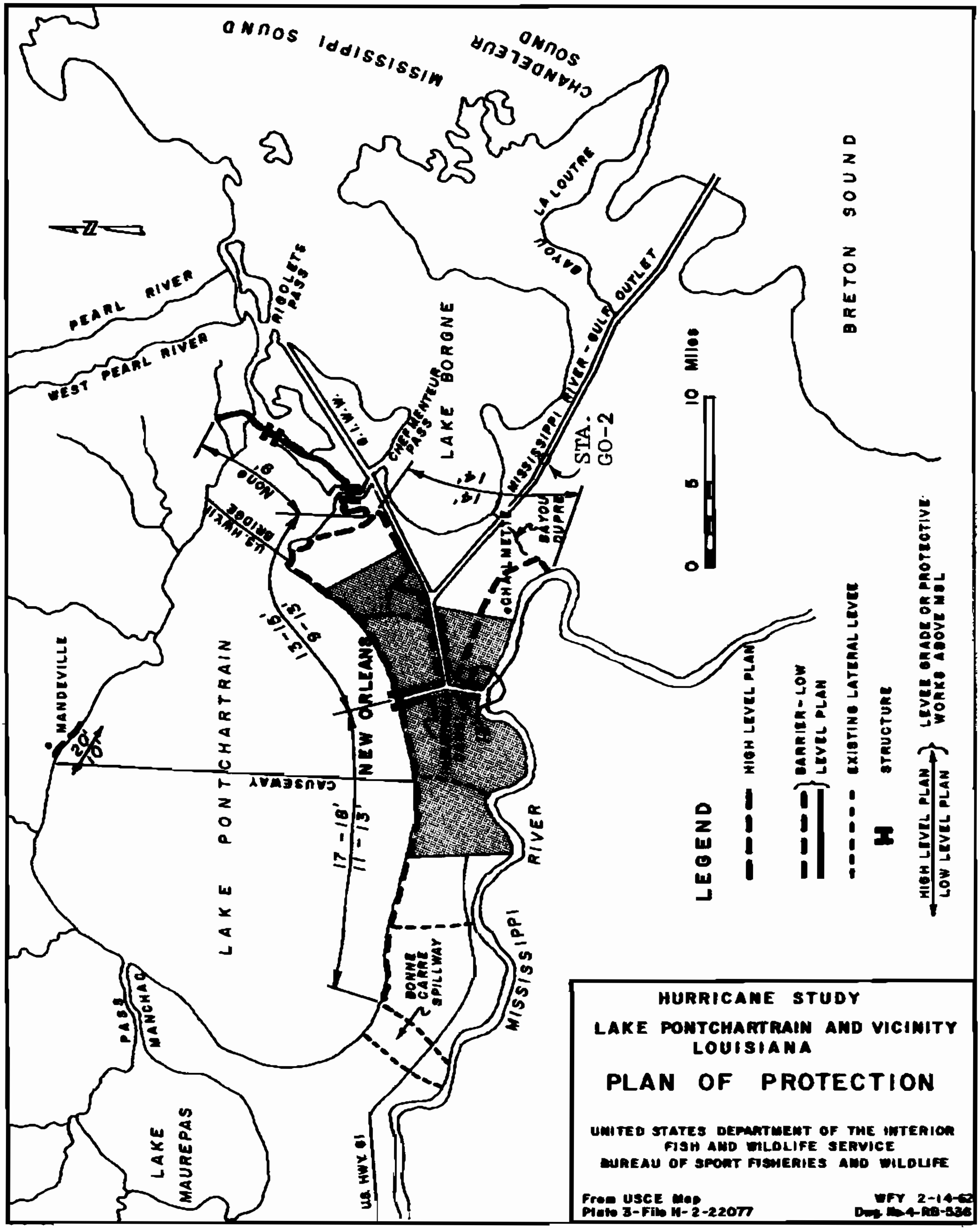
5. The structure necessary to attain this control should be designed and operated to obtain the best possible salinity conditions, not only in Lake Pontchartrain but in the Gulf Outlet channel as well.

6. Further studies to establish the type of intrusion and salinity level which will occur in the Gulf Outlet channel will be required before the most efficient structure design and an operational procedure can be developed.

7. Salt-water intrusion through Gulf Outlet channel is not a hurricane project effect. Consideration of this problem, therefore, should be included as a part of the continuing studies on the Mississippi River-Gulf Outlet project.

LAKE PONTCHARTRAIN MODEL STUDY - DATA SUMMARY PREPARED BY CORPS OF ENGINEERS
(SALINITY P.P.M.)

	Test	LAKE BORGNE			LAKE PONTCHARTRAIN		
		Average Minimum	Average Maximum	Average for Test	Average Minimum	Average Maximum	Average for Test
1.	Base test - 1954 low inflow year.	3,151	10,735	6,463	1,652	3,596	2,278
2.	Base test - 1949 high inflow year.	802	6,889	2,564	647	2,036	1,056
3.	Gulf Outlet open without structures in passes-low inflow year. Start with existing salinity.	2,850	11,515	6,597	2,248	7,941	5,108
4.	Gulf Outlet open w/o structures in passes. Low inflow year. Start with salinity as affected by G.O.	4,125	11,315	7,589	7,166	9,960	8,412
5.	Gulf Outlet open with structures in passes. Low inflow year.	4,712	11,350	7,565	6,619	9,611	7,831
6.	Gulf Outlet open w/o structures in passes. High inflow year.	2,994	6,761	4,105	4,358	6,352	5,338
7.	Gulf Outlet open with structures in passes. High inflow year.	3,029	7,416	4,527	4,200	6,568	5,389
8.	Gulf Outlet flow reduced 1/3 with structures in passes. High inflow year.	1,683	7,089	3,203	1,794	4,715	3,008
9.	Gulf Outlet flow reduced 2/3 with structures in passes. High inflow year.	2,098	6,751	3,707	1,763	3,865	2,622
10.	Gulf Outlet closed with structures in passes. High inflow year.	702	6,682	2,430	657	2,018	1,079
11.	Two-week hurr. closure oper. of all structures. High inflow year.	3,122	7,283	4,217	3,674	6,368	4,822



HURRICANE STUDY

LAKE PONTCHARTRAIN AND VICINITY
LOUISIANA

PLAN OF PROTECTION

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

From USCE Map
Plate 3-File H-2-22077

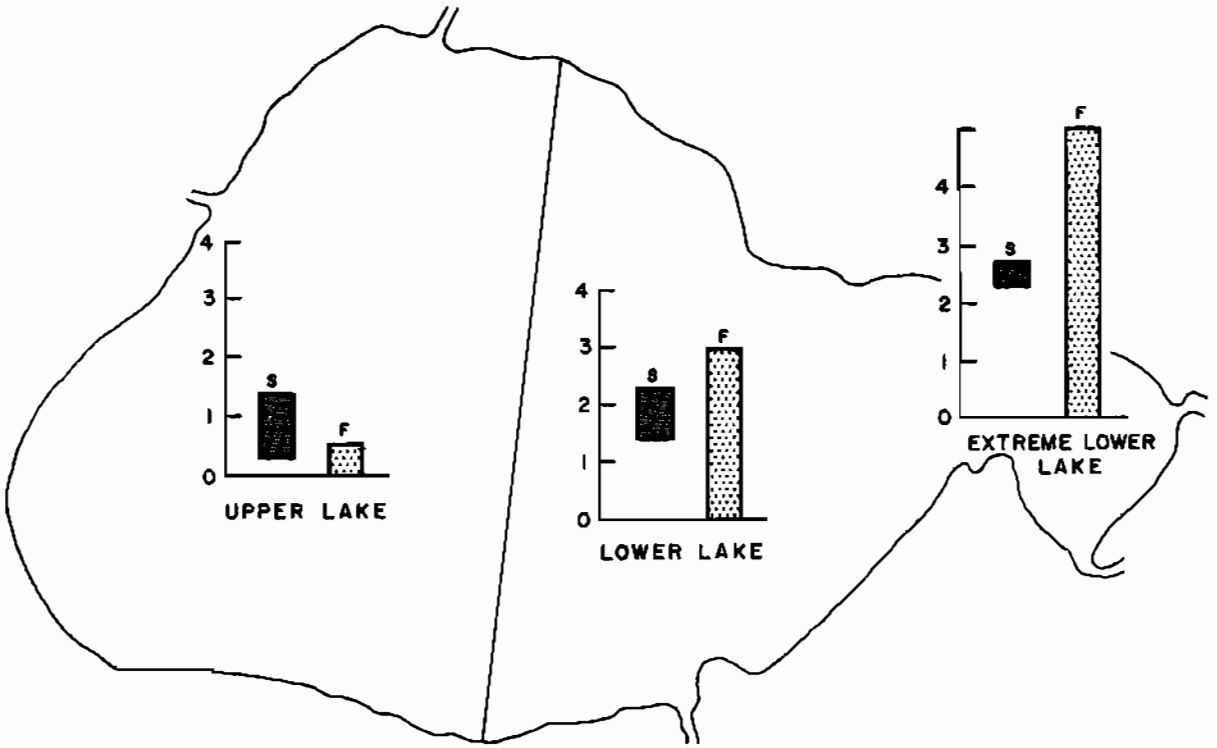
WFY 2-14-62
Dwg. No-4-RB-536

PLATE I

LAKE PONTCHARTRAIN SPORT FISHING

RELATION BETWEEN SALINITY AND CATCH PER FISHERMAN

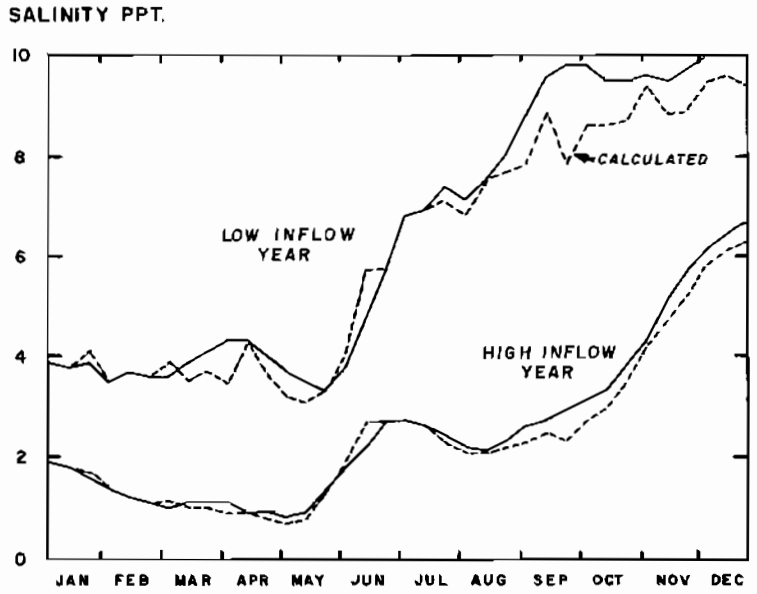
APRIL 1959 — MARCH 1960



S AVERAGE SALINITY SPREAD PPT.

F FISH PER DAY (POUNDS)

FIG. 1

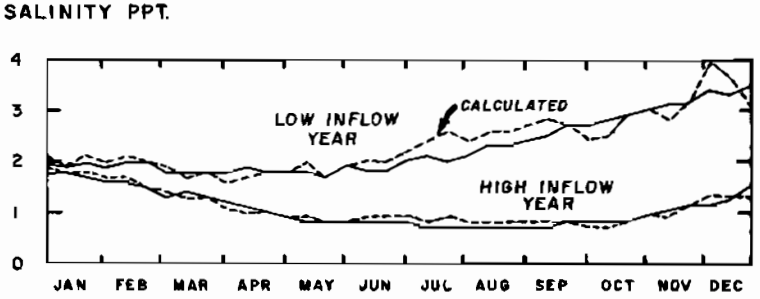


Lake Borgne for Existing Conditions

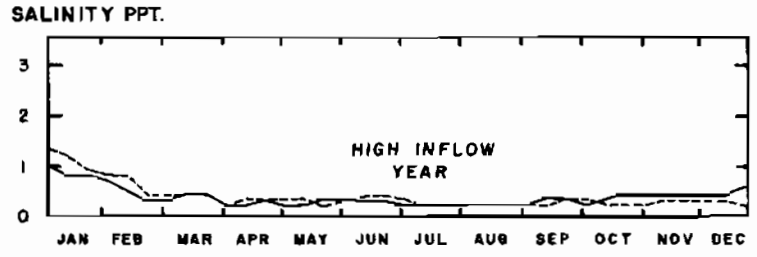
LEGEND

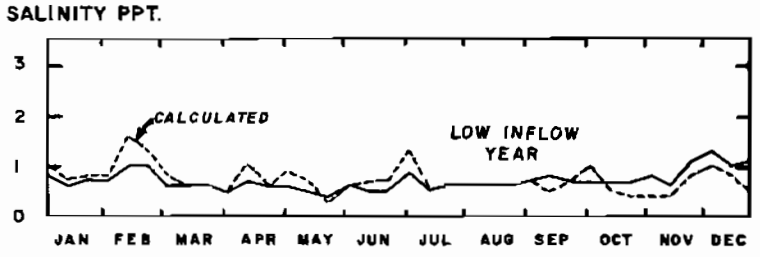
WITHOUT STRUCTURES

WITH STRUCTURES



Lake Pontchartrain for Existing Conditions





Lake Maurepas for Existing Conditions

FIG. 2

EFFECT OF HURRICANE CONTROL STRUCTURES ON SALINITY — FROM MODEL TEST DATA

EFFECT OF GULF OUTLET ON LAKE SALINITY

-FROM MODEL TEST DATA-

(SALINITY AS ANNUAL AVERAGE FROM WET TO DRY YEAR)

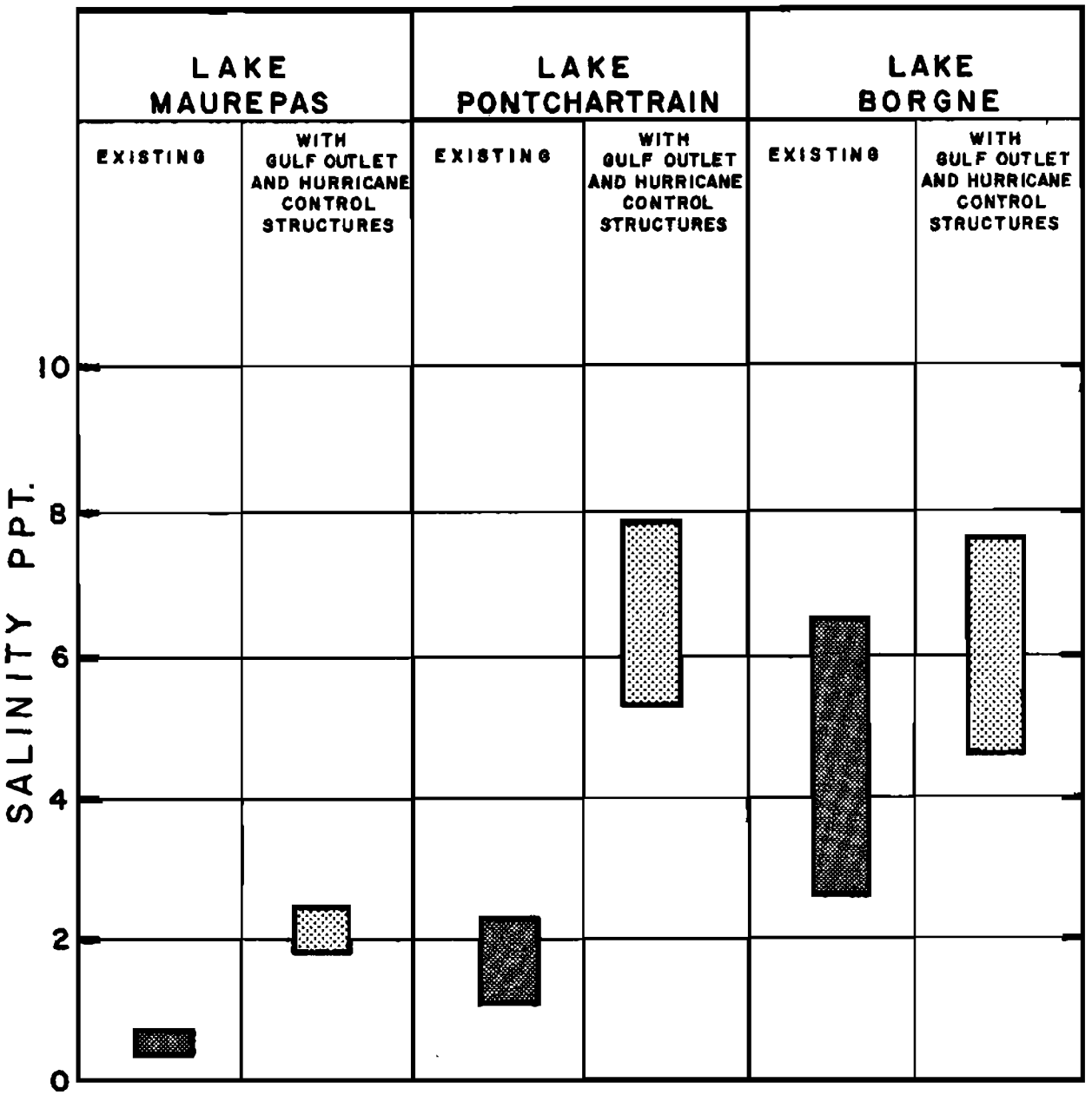
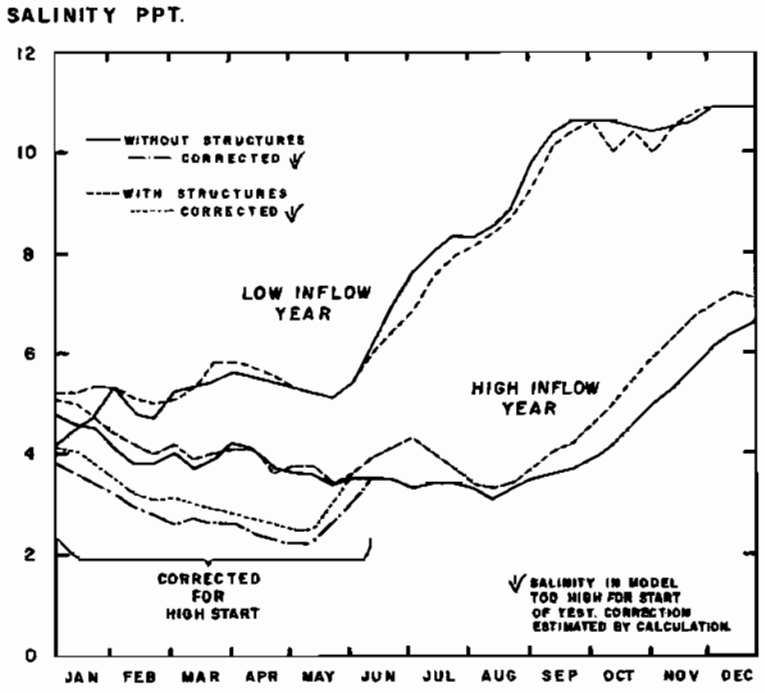
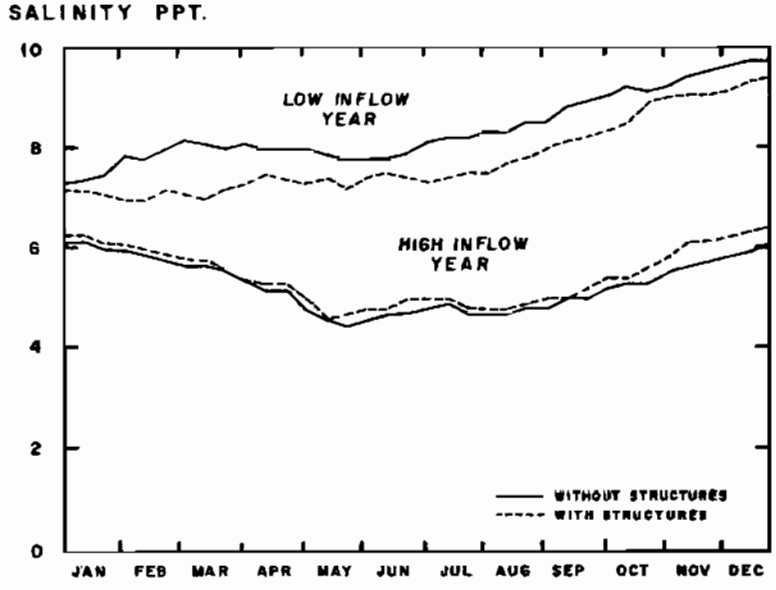


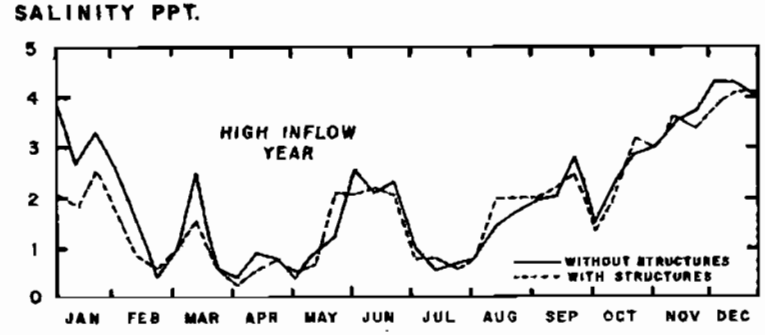
FIG. 3

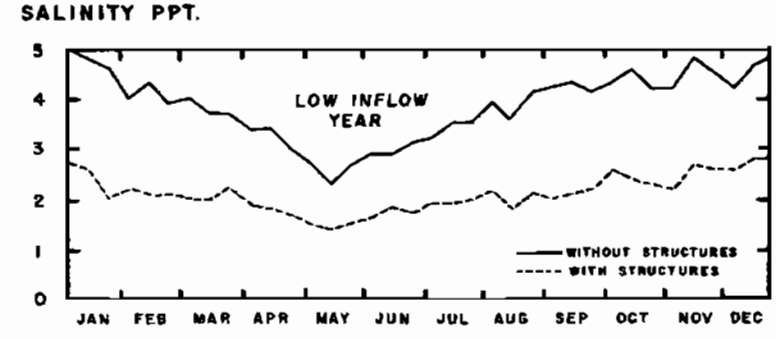


Lake Borgne with Gulf Outlet Channel Open
100 % Flow



Lake Pontchartrain with Gulf Outlet Channel Open
100 % Flow





Lake Maurepas with Gulf Outlet Channel Open
100 % Flow

FIG. 4

EFFECT OF HURRICANE CONTROL STRUCTURES ON SALINITY – FROM MODEL TEST DATA

EFFECT OF 2-WEEK HURRICANE CLOSURE OPERATION ON LAKE PONTCHARTRAIN SALINITY

- FROM MODEL TEST DATA -

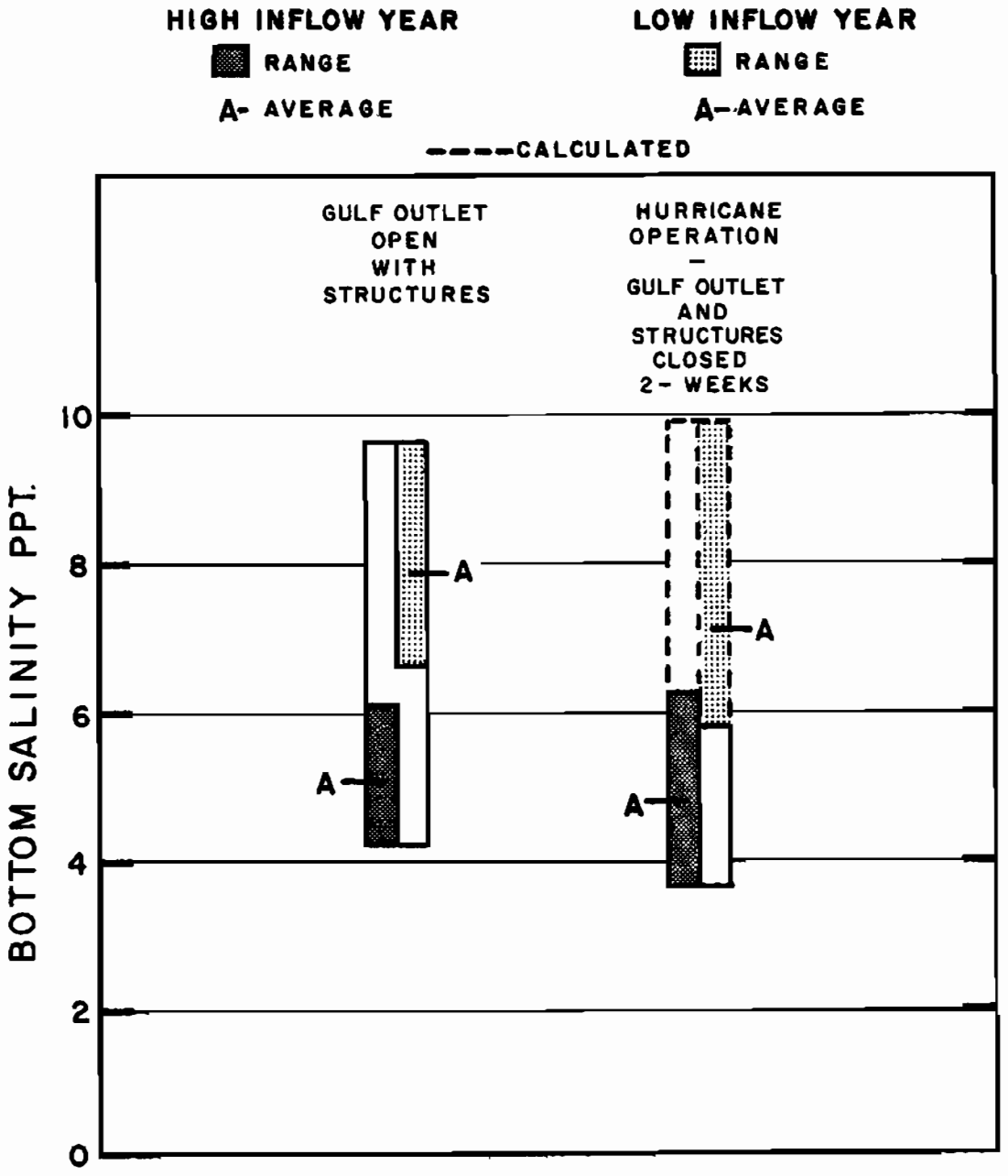


FIG. 5

EFFECT OF HURRICANE CLOSURE OPERATION ON SURFACE SALINITY IN GULF OUTLET CHANNEL AT BAYOU LA LOUTRE

- FROM MODEL TEST DATA -

HIGH INFLOW YEAR

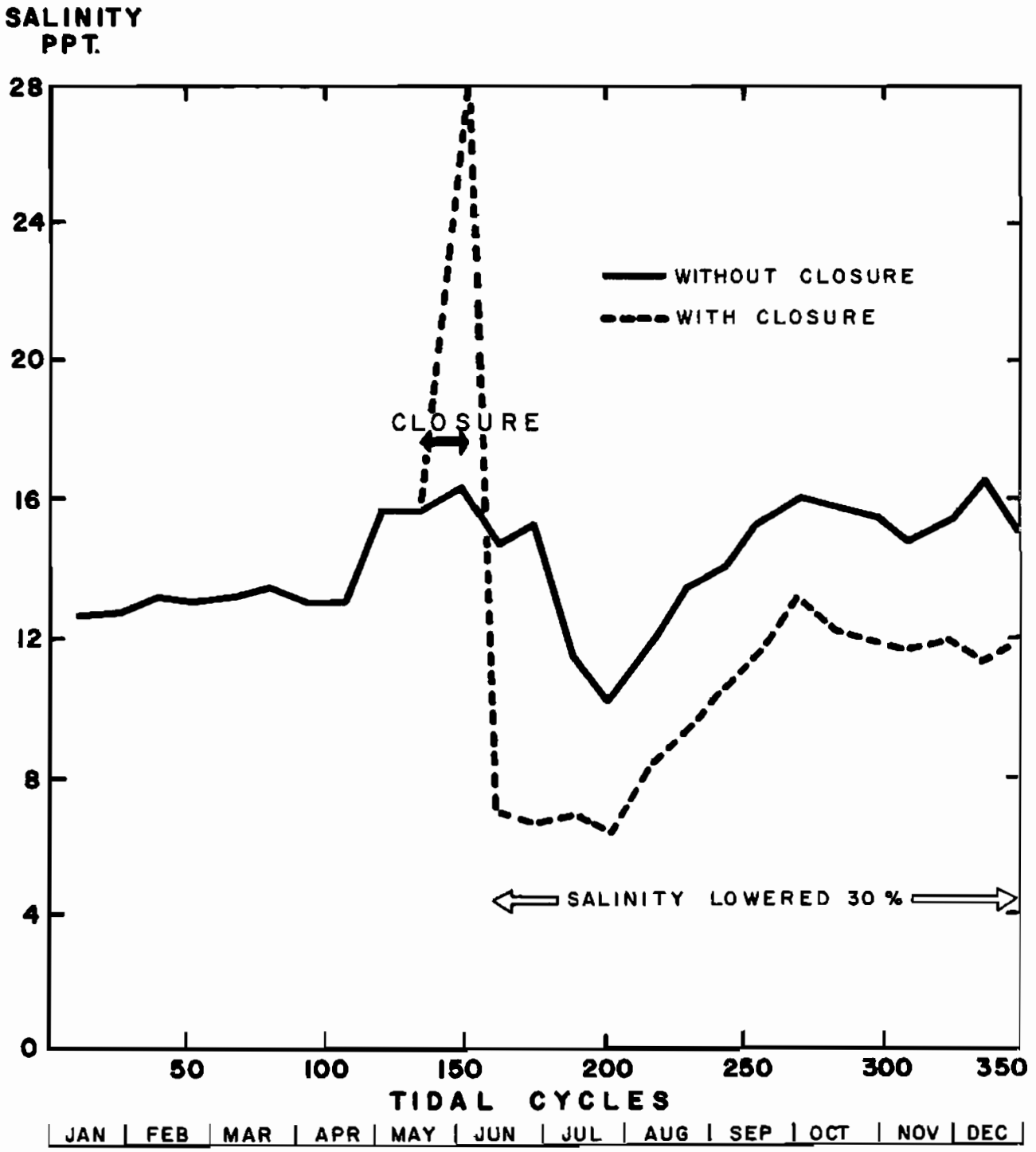


FIG. 6

RESPONSE OF LAKE PONTCHARTRAIN SALINITY TO CONTROL OF GULF OUTLET CAPACITY FLOW

- FROM MODEL TEST DATA -

CONTROL POINT AT JCT. INDUSTRIAL CANAL / LAKE

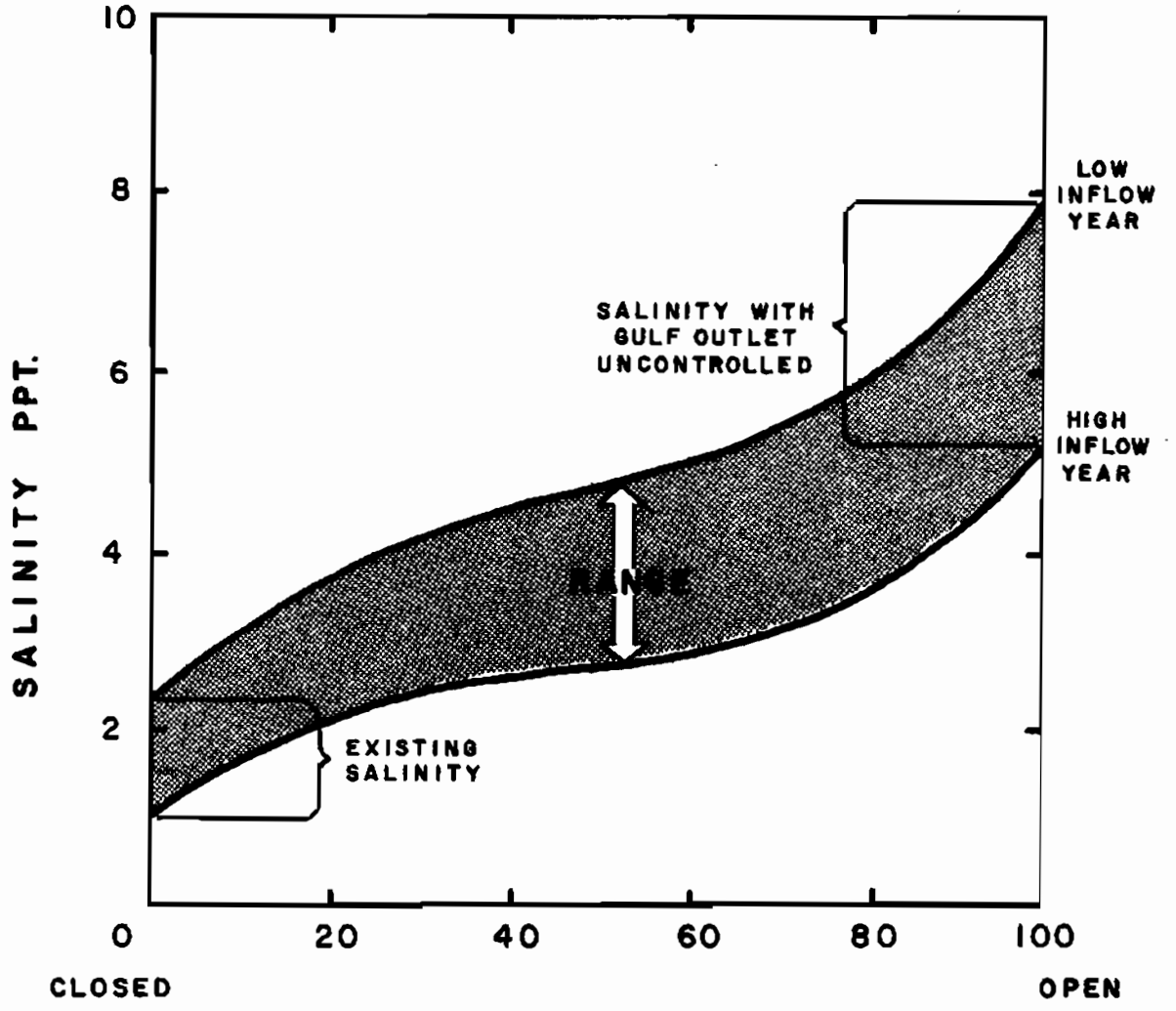


FIG. 7

VARIATIONS IN LAKE PONTCHARTRAIN SALINITY

- FROM MODEL TEST DATA -

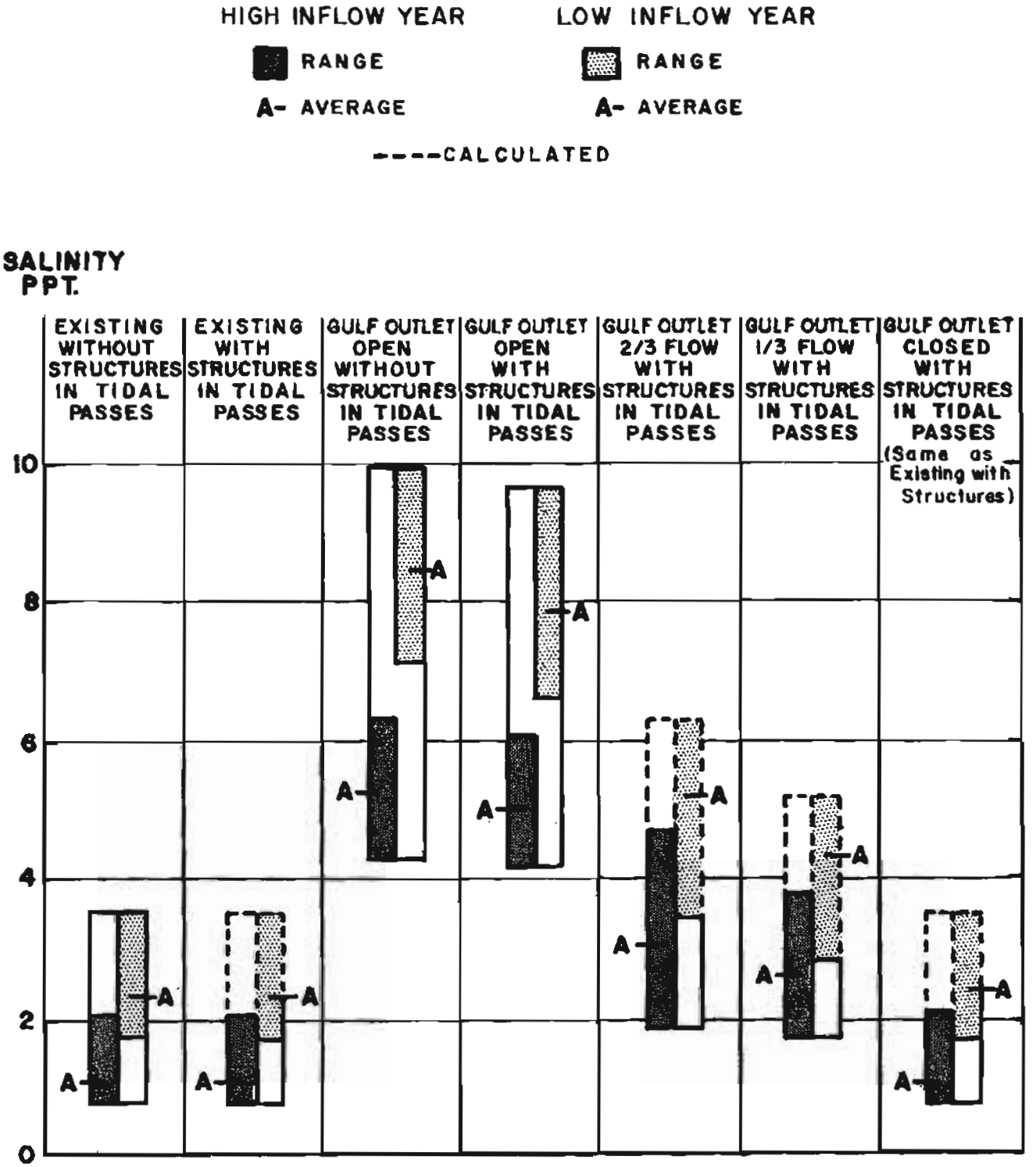
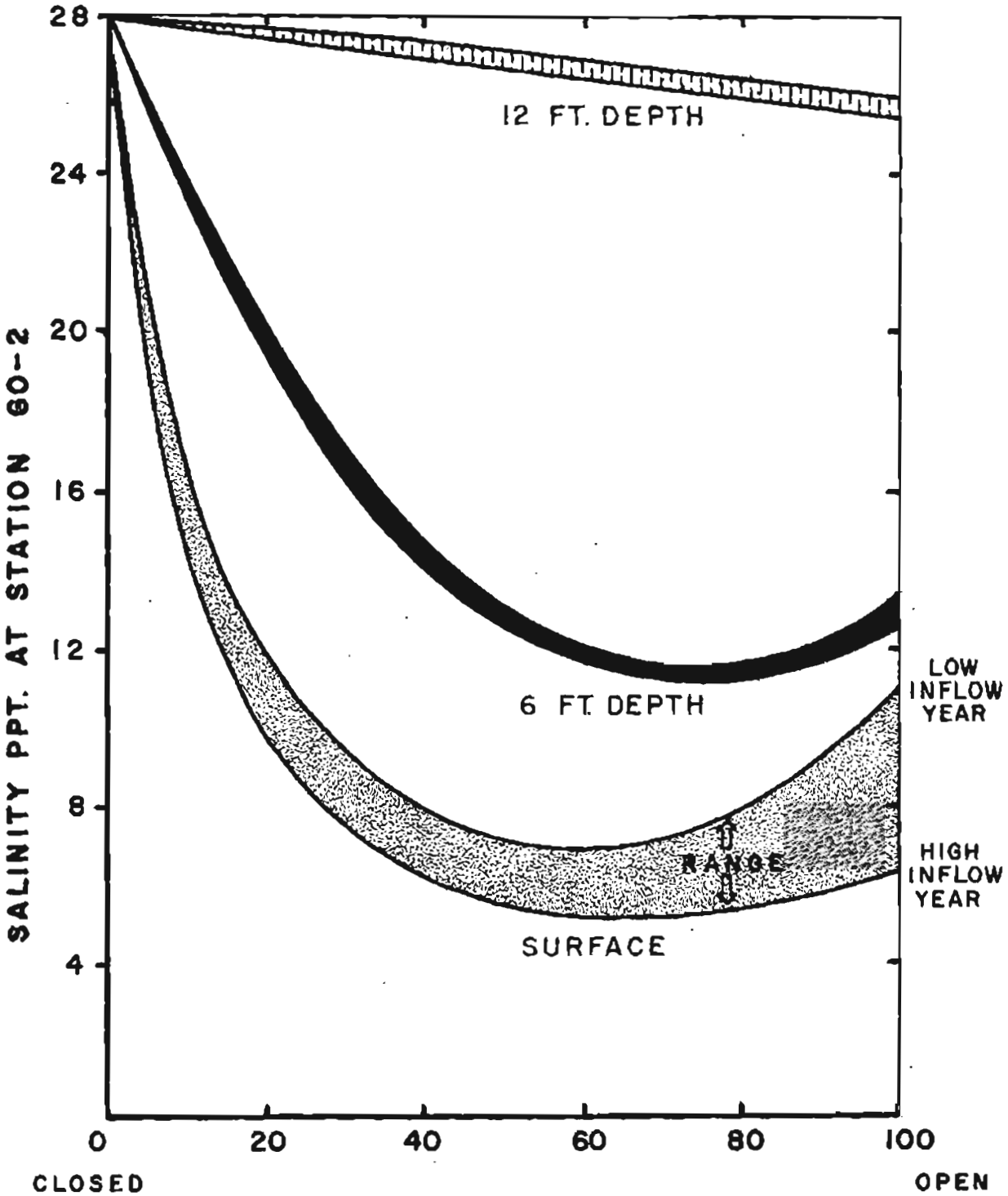


FIG. 8

RESPONSE OF SALINITY IN GULF OUTLET CHANNEL TO CONTROLLED FLOW

-FROM MODEL TEST DATA-



NOTE: LOW INFLOW DATA PARTIALLY CALCULATED

FIG. 9