

LOAN COPY ONLY

DATA RELATIVE TO THE INTRODUCTION OF SUPPLEMENTAL
FRESH WATER UNDER PERIODIC CONTROLLED CONDITIONS
FOR THE PURPOSE OF ENHANCING SEAFOOD PRODUCTIVITY
IN MISSISSIPPI AND LOUISIANA ESTUARIES

Prepared Under A
Mississippi-Alabama Sea Grant
Consortium Research Grant

by

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MASGP-74-18

PREFACE

This study is for the purpose of supporting the justification of developing ways and means and ultimate authorization by appropriate agencies to obtain supplemental fresh water during "dry years" under periodic and controlled conditions to enhance seafood productivity in the Mississippi Sound and related estuaries.

The principal investigator of this study was Dr. David J. Etzold, assisted by Dr. D. C. Williams, Jr., both from the University of Southern Mississippi. The Industry Task Leader Chairman on the project was Mr. Victor Mavar, Mavar Shrimp and Oyster Company, Incorporated, Biloxi, Mississippi. Many people, either directly or indirectly associated with the Seafood Industry, contributed to the project, as indicated in the Introduction. Those contributing do not necessarily infer total agreement with the entire contents of this report.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENT.	ii
PREFACE	iii
INTRODUCTION	1
ATTACHMENTS	
Attachment No. 1: Resolution	7
Attachment No. 2: Extracts from House Document 308-88/2	8
Attachment No. 3: Excerpts from Supporting Documents	24
REFERENCES	40

INTRODUCTION

The basic purpose of this study was to summarize the current literature relative to using supplemental fresh water to enhance seafood and wildlife productivity in Mississippi coastal waters and to explore ways and means of initiating a program of this nature with those directly and indirectly associated with the fishing industry. The study is an outgrowth of a request for assistance by Mississippi Seafood Industry personnel meeting as a group to identify and to solve common problems by working together, with the assistance of the Mississippi-Alabama Sea Grant Coastal Leaders Program.

The following comprise a sketch of the major sequence of events which have ensued on this project.

1. In August of 1973, Mississippi-Alabama Sea Grant Coastal Leaders met with Mississippi Gulf Coast leaders in the seafood industry (industry and government) and formed a seafood industry sub-committee. Subsequent meetings were held in October and November of 1973, and in January, March and May of 1974. Average attendance has been approximately 25 people per meeting. Meetings are open to the public, plus being announced in local news media. Although the industry people are primarily processors (seafood, pet food, and menhaden), some fishermen do attend.

Several projects were selected by the seafood industry personnel, of which a major one was exploring ways and means of obtaining periodic and controlled fresh

water into the Mississippi estuaries via the Bonnet Carre' Spillway. Task leaders are Victor Mavar (Mavar Shrimp and Oyster Co., of Biloxi) and David Etzold, Sea Grant Principal Investigator (University of Southern Mississippi). Concurrence was obtained from Dr. D. C. Williams, Jr., Sea Grant Coastal Leaders Principal Investigator.

2. Discussions of the project merits were next evaluated with the Mississippi-Alabama Sea Grant Consortium Director.
3. A trip was made to New Orleans to discuss the project with the Executive Director of the Gulf States Marine Fisheries Commission, and to solicit his guidance.
4. All activities have been coordinated with the Mississippi Sea Grant Advisory Services.
5. The project was discussed with the Mississippi Marine Conservation Commission.
6. A meeting was held with the Executive Director of Mississippi Marine Resources Council, and his staff to discuss the project.
7. At our October, 1973 meeting, the merits and potential problems relating to the project were discussed.
8. Discussions have ensued with the National Marine Fisheries Service at Pascagoula.
9. Discussions and guidance have been obtained from members of the Gulf Coast Research Laboratory, at Ocean Springs, Mississippi.
10. Several discussions and personal visits were made to New Orleans (Army Corps of Engineers Planning Chief).
11. Discussions with the Mississippi Director of the Office of Science and Technology, Jackson, Mississippi, were made.
12. Discussions ensued with NASA Earth Resources at MTF, in Bay St. Louis.
13. Presentation to the National Sea Grant Site Visit Team in November, 1973, included this project.

14. Articles have appeared in the Mississippi Gulf Coast newspapers a number of times, and were discussed on WLOX-TV on several occasions.
15. The project was discussed with the Mayor and City Commissioner of Biloxi, Mississippi.
16. The Coastal Zone Management meeting at Baton Rouge was attended in February to discuss the project, with a number of Louisiana attendees.
17. A presentation was made to the Gulf States Marine Fisheries Commission Technical Coordination Committee in New Orleans on March 20, 1974, to gain support for utilizing the Bonnet Carre' Spillway as a fresh water source. In effect, the Technical Coordination Committee would not endorse the project without a feasibility study being first conducted. Because the water from the Mississippi River flowing through the Spillway would have to pass through Lake Pontchartrain and Lake Borgne prior to flowing into the Mississippi Sound estuaries, there is Louisiana concern for insuring that the quality of the water be acceptable to all interest groups.
18. A meeting was held in Vicksburg on April 10 with Major General Charles Noble, President of the Mississippi River Commission and Division Chief, U. S. Army Corps of Engineers, and his associates.

General Noble expressed interest in the project and stated that he felt the best route to pursue would be a general feasibility study to determine all alternative potential sources for supplying supplemental fresh water on a periodic and controlled basis to enhance seafood productivity, sports fishing and other wildlife activities in the Mississippi Sound estuarine areas.

Upon request, he assigned his Executive Assistant, Mr. Rodger D. Harris, to help in formulating an appropriate resolution, for presentation to the Legislative delegation for consideration and action.

As a result of comments from the Gulf States Marine Fisheries Commission Technical Coordinating Committee, and from General Noble, the fresh water approach was altered somewhat. Instead of focusing on

utilizing the Bonnet Carre' Spillway as the fresh water source, the plan now requests a general feasibility study to encompass all alternative source possibilities of fresh water diversion into the Mississippi estuaries.

The remaining portions of this document contain attachments relating to the justification for developing a program for obtaining sources and implementing supplemental fresh water into the Mississippi estuaries during the "dry years." An abstract of the three Attachments follow:

Attachment Number 1

Attachment Number 1 is a copy of the RESOLUTION drafted by the U. S. Army Corps of Engineers (upon request), under the direction of Major General Charles Noble, President of the Mississippi River Commission. The RESOLUTION draft was received via telephone, on May 6, 1974, from Mr. Rodger Harris, Executive Assistant to General Noble.

In the last several years, there have been changes in project considerations as a result of actions by U.S. Congress. Also, some projects found not feasible initially are subsequently found feasible due to changes in conditions. The conference with the Corps of Engineers and the resultant resolution drafted suggest willingness to consider the feasibility of incorporating the proposed fresh water project as an integral Corps function.

Attachment Number 2

Upon receipt of the RESOLUTION, identified as Attachment Number 1 above, a copy of House Document 308 was reviewed (under the title of Mississippi River and Tributaries Project, in six volumes, 1964, U. S. Corps of Engineers). Attachment Number 2 includes some of (but by no means all) the areas of discussion relative to fresh water diversion, salt water intrusion, enhancement of fish and wildlife, comments by fish and wildlife agencies, U. S. Corps of Engineers, and others of interest in the study.

Attachment Number 3

Included in this attachment are excerpts from various reports which generally support the value of the introduction of periodic controlled supplemental fresh water to enhance seafood production in the estuarine areas.

The majority of the studies researched and discussed in this report relate to Louisiana, with occasional references to Mississippi. That is because the majority of published literature focuses on Louisiana; however, the problem of salt water intrusion is also prevalent in the Mississippi Sound estuaries. Thus, the referenced material is appropriately applicable to the State of Mississippi.

Last, during the course of the study, essentially no disagreements as to the need for supplemental fresh water were encountered nor found

in previous studies. However, there was not complete agreement as to where the fresh water should come from, how it should be obtained, and as to the quality of sources which may be available. The purpose of this document, and the associated resolution, is designed to initiate a feasibility study relative to the Mississippi Sound and adjacent estuaries.

Attachment No. 1

RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE U. S. SENATE (& HOUSE) THAT THE CHIEF OF ENGINEERS OF THE U. S. ARMY BE, AND IS HEREBY REQUESTED TO REVIEW THE REPORT ON THE MISSISSIPPI RIVER AND TRIBUTARIES, PUBLISHED AS HOUSE DOCUMENT 308, 88th CONGRESS, AND OTHER PERTINENT REPORTS, WITH A VIEW TO DETERMINING THE ADVISEABILITY OF MODIFYING THE RECOMMENDATIONS CONTAINED THEREIN WITH PARTICULAR REFERENCE TO PROVIDING FRESH WATER INTO LAKES MAUREPAS, PONTCHARTRAIN, BORGNE, AND MISSISSIPPI SOUND AREAS IN THE INTERESTS OF IMPROVING THE WILDLIFE AND FISHERIES RESOURCES OF THIS AREA.

Attachment No. 2

Extracts from:

Mississippi River and Tributaries Project

in Six Volumes

1964

U. S. Corps of Engineers

also printed as

House Document 308-88/2

Note: All six volumes of Mississippi River and Tributaries Project are in the Louisiana State University Library. (The accurate recording of referencing the exact page numbers of the quotes are difficult due to frequent repetition of numbering.)

MISSISSIPPI RIVER AND TRIBUTARIES
PROJECT

LETTER

From

THE SECRETARY OF THE ARMY

Transmitting

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED APRIL 6, 1963, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A REVIEW OF THE MISSISSIPPI RIVER AND TRIBUTARIES PROJECT, IN RESPONSE TO A RESOLUTION ADOPTED JUNE 12, 1964, BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, AND TO OTHER RESOLUTIONS BY THAT COMMITTEE AND BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, LISTED IN THE ACCOMPANYING REPORT OF THE MISSISSIPPI RIVER COMMISSION, AND TO THE FLOOD CONTROL ACTS OF JULY 24, 1946 AND MAY 17, 1950

IN SIX VOLUMES

May 21, 1964. -- Referred to the Committee on Public Works and ordered to be printed with illustrations

U. S. Government Printing Office
Washington: 1964 .

MISSISSIPPI RIVER AND TRIBUTARIES REPORTVOLUME INDEXVOLUME

- I Mississippi River Commission
 Main Report
 Annex A - Resolutions and Acts of Congress Incorporated in
 Authorization for Comprehensive Review
 Annex B - Synopses of Reports Related to Amendments of the
 Plan for Flood Control in the Alluvial Valley
- II Mississippi River Commission
 Annex C - Project Design Flood Study
 Annex D - Flowlines
 Annex E - Freeboard Requirements
- III Memphis District
 Annex F - Cairo Drainage District and Mounds-Mound City
 Area, Illinois
 Annex G - St. Johns Bayou, Missouri
 Annex H - St. Francis and L'Anguille Basins, Missouri and
 Arkansas
 Annex I - West Kentucky Tributaries, Kentucky
 Annex J - West Tennessee Tributaries and Reelfoot Lake
 Area, Tennessee
 Annex K - Lower White and Cache Basins, Arkansas
- IV Vicksburg District
 Annex L - Yazoo Backwater Project, Mississippi
 Annex M - Big Sunflower River Basin, Mississippi
 Annex N - Boeuf and Tensas Rivers and Bayou Macon,
 Arkansas and Louisiana
 Annex O - North Bank Arkansas River Levees
 Annex P - Grand Prairie Region and Bayou Meto Basin,
 Arkansas
 Supplement to Annex P - White and Arkansas Rivers and
 Tributaries with reference to the Grand Prairie
 Region, Arkansas
 Annex Q - Yazoo Headwater Project, Mississippi
- V New Orleans District
 Annex R - Red River Backwater Area
 Annex S - Atchafalaya Basin Floodways
 Annex T - Area West of West Atchafalaya Basin Protection
 Levee
 Annex U - Mississippi-Atchafalaya Section
 Annex V - Pontchartrain Basin Area

VOLUME INDEX (Cont'd)VOLUME

- VI Mississippi River Commission
- Annex W - U. S. Fish & Wildlife Service Reports on Main Stem Features
 - Annex X - U. S. Fish & Wildlife Service Reports on Tributary Basin Features
 - Annex Y - Benefits of Main Stem Features
 - Annex Z - Summary of Reports by U. S. Soil Conservation Service

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

November 2, 1961

Dear General Wilson:

This is in reply to your letter of May 4, 1961, requesting our comments on your proposed report on a comprehensive review of the Mississippi River and Tributaries project. Reference is also made to your letter of June 23, 1961, concerning certain modifications in your report submitted on May 4, 1961.

The resolution of June 12, 1954, by the Committee on Public Works of the United States Senate, the authority for the report, directed that any feature of the project be considered during its examination and review. The Mississippi River Commission report recognized the diminishing natural resources, increasing need for conservation, Federal interest in conservation, and attitude of local interest in paragraphs 40, 41, 42, 43 respectively. Also, Section 1 of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. 661 et seq.) provides that ". . . fish and wildlife shall receive equal consideration and be coordinated with other features of water-resource development programs . . ." Accordingly, we recommend that paragraph 3 of your report mention fish and wildlife consideration as being included within the scope of the study.

Paragraph 49(b) lists six measures as enhancement features specifically for fish and wildlife purposes. Subsequent to receipt of the report for Departmental review, representatives of the Bureau of Sport Fisheries and Wildlife discussed with representatives of your office the appropriate classification of these features. The Bureau representatives pointed out that the Mississippi River Commission report in paragraph 58 recognized estimated annual losses to fish and wildlife in each of the annexes. In accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U. S. C. 661 et seq.), the six measures set forth in paragraph 49(b) of your proposed report meet the requirements for mitigation measures. In your letter of June 23, you indicated that you were revising your report to include the cost of these measures totaling \$4, 731, 000 for mitigation purposes as a part of the overall cost of the flood control project. We are gratified at your decision, and recommend that these measures be included among the remedial measures listed in paragraph 49(a) of your report.

Paragraph 49(c) of your report lists five measures costing \$8, 397, 000 and recommends that they be considered as part of a separate fish and wildlife

conservation program with the cost to be borne by the State or Federal fish and wildlife agencies. The major features included in this list are items 4 and 5 which cover recommendations made in the report by the Regional Director of the Bureau of Sport Fisheries and Wildlife entitled, A Plan for Freshwater Introduction into Sub-delta Marshes Below New Orleans, Louisiana. The 1954 resolution by the Committee on Public Works of the United States Senate indicates the intent of the Congress to include works and measures for ". . . any modifications that are advisable with respect to the project . . ." from the Head of the Passes to Cape Girardeau, Missouri.

We believe that the plan for fresh water introduction clearly represents an integral part of the Mississippi River and Tributaries Project. It involves the breach of main levees built along the lower Mississippi by the Corps of Engineers for flood protection and the substitution of gated structures for the sections of levees breached. Through these structures, fresh water would be introduced into the marshes with very substantial benefits to shellfish and other fish and wildlife resources. These benefits would have National significance similar to the National significance of the benefits from the original installation of these levees.

The State of Louisiana vigorously supports the inclusion of these measures in the revised plan for the Mississippi River and Tributaries Project. Furthermore, it is our understanding that the State stands ready to bear an appropriate share of the cost of these modifications. These improvements are, however, of a magnitude beyond the financial ability of local interests to bear by themselves. Substantial expenditures have been made by these local interests to maintain the fish and wildlife resources of the area; and economic, as well as recreational values, important to several States and the Nation are involved.

Finally, the inclusion of measures such as these represents precisely the type of fish and wildlife enhancement features for incorporation in project plans that the Congress contemplated by its approval of the amendments to the Fish and Wildlife Coordination Act passed in 1958 (P. L. 85-624).

We are gratified to note, in your letter of June 23, that you believe that the Corps of Engineers should be designated as the construction agency for these structures. We agree. We are concerned, however, by your statement that the initiation of action to proceed with these features should be on the part of the Fish and Wildlife Service. This Department strongly urges that you include in your report a firm recommendation that the Plan for Fresh Water Introduction in Subdelta Marshes Below New Orleans be authorized for construction by the Corps of Engineers as an integral part of the Mississippi River and Tributaries Project. We also recommend that paragraph 53 of your report be altered to show the \$8,397,000 for these fish and wildlife enhancement features and to include this enhancement as a project purpose with the cost included in the total project cost.

Grand Prairie-Bayou Meto Basin: The Mississippi River Commission finds that the local interests have widely divergent views as to the plan of improvement to be adopted and are not able to provide local cooperation for any improvement at this time. It recommends that the authorized project be placed in a deferred-for-restudy category. The Commissions' report states, "Adjustment of local views necessary to reactivate the project would include definition of a fish and wildlife conservation plan."

Since your proposed report requests authority for an increase in cost of \$3,434,000 for Bayou Meto and \$211,000 for Indian Bayou respectively, we presume that this increase includes the cost of remedial fish and wildlife features which would be required under the presently authorized plan.

The opportunity of reviewing your report is appreciated.

Sincerely yours,

Assistant Secretary of the Interior

Lieutenant General Walter K. Wilson, Jr.
Chief of Engineers
Corps of Engineers
U. S. Department of the Army
Washington 25, D. C.

FISH AND WILDLIFE FEATURES

50. The recommendations made by the Mississippi River Commission concerning the fish and wildlife aspects of this report are summarized as follows. Certain modifications incorporated into the flood control improvements primarily for mitigating losses to fish and wildlife are presented as part of the works serving the flood control purpose, with costs included as a part of the costs of the flood control improvements. Work recommended in this category includes remedial works in the Big Lake Area of the St. Francis Basin costing \$446,000 and a series of low dams in Big Creek and its tributaries, a sub-basin of the lower White River Basin, at a cost of \$100,000. Other recommended measures are presented in the Commission's report for the specific benefit of fish and wildlife, with their costs allocated to this purpose. The improvements in this second category are listed in Table 1 of the Mississippi River Commission's report, at a total estimated Federal cost of \$4,731,000. Finally, certain improvements requested by fish and wildlife interests, while justified, were considered to be unrelated to existing or recommended flood control projects, but were recommended by the Commission as a part of a separate wildlife conservation program to be undertaken by the State or Federal agencies concerned, outside the scope of the Mississippi River and Tributaries flood control project, with the Corps of Engineers serving as the construction agency, if requested. This third category of works consists of small water control structures in the Yazoo River Basin and structures in the Mississippi River main line levees below New Orleans to introduce fresh water from the Mississippi River into adjacent low lying lands, primarily for improving conditions for oyster production. The estimated total cost of the structures recommended by the Commission in this category is \$8,397,000.

Corps of Engineers, U. S. Army
Office of the President
Mississippi River Commission
Vicksburg, Mississippi

SUBJECT: Comprehensive Review of the Project for Flood Control of the Mississippi River in its Alluvial Valley and for Improvement Between the Head of Passes and Cape Girardeau, Missouri

TO: Chief of Engineers
Department of the Army
Washington 25, D. C.

I. AUTHORIZATION AND SCOPE OF REPORT

1. AUTHORITY

a. Principal resolution. This report is submitted in compliance with instructions from the Chief of Engineers dated 17 June 1954, to the President of the Mississippi River Commission, and in response to a resolution adopted 12 June 1954 as follows:

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Chief of Engineers of the United States Army is hereby requested to examine and review the project for flood control of the Mississippi River in its alluvial valley and for its improvement from the Head of the Passes to Cape Girardeau, Missouri, published in House Document Numbered 359, Seventy-seventh Congress, First Session, and other reports, as authorized by the Flood Control Act approved May 15, 1928, as amended by subsequent Acts of Congress, as one comprehensive whole and in its entirety, and to submit at the earliest practicable date recommendations for any modifications that are advisable with respect to the project or any feature of the project."

b. Other authorizations combined. In addition to the resolution quoted above, the comprehensive review includes response to sixteen other resolutions and two specific acts of Congress relating to the Mississippi River or certain tributaries in the alluvial valley. These authorizations are listed below, and the complete texts are quoted in ANNEX A, entitled "Resolutions and Acts of Congress Incorporated in Authorization for Comprehensive Review."

(7) New Orleans and Krotz Springs, La. hearings. The Governor of Louisiana cited an estimate of \$160,000,000 in annual income from hunting and fishing in Louisiana as an important item of the State's economy. The State Fish and Game Commission proposed that lands be purchased in fee and turned over to fish and game agencies for administration wherever easements for flood control exceed fifty percent of value of the land. The importance of oyster culture in bay areas was cited and requests were made that fresh water be diverted from the Mississippi River to improve oyster breeding areas. Other requests were made for preservation of fishing and hunting areas in the lower Amite River, a small-boat channel in the Bonnet Carre Floodway, preservation of water levels in borrow pits, and weirs in canals in the West Atchafalaya Floodway.

r. Pontchartrain Basin. The Fish and Wildlife Service reports that the fish and wildlife resources in the area are of great value and include oysters, fur resources, and waterfowl. However, the natural productivity of the area has declined in recent years through both natural changes and man's activity. The Service recommends the installation of water-control structures and appurtenant facilities in the main-line levees to introduce fresh water into the coastal marsh area to reduce the salinity in oyster-producing areas. Since the project levees, originally constructed by local interests, have been completed for many years and no change in the interest of flood control is necessary, the Commission recommends that the works for fresh water delivery, at an estimated cost of \$3,482,000, be considered a separate feature for authorization outside the scope of the Mississippi River and Tributaries project, to be funded and administered by the Fish and Wildlife Service, and that the Corps of Engineers be authorized to cooperate with the Fish and Wildlife Service in the design construction of this project if the fish and wildlife project is authorized by Congress.

e. Possible diversions for fish and wildlife. The possible diversions for fish and wildlife, mentioned in paragraph 45, would take place in the section below New Orleans. The quantities required probably would be negligible compared with total flow and would have no serious effect on maintenance of the navigation channel.

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

A PLAN FOR
FRESHWATER INTRODUCTION FROM THE MISSISSIPPI RIVER
INTO SUB-DELTA MARSHES BELOW
NEW ORLEANS, LOUISIANA
AS PART OF THE
MISSISSIPPI RIVER AND TRIBUTARIES REVIEW

Report prepared by
Branch of River Basin Studies
Vicksburg, Mississippi

EFFECTS OF FRESH WATER INTRODUCTION

47. Considering the value of fish and wildlife resources, and the rapidity with which changes are occurring, attempts at improvement have been relatively insignificant. Measures now being employed cannot keep abreast of the increasing changes unless they are expanded and supplemented by more forceful methods. Introduction of fresh water to re-establish natural patterns of salinity and alluviation and increase fertility would provide the most effective method of restoring fish and wildlife production.

AREA NO. 2

68. Description. Area No. 2, containing 77,500 acres, is located east of the Mississippi River between Point a LaHache and Homeplace, and extends to Breton Sound. Included in this area are American Bay, Bay Crabe, Grand Point Bay, Bay Gardene, Bay la Fourche, Black Bay and parts of Lake Campo and Long Bay. Approximately 85 percent of the entire area is covered by water with an estimated volume of 135,000 acre-feet. Salinity levels, particularly away from the river, are usually in excess of 20 ppt. throughout most of the year, and consequently oysters are subject to severe disease and predation.

69. Fish and Wildlife Values. The annual oyster harvest from 1,531 acres of leased bottom is estimated to be 80,000 bushels with a net value of \$35,000. The annual waterfowl value, which is low, is estimated to be about \$1,900, based on a maximum concentration of 4,000 ducks and 415,000 duck-days use. Additional values involving sport and commercial fisheries and fur are present.

70. Plan of Development. The introduction of fresh water would require a water-outlet control structure downstream from Bohemia and a 5-mile training channel running through the upper end of American Bay to the vicinity of Bay Gardene (Plate 3). The structure itself would contain two taintor gates having dimensions of 10 x 30 feet. The training channel would be 6 feet in depth and 160 feet wide, (Appendix A). Plate 4 shows the type of structure contemplated, and Plate 5 shows the design. Since a man-made levee is not present at this location, the structure required would be the simplest for any of the areas considered. About 2,610 acres of land and marsh would be required for structure site and channel right-of-way.

71. In order to effect a 50 percent dilution of the 135,000 acre-foot of water, a discharge varying from a minimum of 1,500 c. f. s. to a maximum of 4,400 c. f. s. would be required from February 1 to June 1

(Appendix B). Because of the rapidly falling river stage after June, discharges would become smaller as summer progresses. However, with proper dilution effected prior to June, sufficient flow would be maintained from June to September to prevent return of high salinity levels until fall, barring, of course, a complete flushing of the area by hurricane tides. The structure was so designed that, depending on river stage, proper dilution could be achieved, 4 years out of 5, in a period of 15 to 45 days. Figure 4 shows discharge requirements and the maximum discharge obtainable. The calculated mixing time to achieve a 50 percent dilution was based on the time required to discharge a volume of water equivalent to that present in the area (135,000 acre-feet). The actual mixing time would be longer, but would not be known until after the initial period of operation.

72. Operation of the diversion structure would be controlled and correlated by salinity levels in the project area of influence. After the initial discharge period, an operational graph would be prepared to indicate time-discharge requirements for achieving the necessary dilution.

73. Because of the grossly polluted condition of Mississippi River waters, the oyster harvest would be controlled in keeping with public health standards. During years of late oyster harvest, waters would not be discharged until the harvest is completed. The area then would be closed to oystering during periods that pollution is evident. Fortunately, when the source of pollution is curbed, in this case when discharges are terminated in the late summer, pollutants dissipate rapidly. Since harvest would not commence until early winter, several months would be available for pollutants to dissipate. The Louisiana State Department of Public Health would make frequent bacterial counts to determine the degree of pollution and determine when the area should be closed to oystering. Under such a system of control the public would be protected.

74. Operation, maintenance, and administration of the project would be vested in the Louisiana Wild Life and Fisheries Commission except during periods of emergency or disaster, when control may be temporarily vested in an agency charged with safeguarding the general public.

75. Costs. Estimated first cost and annual charges of the project are summarized in Table 4.

DISCUSSION AND CONCLUSIONS

100. Local and State interests have for years requested the introduction of Mississippi River water into selected areas of sub-delta marshes. This study substantiates the general view that rapid deterioration

of valuable fish and wildlife habitat is occurring from natural and man-caused changes which are resulting in adverse ecological conditions. Immediate alleviation of these adverse conditions can best be attained by a controlled diversion of fresh water into affected areas. Four such areas at selected locations have been considered in this report. The introduction of water would retard deterioration of the fish and wildlife habitat and would improve ecological conditions not only for oysters, muskrats, and waterfowl, but for most other fish and wildlife as well.

101. That benefits are experienced following natural overflow of fresh water into the marshes is an established fact. However, with the exception of the State's Bayou Lamoque diversion project, prior introductions have not been controlled and, in some cases, have resulted in excessive flushing and consequent mortality to fish and wildlife. Nonetheless, the overall effect was usually beneficial, with a marked improvement in fish and wildlife production. Two of the three openings of the Bonnet Carre' Floodway were considered beneficial almost immediately. The other opening was initially disastrous to the oyster industry, but had residual effects that were beneficial. In the years following, oyster production increased to a point more than offsetting the original loss. In the area affected by the Bayou Lamoque diversion, under conditions of controlled flow, the quality of oysters improved so markedly a barrel of oysters produced twice the former quantity of meats. In addition, an increased survival of young oysters was obtained so that a greater yield in the future is to be expected. With controlled introduction, the adverse effects of floods and crevasses can be eliminated and the beneficial effects enhanced.

MISSISSIPPI RIVER AND TRIBUTARIES
COMPREHENSIVE REVIEW REPORT

ANNEX V
PONTCHARTRAIN BASIN AREA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
New Orleans, Louisiana

VIII. CONCLUSIONS

18. Conclusions. The plans of the U. S. Fish and Wildlife Service for diversions of Mississippi River waters into oyster producing areas below New Orleans appear to be amply justified on the basis of the analysis presented in the Service report. Studies indicated that diversion of fresh Mississippi River water into the marshes would help restore and maintain a more favorable fresh-salt oyster crop in the designated areas. The Service finds that levee construction and other improvement works of man have caused serious deterioration of the oyster production, as well as other fish and wildlife aspects of the tidal marsh. As evidence of the beneficial effects of fresh water flows, the Service points out that as a result of the several operations of the Bonnet Carre' spillway and the introduction of fresh water into the marshes, the production of oysters improved materially during the several years following each operation. The Service further cites the fact that during the past several years, operation of the Bayou Lamoque diversion structure on the east bank of the Mississippi River, even on a limited basis, has had marked beneficial effect on oyster quality as well as production in the localized area. The preliminary plan and estimate of costs for the proposed work as submitted by the Fish and Wild Life Service appear reasonable. However, in view of the fact that project levees have been completed for many years, and no change in the plan for flood control in this vicinity is found to be necessary, the plan of the U. S. Fish and Wildlife Service is considered an independent development and not a feature of the Mississippi River and Tributaries Project. The proposed diversions are not objectionable from the standpoint of navigation or flood control, but are matters that should be sponsored by appropriate conservation agencies. In this respect, Federal funds involved should be appropriated specifically for fish and wildlife purposes and administered by the Fish and Wildlife Service subject only to approval of construction plans by the Federal flood control and navigation works. The improvements for Area 2 should be given first priority in view of the smaller total cost and the higher benefit-cost ratio.

Attachment No. 3

Excerpts from:

1. "Historical Changes in the Mississippi and the Adjacent Marine Environment."
 2. "The Relationship of the Bonnet Carre' Spillway to Oyster Beds in Mississippi Sound and the 'Louisiana Marsh,' with a Report on the 1950 Opening."
 3. "Fish and Wildlife Study of the Louisiana Coast and the Atchafalaya Basin," a Report on Mississippi River Requirements for Estuarine Use in Coastal Louisiana---November, 1970.
 4. "Louisiana Wetlands Prospectus - Conclusions, Recommendations, and Proposals of the Louisiana Advisory Commission on Coastal and Marine Resources, September, 1973."
-
5. Other applicable documents relative to supplemental fresh water requirements.

Excerpts from "Historical Changes in the Mississippi River
and the Adjacent Marine Environment"

by
Gordon Gunter

Russell and Howe (1935) have pointed out that the Mississippi may be termed the "Father" of Gulf coast geology and geomorphology. It has a commensurate relation to the estuarine life of the region. The center of production of the white shrimp (*Penaeus setiferus*), of the South Atlantic and Gulf Coasts of the United States, is in Louisiana. It is significant that the two main centers for blue crab and oyster fisheries are widely separated at two large estuarine areas, the Louisiana Coast and Chesapeake Bay. Other items could be mentioned, but the importance of the Mississippi River to the life of the adjacent sea is self-evident and there is no need to belabor the point. (121-122)

It is obvious that changes in this vast river system, even those which might be negligible or transient from the geological viewpoint, would have far-reaching effects upon the life of the valley and the marine area at its mouth. Price (1947) has pointed out the difference in this respect between the viewpoint of the biologist and the geologist. He says, (p. 1657), concerning sedimentation, "What to the geologist may be an incidental shallow scour and fill--may involve considerable restriction and local extinction of biological communities, especially of the bottom dwellers." (121-122)

Floods have been noted since 1543, when DeSoto's party saw a rise in March, extending for several leagues on each side of the channel. La Salle's party reported the same situation in 1684 (Russell, op. cit.). The initial settlement of New Orleans was held up by floods in 1717. In its natural condition the river annually overflowed its banks and spread out over the flood basins for many miles on either side. This situation made levees necessary from the time of first settlements of white men in Louisiana. A flood has been defined as a water stage high enough to overflow the natural levees or banks of the river. Elliot (1932) gave a list of 58 recorded major floods between 1717 and 1929. This is an average of one every 3.6 years. (122)

In summary, levee construction started in 1717, 235 years ago, at New Orleans and was a gradual process up until about 1880. From that time the rate was accelerated, until the nineteen-thirties when the whole system was greatly extended and more or less stabilized, following the disastrous flood of 1927. Flood heights became higher as the levee system increased. (124)

Bayou Lafourche, Bayou Plaquemine and the minor flood distributaries which doubtless existed previous to the levees, spread large quantities of fresh water from the Mississippi every spring over a wide area of the Louisiana Coast. This water drained into Terrebonne, Barataria and adjoining smaller bays over a hundred mile segment of the coast west of the river. Bayou Manchac and minor distributaries east of the river drained flood waters into Mississippi Sound and adjacent waters east of the river. Today, the annual spring flood waters which formerly flowed into this wide estuarine and bay area are all channeled in the main stream of the river and flow out at its mouth into the open Gulf of Mexico. The Bonnet Carre' Spillway has been opened three times since its completion in 1932 and constitutes an exception to the above statement. However, it is a special case and will be discussed later. (125)

Looked at in a somewhat schematic way, the Mississippi formerly discharged its water over a somewhat arc-like or triangular area, with the main flow at the mouth or center into the open Gulf and a diminishing amount of fresh water flowing towards the ends of the arc into the bays and Mississippi Sound. At present this central flow has increased, as has the flow at the westernmost part of the arc, at the expense of the other parts of the area. Thus the open Gulf near the mouth of the river and Atchafalaya Bay get more fresh water now than in the past, while Terrebonne, Barataria and adjacent bays, and Mississippi Sound get less. These latter areas formerly received flood waters seasonally every year. A seasonal cycle in salinity resulted. Although the mouth of the river carries more water than formerly and some of it of necessity gets into the bays through the passes and seaward channels, this water is mixed with sea water and is no longer fresh. This situation also prevailed to some extent previously and it is very improbable that an increased influx of partly saline water from seaward would lower bay salinities as much as the former larger amounts of pure fresh water from land. Therefore, there is doubtless less of an annual cycle in salinity and the bay salinities are higher. (126)

The Bonnet Carre' spillway was constructed by the U. S. Army Engineers 24 miles above New Orleans on the site of an old crevasse. It empties water into Lake Pontchartrain and thence into Mississippi Sound. It was in operating condition in 1932 and was first used in 1937 when it was opened from February 4 to March 16, with a maximum discharge of 210,000 second feet. On the other hand the 1945 opening of this spillway from March 23 to May 20, with a maximum discharge of 318,000 second feet, was reported to have caused extensive damage to oysters in Louisiana and Mississippi (Anderson and Power, 1949). The spillway question was discussed in considerable detail by Gunter (1950). (127)

As a side issue to the main consideration of this paper we might stop for a moment to consider the influence of the changes of the river upon the life of the river and its flood basins. Here we are without exact information but certainly the changes have been extensive. It is quite generally true that much of the fish life of the rivers spawns in the spring in backwaters and flood basins where the larvae have food and quiet waters. Today a large part of this former nursery and feeding-ground is cut off. As a result the muddy main stream is comparatively barren to what it was in earlier days. There has doubtless been a comparable decrease in waterfowl and all other forms of life which subsisted in and around the former vast overflow areas. (129)

With the cutting off of the fresh water and sediments entering the estuarine waters near the river there was a parallel reduction in the nutrient salts brought down into the bays. Conversely there was an increase off the mouth of the Mississippi and in the Atchafalaya Bay region. (132)

The American oyster, Crassostrea virginica (Gmelin), is an estuarine species. It flourished best in waters between a salinity of approximately 15 and 30 per mille. At the higher salinities the Gulf oyster borer, Thais haemostoma, and other enemies which cannot tolerate a low salinity, prey on oysters and at times cause great damage. Apparently, the oyster could flourish in higher salinities than it does on the Louisiana Coast were it not for the conchs (c. f., Burkenroad, 1931) and possibly other enemies. The important point for the present discussion is the fact that the oyster lives only in a relatively narrow strip of water of intermediate salinity along the coast line, between the danger of fresh water on the one hand and high salinity on the other. Therefore, when the salinity of the waters changes at a particular spot, the equilibrium of the oyster with this local environment is upset in various ways and some of the end results can be seen. Since the adult oyster is commercially important, its fluctuations have been observed. Therefore, it is an indicator of salinity changes. (132)

In the First Annual Report of the Oyster Commission of Louisiana (1904 p. 26) it is stated that formerly some of the best reefs in the state were in Jefferson Parish, but they had become unproductive. The Commission quoted the two explanations offered by the oystermen. One group maintained that the reefs were overworked and no spawning stock was left. The other said the water had become too salty. The Commission did not presume to judge the case, adding "but it is a fact that these once magnificent reefs show no disposition to become productive again." (132)

In the Second Biennial Report of the Oyster Commission of Louisiana (1906, p. 17) it was stated that natural oyster conditions which formerly prevailed in lower Plaquemines Parish have been interfered with by "the continuous extension of the levee system, particularly on the east or left bank of the Mississippi River." It was recommended that gaps in the levees

be permitted at suitable intervals so that a flow of fresh water might mingle with salt waters of the Gulf. . . . " . . . we believe . . . their construction would result in an immense increase in the crop of fat oysters; and oyster beds now extinct, which were productive many years ago, before the levee system was extended into that section, would once more become productive." (132-133)

The same report stated that the beds in Caminada Bay were extinct, and the beds in Timbalier Bay were practically extinct. It was stated that these beds were destroyed by overfishing and ravages of the "snail or borer," due to the closure of Bayou Lafourche. It was further stated that the principal beds in Lafourche Parish were located in Lake Raccourci, which six years ago was fresh water. The outlook for oyster culture in that parish was said to be encouraging, unless "fresh water can be secured through Bayou Lafourche." (133)

The report of the Conservation Commission of Louisiana (1944) reiterated the remarks concerning too much salt water over the oyster beds in Plaquemines Parish and the need for canals from the river. The localities affected were said to be California Bay and Quarantine Bay to the east of the river, and Bayou Cook, Bastian Bay, Grand Bayou and adjacent waters to the west of the river. (133)

The Sixth Biennial Report of the Department of Conservation (1924) reported that breaks in the levees benefited the oyster beds both east of the river and in Barataria Bay. The following remarks (p. 99) concerning the east bank crevasse are worth quoting: "The break in the levee at Poydras Plantation, about fifteen miles below the city, improved the oyster crop in some parts, although a large area of productive reefs were considerably affected. This, however, was only temporary for the oysters are now more prolific than ever. While the oysters near shore were destroyed by flood waters, the dead reefs located out in Chandeleur and Breton Island Sounds have benefitted, being now covered with oysters." The Department went on record as favoring spillways in the river because of the benefit they would have on the oyster industry. (134)

The worst flood the State of Louisiana ever experienced was in 1927. This flood received considerable attention in the Eighth Biennial Report of the Department of Conservation (1928). Water from the Junior Crevasse killed oysters in Barataria Bay, but the greater part of the area was said to be "almost nonproductive" due to high salinity and the abundance of the "periwinkle." The damage is said to have been more than compensated by the fresh water, which allowed a heavy set of spat and killed the Thais. The net result was that reefs of Barataria Bay, "which have been barren for several years, show a heavy growth of young oysters, which will be ready for market about the first of 1929." (p. 184). It was added that the supply would be exhausted soon and would not be renewed when the customary salinity returned. (135)

Enlarging upon this point (p. 129) the report says that since 1937 (it was first reported in 1936) a wave of mortality "strikes in the late summer through the beds of West Plaquemines, Jefferson, Lafourche, and part of Terrebonne Parishes; in some instances as many as 80 per cent of the highly cultivated oysters on the best grounds have been killed." It was believed that a combination of three circumstances caused the trouble: 1. poor condition of the oysters at the end of the summer, 2. activity of the borers and other enemies, and 3. extreme saltiness of the water. (135-136)

It was stated that passes into the Gulf had widened and the Mississippi River had been low for the past 5 years. "The extreme saltiness for the past years has been progressive and since 1937 has very sharply increased." (136)

It was reported that the Police Jury of Plaquemines Parish had conducted a survey to determine the quickest and most feasible way of obtaining additional river water for the oyster beds of that parish. The Louisiana Department of Public Works also conducted an investigation of the feasibility of flumes under the levees in Jefferson, St. Bernard and Plaquemines parishes. The Department of Conservation endorsed the move to get more river water over the oyster beds. (136)

Several oyster reefs seem to have been wiped out by rising salinity, as noted above. These effects may be indirect, in that high salinity exposes the oysters to attacks of Cliona, Polydora, Martesia, Menippe, Thais, Democystidium, and other pests. In other cases effects may be direct when the salinity becomes too high for Rangia, Brachidontes and other species. Salinity increases are gradual and similar to climatic changes. They fluctuate from season to season and from year to year, but the maxima and minima become higher at a given point. Therefore, the large Louisiana oyster industry exists in a situation which is not at equilibrium. The evidence points to an inexorable encroachment of saltier water. Some oystermen have attempted to continue in areas where oysters can no longer be raised. Instead they must move inland and abandon their claims, just as plantation owners have had to do when their land turned to marsh. (138)

Excerpts from "The Relationship of the Bonnet Carré Spillway
to Oyster Beds in Mississippi Sound and the "Louisiana Marsh,"
with a Report on the 1950 Opening"

by

Dr. Gordon Gunter

Because of the influence of fresh water on oyster beds, openings of the spillway have received considerable attention in recent years. The American oyster, Crassostrea virginica (Gmelin), is an estuarine animal which flourishes best in a mixture of fresh water and sea water. Butler (1949a) presented evidence that 6 parts per thousand salinity is a critical point and lower salinities are harmful. However, oysters can live at salinities lower than 6 per mille for a long time and field observations indicate that the critical point of low salinity is lower than Butler postulated. Since the flow of fresh water from land fluctuates, the oyster is often subjected to too much fresh water. This problem which has confronted the oyster industry around the lower Mississippi River for many years and the relation of the Bonnet Carré Spillway to oyster beds in Mississippi Sound is a part of the general problem. (21).

Viosca (1938) made some general observations on the effects of the 1937 spillway opening on marine life in Mississippi Sound. He noted the importance of the Pearl River in determining the salinity characteristics of Mississippi Sound and called attention to the nutrient salts brought into the Sound by the spillway. In 1937 he noted an oyster mortality of 10 per cent in Mississippi Sound which he attributed to effects of the Pearl River. Viosca reported a beneficial effect of the 1937 opening of the Bonnet Carré Spillway and his words are quoted:

.... The general effect of the two floods (Pearl River and Bonnet Carré) on oysters in the sound was beneficial; and, although the oysters in the affected area lost their salty flavor, they fattened and grew considerably during the spring and made fine canning stock....

In Mississippi Sound, where the spillway flow combined with that of the Pearl River flood, the muddy fresh water reached as far east as Gulfport for a short time and as far east as Cat Island Channel and Pass Christian for a longer period. Although the oysters on Telegraph and St. Joe Reefs were freshened, they are reported to have doubled in size during 2½ months after the opening of the spillway. The conchs, or oyster drills, on these reefs were killed by the fresh water. Speckled trout, driven eastward, were taken in unusually large quantities along the shores of Mississippi Sound during March and April....

The effect of the spillway was, on the whole, very beneficial because of its fertilizing effect on the waters of Lakes Pontchartrain and Borgne, and Mississippi Sound. A biological cycle of organisms was started which was destined to materially increase the food supply in this area for some time. The plant growths were greatly stimulated, and associated animal life, such as scuds and grass shrimp, was found in great concentration. Plankton feeders, such as mullet, anchovies, menhaden, and shad were seen in great abundance everywhere, and in addition to the large crops of crawfish and river shrimp which served as an accessory food supply for a time, both species of salt-water shrimp thrived. The commercial shrimp crop taken in Lake Borgne and Mississippi Sound was the greatest since the shrimp trawl was introduced. . . .

In Mississippi Sound, the benefit to the oyster reefs persisted into the fall. There was a fine set of oysters which will develop as next year's crops; and all conchs were destroyed. Fish and shrimp were more plentiful than usual during the summer and fall. (25, 27).

Due to the fact that the spillway was opened on 28 January, its influence on oyster beds in the Sound and the Louisiana Marsh lingered during most of 1937. Oystermen and dealers concerned with the Mississippi Sound are generally agreed that the 1937 spillway opening was beneficial. All observations and available information indicate that the effect of this opening was beneficial to marine life and that the fact was widely recognized. (28).

In contrast to the 1937 opening of the Bonnet Carre', the 1945 opening was generally reported to have caused considerable damage. No study of the oyster beds of Mississippi Sound was made between 1937 and 1945 until after the beds were reported to have been killed by water from the spillway, which was open from April 24 to May 17. During July, 1945, approximately two months after the spillway was closed, Dr. A. E. Hopkins, then Director of the Pensacola Laboratory of the U. S. Fish and Wildlife Service, made an examination of the area with officials of the Louisiana Department of Wild Life and Fisheries. No reports were published. Doctor Hopkins stated (Hearings Comm. Flood Control, H. R. 3888, 79th Congress, 1946, p. 95):

Throughout this entire area on all of the major grounds, I found practically 100 percent mortality. In a few cases I found a few live oysters. They were in the neighborhood of Grand Pass, (29).

Officials of the Mississippi Seafood Commission reported that in the fall of 1945 a good set of seed settled on shells of oysters killed the previous spring (Engle, 1948, p. 3). (29).

Under the title of "What Spillway Really Did," Owen and Walters (1950), published results of the State of Louisiana investigation. They collected data on turbidity, salinity, temperatures, and oyster mortality and made aerial observations on the progress of river water through Lake Pontchartrain.

They showed that the river water did not start out of the Lake until 3 March, twenty-one days after the spillway was opened. They observed no sedimentation of the oyster beds. Salinity samples at 22 stations were taken. From 11 February to 17 February (before the river water got out of the Lake), they showed that Lake Borgne and the northern part of the Sound, from about Pass Christian westward, had a salinity of 3 parts per thousand or less. The remainder of the Sound had a salinity ranging from 6 to 12. From 6-11 March all stations in Mississippi Sound and Lake Borgne were found to have a salinity less than 2 per mille. They stated that the salinity began to rise again on 22 March, five days after closure of the spillway and gave a figure showing that on 6 April all parts of the Sound, except the western tip and a narrow band from Pass Christian west on the northern shore, had salinities between 6 and 11 parts per thousand. They said the bulk of Mississippi River water had not reached the Sound at that time, but the rise in salinity was still gradually progressing. They found that the fresh water had reduced the conch population. Mortality checks on the two important Louisiana reefs in the west of the Sound showed a progressive but low mortality at Grand Bank. A check on 3 March and 6 April gave 13.3 and 13.6 per cent mortality. Half Moon had an average 15.2 per cent mortality in three checks from 23 March to 6 April. They concluded:

In 1950, because of the time of the year and relatively short exposure, the major reefs of Louisiana were not materially damaged but are expected to be benefited as a result (of) opening of the Bonnet Carre Spillway. (35).

Since oyster mortality was slight and nutrients were brought into the area by the river water and certain predators and injurious organisms were exterminated in the area, it is clear that the 1950 opening of the Bonnet Carre Spillway was beneficial to the oyster beds in Mississippi Sound and the Louisiana Marsh. The implied dire possibilities of continuing "adverse conditions" by Butler and Engle (1950) did not come to pass. There seems to be nothing to add to the conclusion of Owen and Walters (1950a), that the opening was "highly beneficial" to Louisiana oyster beds except to extend it to cover Mississippi Reefs as well.

This is the most important immediate conclusion of this study. However, it does not cover all aspects of the spillway-oyster problem and some of them will be treated in following topics. (41, 43).

The common American oyster has become accustomed to estuarine life where it undergoes wide fluctuations of turbidity and salinity. Oysters can survive a salinity as low as 2.0 per thousand for about a month at low

temperatures. In fact, they can survive in fresh water for several days. They apparently accomplish this by closing the shell tightly and living anaerobically, which is the same way they survive in air. Under these circumstances it is likely that they utilize glycogen by reducing it. The ability to live for extended periods without oxygen is one of the adaptations of the oyster to live a little longer or cling tenaciously to life when covered by mud, exposed to air or exposed to fresh water. Thus, if conditions reverse themselves in a week or so, many oysters will survive. Since the ability to live with the shell shut tight is closely connected with the glycogen reserve, the survival rate will depend upon the previous condition of the oyster or, as it has been called, the fatness or strength. Likewise, it depends on the length of exposure and the temperature of the water, because rates of physiological processes are slower at lower temperatures. In other words, oysters may survive dangerously low salinities by beating a physiological retreat and walling themselves off from all environmental effects except those of temperature. (50).

On the basis of discharge records, it appears that somewhere between 12, 500, 000 and 24, 500, 000 acre-feet of water there lies a critical point where flood waters coming through the spillway cause extensive damage to the Mississippi oyster beds between Bay St. Louis and Cat Island and the Louisiana beds in the Marsh.

The effect of the spillway waters is influenced by several other factors. If the discharge is fast, and remains on the beds a short time, mortality will not result. If the spillway waters come early in the season, when condition of the oysters is good and the temperatures are low, mortality will be less than in later months. Mortality from low salinities is produced by a combination of fresh water from the spillway and the Pearl River. If the Pearl River discharge is low, previous to spillway openings, oyster mortality will be at a minimum.

Spillway discharges always kill out oysters pests and predators and put thousands of tons of nutrient salts into the area. In 1950 this amount was estimated at over 50, 000 tons. Because of the nutrient salts brought in by the river water a greater abundance of shrimp and other marine life may normally be expected following the return of normal salinities.

Concerning the influence of fresh water, Owen and Walters (1950) stated:

It is essential for the maintenance of a successful oyster population that there be a source of nutrient-bearing fresh water. During the past few years Pearl River has had above normal drainage into the Sound. This undoubtedly has created an adverse environment for oysters on the northern shore of the Sound and frequently for those reefs immediately opposite the mouth on the southern shore (Butler 1949). In the opinion of the authors, however, this is far outweighed by the benefits to those reefs in the southern region of the 'Louisiana Marsh' and to those of eastern Mississippi Sound.

This statement holds true of any fresh water influx and is also applicable to the spillway. In every year the effect of the spillway is partly beneficial. In two out of three openings the effect has been all good. In one year the effect was partly destructive to oysters while benefiting those farther out. In the long run, it is quite probable that the total beneficial aspect of the spillway to the marine life of the affected area outweighs the oyster mortality caused in some years. (54).

Viosca's (1928) discussion is the broadest presentation to date on the effect of Mississippi River floods upon the fisheries, aquatic life and wildlife. He treats of effects both in fresh and salt water and pointed out that in relation to salt water areas "the floods on the whole are decidedly beneficial." He listed specifically benefits to oysters, fish, shrimp and the blue crab.

The Bonnet Carre' Spillway was constructed specifically for flood control. It can also be viewed as a problem in biological engineering. The encroachment of salt water as a result of the levee system and its harmful effects on oysters has been a subject commented on many times. The first is in the Second Biennial Report of the Oyster Commission, State of Louisiana, (Feb. 1904-Feb. 1906). There are several subsequent comments in these reports which it is not necessary to quote. The latest comment is that of McConnell (*op. cit.*). Even in Mississippi Sound the water sometimes becomes too salty for maximum oyster production. This has resulted in requests to the Corps of Engineers that the spillway be opened for the benefit of the oyster beds. Controlled openings for this purpose would be beneficial and feasible from a biological standpoint. This would cause some silting of the floodway unless the water were kept in a narrow channel. Whether or not such a project should be undertaken depends on the conflict between biological and flood control needs. If the cost of these controlled openings is not too much, and the resultant silting does not seriously reduce the carrying capacity of the floodway, the controlled openings should be carried out. In this case, attempts to measure the improvement of oyster beds on a value basis, as shown by increased production, should be made in cooperation with the proper State agencies. This would involve analysis of production figures and some examination of the beds before and after openings.

All vast engineering projects involving large land or water areas change the environment and the biological potential or productivity. In some cases it may be increased. Value assays of such projects should include biological considerations. Certainly any attempt to enhance the biological productivity of an area through an engineering project, such as manipulating the Bonnet Carre' Spillway to help the oyster industry in dry years, is all in the public interest. (55).

Excerpts from "Fish and Wildlife Study of the Louisiana Coast
and the Atchafalaya Basin," a Report on Mississippi River
Requirements for Estuarine Use in Coastal Louisiana ---
November, 1970

The estuarine zone is currently marked by change which is non-cyclic in nature. Deprived of its sedimentary input by perfection of flood control and navigation improvements, it is shrinking in size. Deprived of its fresh water input by the same works, and subject to myriad factors which tend to modify the tidal regimens, its water chemistry is being altered as average salinities in most areas rise. In the absence of measures specifically intended to moderate current patterns of change, estuarine productivity may be expected to progressively decline. (1)

As the above suggests, among the important needs for maximizing estuarine productivity in the fish and wildlife resource are inputs of sediment and fresh water. This report is concerned specifically with water needs. However, the only practicable means of introducing sediment in the massive quantities required is through diversion of riverflow. Hence, water must serve as the vehicle for transporting the sediment required. It is appropriate, therefore, that the needs of the estuarine area, both as to sediment and fresh water, be expressed in terms of riverflow. (1)

Salinity. In the past, water salinities in coastal Louisiana were generally characterized by relative stability, particularly with respect to the transition from fresh to saline zones, and by gradual salinity change during and after floods. This was due in large measure to the length of the flood season and the network of natural drainage channels which served to buffer the effects of both the tidal influx of saline water and the input of fresh water runoff. This tempering of the effects of floods and tides, and the prolonged flood season, served to maintain areas of low salinities that were much larger than such areas are today. (3-4)

Nutrients. Historic change in the nutrient content of the marshes is difficult to ascertain, as is a precise determination of what might be optimum levels of the various nutrients for maximum productivity. Data in sufficient quantity to determine the former are not available. Because of the many other interrelated factors operating in the determination of overall productivity, the individual effects of each nutrient cannot be readily isolated. Existing data show that excessive nutrient levels can be as deleterious to fish and wildlife productivity as the converse. However, observations of the effects of the operation of the Bonnet Carre' Spillway and the diversion structures installed and operated in the Mississippi River levee by Plaquemines Parish and the State of Louisiana, Department of Public Works indicate that discharges of river water

have had a beneficial effect on the adjacent estuaries and marshes. This indicates that Mississippi River water has, by virtue of its composite effects on the coastal area, improved fish and wildlife productivity, and, conversely, that the historic changes, in reducing the input of river water to the coastal zone, have deleteriously affected this resource. (8)

Salinity. The prognosis for salinity change in the coastal area is for continuing general increases in salinity in Units I, II, IV, and V while no significant changes are foreseen in Units III and VI through IX, because of the natural marsh configuration and man-made controls which operate to maintain existing salinity patterns. (11)

The large zone of brackish water and marsh with salinity above approximately 5 ppt is extremely productive of many kinds of fish, oysters, shrimp, and crabs. Some of these, such as the oyster, require this type of environment throughout their life cycle. For other animals, including the penaeid shrimp, crabs, menhaden, and speckled sea trout, this type of habitat is essential during some phase of their life cycle, usually some stage of their early life history. This nursery zone may extend, for various animals, from nearly fresh water to water near full sea strength. Certain animals are further restricted in their distribution within this brackish zone by specific habitat requirements such as tolerance to a rather narrow range in salinity. More than 90 percent of the off-shore fisheries catch is, therefore, directly dependent on this area for recruitment. (13)

The fisheries productivity of all hydrologic units has changed in response to the various environmental changes. In certain areas the productivity of some animals has been increased by favorable changes, but considered in their totality, the overall effect of these changes has been unfavorable. The reduction in area subject to overflow has adversely affected fresh water and marine fisheries by reducing the input of nutrients. Dense growths of alligator weed and water hyacinth have not only reduced the basic productivity of much of the fresh water zone, but have increased the difficulties attendant to the utilization of such areas. The general increase of salinity in Units I, II, IV, and V has been detrimental to the overall productivity of these waters and also to productivity in the contiguous offshore waters. Many formerly productive reefs are no longer suitable for oysters as the increased salinity favors oyster predators and diseases. Shrimp, crabs, and fish apparently have a wider range of tolerance to change in salinity and are also mobile; consequently, they are not as much affected by these changes. Fishing has noticeably improved in some areas formerly of very low salinity which were little used by the adults of either fresh water or marine life. The increased salinity in such areas has increased the attractiveness of these areas to adult marine fish, but this improvement has been at the expense of reduced nursery grounds. (13)

Sport fishery. The fishery productivity of the coastal area is directly related to salinities, which are too high in Units I, II, IV, and V, and in Calcasieu Lake of Unit IX. Optimum conditions in these units can be achieved by the maintenance during spring, summer, and fall of the 15 ppt isohaline at the general location shown on Fig. 3. Existing salinity regimens are satisfactory in the remainder of the coastal zone. (16)

Requirements for salinity alteration and/or water level management. This class of water needs relates to the requirements for maintaining a water chemistry and/or vegetative development conducive to high productivity in the fish and wildlife resource. (17)

The first requirement is to maintain a certain salinity gradient in the water bodies of the estuaries during specific months of the year. The desirable condition is defined by the position of the 15 ppt mean salinity isohaline constructed across the coastal zone (Fig. 3). During spring, summer, and fall, an average salinity of 15 ppt should be maintained at the line shown. Short duration fluctuations due to wind and tide are tolerable. This regimen is required to maximize productivity in the commercial and sport fishery resources in the units involved (I, II, IV, V, and IX) and develops the largest water requirement of the four resource categories. (21)

The second condition pertains primarily to marsh salinities. The line defining the brackish-saline marsh contact has been designated as a critical line for defining salinity requirements of the marsh communities. A comparison of marsh vegetation in the period 1941-45 and 1968 indicates that this brackish-saline contact line has shifted significantly in a number of areas during the past 25 years. Most shifts indicate salt water encroachment and have been deemed detrimental. A seaward shift of this contact line is considered favorable. It would be desirable to maintain the present position of the contact in those areas where it has moved seaward and to reestablish the 1941-45 position of the line in those instances where salt-water encroachment has occurred. In order to achieve those results, it has been recommended that the seawardmost position of the saline-brackish marsh contact (a combined line constructed from 1949 and 1969 marsh-vegetation maps (as shown on Fig. 3)) be used to define desirable salinity conditions from the standpoint of marsh ecology. The requirement states that salinities are not to exceed 15 ppt salinity at this line, more often than 5 percent of the time. If the condition established in par (b) above is met, this condition will be met also in spring, summer, and fall. This requirement dictates water needs throughout the year in Unit IX and establishes the index for water needs during the fall and winter (Oct-Mar) in Units I, II, IV, and V. (21)

Excerpts from "Louisiana Wetlands Prospectus - Conclusions, Recommendations and Proposals of the Louisiana Advisory Commission on Coastal and Marine Resources, September, 1973."

Referring to the figures, we see that oyster production per acre leased has been decreasing for at least 28 years. In 1945, almost 500 pounds of oyster meats were produced per acre but in 1973 only about 50 pounds per acre are being produced. This is a tenfold reduction in production per acre. The causes of the drop in production are difficult to pinpoint but probably are the results of: (1) changes in types of production, from intensive to extensive, (2) competition for space with activities of the mineral extraction agencies, (3) saltwater intrusion, which brings the oyster drill, a predator, and (4) increasing urbanization and its sewage and solid waste. (125)

In summation, the oyster industry is literally being squeezed out between urban pollution on the landward side and the conch line (saltwater line) on the seaward side. (125)

Saltwater intrusion occurs when saline ocean waters intrude into previously freshwater areas. When this happens, the vegetation and wildlife, which have adapted to freshwater conditions, die or escape. This causes an impact in the biological system and productivity is adversely affected. (140)

The reasons for increasing saltwater intrusion are many: fresh water shortage resulting from extensive flood control works (levees, for example), increased canalization and channelization (which serves as a conduit for seawater), erosion and loss of barrier islands or beaches. The pattern of saltwater intrusion is fingerlike in that seawater intrudes up channels, natural or manmade, where the flow of freshwater from the landward side is low. (142)

Another good biological indicator of salinity concentrations and patterns is the "conch" (oyster drill), a deadly predator of oysters. The conch prefers saltier waters and generally is not found in waters which have less than 15 ppt (parts per thousand) salt. The "conch line" (the line which separates fresh and salt water into fresher than 15 ppt or saltier than 15 ppt) can then be drawn by determining salt concentrations in a waterbody. Generally this results in a lateral line drawn across a waterbody which shows the limit of the conch's intrusion into fresher areas. Toward the fresher or landward side of the line, there will be no conchs; toward the seaward side of the line, there are conchs present and oysters cannot be raised year-round in this area. (142)

Louisiana Wild Life and Fisheries Commission data indicate that mean salinities in Lake Pontchartrain have increased from yearly averages of 1-to-3 ppt in the early '60s to the current yearly averages 4-to-9 ppt. (143)

Introducing fresh water into marsh areas for estuarine management is another proposed major water resource project. South of the Gulf Intra-coastal Waterway, most of the area is fresh-to-brackish marshes, lakes, ponds and waterways. These marshes are extremely important elements of the estuarine area because they directly shelter migratory waterfowl, fur-bearing animals, and commercial reptiles. Used for recreation and fishing, the area is important also for its scenic value. The marshes south of the GIWW form a buffer zone against flooding inland areas by storms. (283)

Methods are being studied for providing supplementary freshwater for estuarine management to offset saltwater intrusion. This supplementary freshwater, introduced through control structures from the Mississippi and Atchafalaya rivers into the estuaries, could optimize the saltwater/freshwater balance. A surface water plan for the Terrebonne-Barataria area is forthcoming (6). (283)

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