OCS Study
MMS 90-0078

A Study of Marsh Management Practice in Coastal Louisiana

Volume IV: Appendixes

U.S. Department of the Interior
MMS Minerals Management Service
Gulf of Mexico OCS Region

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PREFACE

The role of marsh management in combatting wetland loss has been viewed with increasing importance in recent years. During the 1980s there was a dramatic increase in the use of marsh management techniques to mitigate coastal wetland loss in Louisiana. The popularity of this technique as a mitigative tool is indicated by the number of marsh management projects submitted for consideration in the Governor's Coastal Wetlands Conservation and Restoration Plan, which was approved in March of this year. However, there is growing concern about the potential environmental impacts, particularly cumulative impacts, of this type of wetland management. Because of this concern, the U.S. Army Corps of Engineers is developing a programmatic environmental impact statement on marsh management in coastal Louisiana. At public scoping meetings held in February 1988, the Corps of Engineers determined that public opinion about the effectiveness and environmental impacts of marsh management varies widely.

This study is the first detailed review and analysis of the effectiveness of marsh management in coastal Louisiana. The findings will be incorporated into the Corps of Engineers' programmatic environmental impact statement. While no single study provides all the answers, we hope that these results will clarify many of the issues raised at the scoping meetings. Management policies should be based on objective, scientific data. The information gathered during this study will be useful in refining and revising current management policies and will contribute to the better management of our wetland resources.

Donald R. Cahoon
C. G. Groat
Louisiana Geological Survey
December 1990

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%	-	percent
cm	-	centimeter
g	-	grams
cm^3	-	cubic centimeters
m	-	meters
yr B.P.	-	years before the present
ft	-	feet
MSL	-	mean sea level
ppt	-	parts per thousand
mg/l	-	milligrams per liter
ppm	-	parts per million
'	-	feet
"	-	inches
mm	-	millimeters
RSL	-	relative sea level
mi^2	-	square miles
km^2	-	square kilometers
cfs	-	cubic feet per second
m^3s^{-1}	-	cubic meters per second
NTU	-	Nephelometric turbidity units
"/yr	-	inches per year
cm/yr	-	centimeter per year
NGVD	-	National Geodetic Vertical Datum
mi	-	mile(s)
Pub. L.	-	public law
La. Rev. Stat.	-	Louisiana Revised Statutes

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Project Management

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APPENDIX A

EXCERPTS OF LOUISIANA COASTAL RESOURCES PROGRAM MARSH MANAGEMENT MANUAL

SECTION IV

Environmental Policies and Technical Guidelines

Introduction

This section contains the criteria used by the Department of Natural Resources, Coastal Management Division to evaluate marsh management plans submitted for implementation approval under the Coastal Use Permitting Program of the La. Coastal Resources Program (Act 361 of 1978). This section also contains selected Soil Conservation Service (SCS) environmental policies and guidelines that have an impact on the technical assistance provided landusers through local Soil and Water Conservation District Programs.

La. Coastal Resources Management Program

Coastal Management Program

In 1978 the state legislature enacted the Louisiana Coastal Resources Program (LCRP) (La. R. S. 49: 213.1 et seq.). This legislation authorized the implementation of a Coastal Use Permitting (CUP) system for the purposed of resolving resource use conflicts in the coastal region. The permitting process was implemented in October, 1980 and is administered by the Louisiana Department of Natural Resources (DNR), Coastal Management Division (CMD). In 1981, the state established the Coastal Erosion Protection Trust Fund. This legislative action authorized funding for major shoreline, barrier island wetland restoration and erosion control projects. This program is administered by the DNR, Coastal Restoration Division.

Most dredge and fill development activities proposed within the state's coastal zone are subject to the CUP permitting process (LCRP, FEIS 1980; Clark et al., 1983) as well as that of the Sections 10 and 404 permitting authority of the U.S. Army Corps of Engineers. Most permits are conditioned to require some level of site restoration in order to minimize environmental impacts. For activities where site restoration efforts are not sufficient to offset damages, the applicant may be required to implement off-site marsh enhancement measures to mitigate unpreventable damages associated with the permitted activities (Clark, et al. 1983). The permitting process has not likely reduced development activities in the coastal region, but it has significantly reduced wetland damage by requiring that development activities be conducted in an environmentally sound manner.

The CUP process in Louisiana has evolved into a well balanced resource management program. The program is designed to motivate landowners and coastal developers to strive for a balance between development and preservation. The CMD encourages a range of beneficial uses of the wetland resources. The LCRP was established with expressed goals which include those to protect, develop, restore, and enhance, coastal resources, encourage multiple uses and to determine the future course or development and conservation in the coastal zone (LCRP, FEIS, 1980). The CMD has implemented a systematic interdisciplinary approach to planning and decision making that supports diversity of individual choices and insures a balance between coastal resource development and conservation. In addition to governmental actions to reduce or reverse wetland losses, private landowners and corporations have become increasingly aware of the benefits to be derived from planning and implementing marsh management practices. For example Tenneco (Fina) implemented in 1983 at considerable expense, a 5000 acre marsh management plan south of Theriot, Louisiana as part of the first Mitigation Banking Project in Louisiana (Soileau, 1983).

Coastal Use Permitting Process

Coastal use permitting programs was initiated in 1980 by the Louisiana Department of Natural Resources, Coastal Management Division. The permitting process is authorized under the Louisiana Coastal Resources Program established by the State in 1978. Those activities which normally require Coastal Use Permits (CUP), as outlined in the State Coastal Resource Management Act include: (1) dredge and fill operations, (2) water control structures, (3) flood protection facilities, (4) commercial, industrial and residential developments, (5) extraction activities, (6) activities which may modify surface water flow, (7) shoreline modification projects, (8) waste disposal activities, (9) wastewater discharge, (10) recreational developments, and (11) drainage projects. Certain activities, however, are exempted from the permit process. Those activities which normally do not have a direct and significant impact on coastal waters or which are located outside of the coastal zOne normally do not require a CUP. They include: (1) agricultural, forestry, and aquaculture activities on lands that have a history of these uses; (2) hunting, fishing and trapping; (3) maintenance and repair activities not involving dredging; (4) residence or camp construction; (5) navigational features; (6) activities occurring within fastlands (leveed lands) or those above 5 feet M.S.L.; (7) emergency uses if there is a significant threat to life or property; (8) activities commenced prior to September 30, 1980, the date Louisiana Coastal Resource Program was implemented, and (9) other activities which do not have a direct and significant impact on coastal waters. The authority for determining exemptions rests with the CMD Administrator or Secretary of DNR.

Coastal Use Permit Process

The CUP review conducted by the CMD includes: (1) publishing 25 day public notice in which the nature and location of the proposed activity is described, (2) onsite field investigations of major projects, (3) an examination of the affected Coastal Use Guidelines, (4) a review of available and resource data sets and studies, (5) consultation with experts concerning the social, economic or environmental impacts of the project, (6) communications to resolve issues between the CMD and the applicant, experts, or other interested entities, (7) a final recommendation of permit issuance including conditions and/or alternate methods to minimize environmental effects, or a recommendation of permit denial with a description of suggested permittable alternatives which, if make a part of the application, would make the project consistent with the Guidelines. The Secretary of DNR acts on the recommendation of the CMD Administrator and makes the final decision to issue or deny the permit. The Secretary's decision is the final administrative action by the state, but is subject to judicial review. (Clark et al 1983)

Marsh Management Plan Guidelines

Through proper planning, many regions of the marsh can be managed to reduce losses to open water, reduce saltwater intrusion and environmentally sensitive areas can be protected. Through its permitting program, CMD encourages sound marsh management decisions by land users.

Marsh management plans are developed to achieve a number of different goals. Many plans are submitted to CMD for the purpose of outlining measures that a CUP applicant will perform to counteract wetland erosion that may result from the proposed activity. Other plans focus on measures which combat land loss and wetland deterioration caused by current natural processes or past development activities. All plans are evaluated by the CMD and other wetland advisory agencies to insure that implementation will result in long term protection and enhancement of the impacted wetland system.

To insure a uniform and objective review of CUP applications, a series of guidelines have been developed for use during permit review. These are very specific guidelines that are rigorously adhered to by the CMD and must be closely observed by all permit applicants. LCRP guidelines that apply primarily to marsh management plan applications include: (1) impoundment levees shall not be constructed in wetland areas except in conjunction with an approved marsh management plan or for pollution prevention or control (Guideline 2.5), (2) all management plants, implemented, will increase or otherwise enhance the productivity of the impacted area (Guideline 7.5), (3) all water control structures will be designed, built and installed using the best practical techniques that reduce the potential for structural failure, allow for tidal exchange, and minimize obstruction of the migration of aquatic organisms be constructed in brackish or saline areas (Guideline 7.8). Some researchers have indicated that certain types of control structures namely fixed crest weirs may reduce the access of certain fisheries organisms into and out of management areas (Herke, 1979; Herke et al 1984). The major LCRP marsh management goals encourage the management techniques which reduce erosion and increase overall marsh or wetland productivity (LCRP, FEIS, 1980).

In addition to meeting the requirements of CMD guidelines, applicants submitting marsh management permit applications are requested to clearly define plan objectives in a plan. To support the stated goals, the following information is generally required to be included in these plans: (i) area history; (ii) vegetational analysis of the management area; (iii) management strategies to be employed which includes water management procedures and structures; (iv) an outline of the monitoring program that will be implemented to determine if management objectives are being achieved; and (v) any known future non-marsh management development activities that are planned for the managed area. The following should also be included in the plan if applicable: potential environmental impacts, and the proximity of the management area and probable impacts to specific features, such as beaches, tidal passes, historic sites, critical areas, and navigation and public access facilities. Water management procedures should include the types of structures to be installed, construction techniques, a description of regional hydrology, and nonstructural conservation practices contemplated. Other appropriate information as described in LCRP Guideline 1.6 which outlines the information required for permit review should also be included by those who submit marsh management plan CUP applications (LCRP, FEIS, 1980).

Marsh Management Plan Guidelines

The following specific information should be provided to the Coastal Management Division by those applicants contemplating implementing marsh management plans.

The criteria by which CMS review marsh management plans are established by the following Coastal Use Guidelines:

<u>Guideline 1. 6-</u> Information regarding the following general factors shall be utilized by the permitting authority in evaluating whether the proposed use is in compliance with the guidelines.

c) techniques and materials used in construction, operation and maintenance of use.

d) existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity and salinity; and impacts on them.

h) extent of resulting public and private benefits.

k) extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited.

l) proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands.

q) extent of impacts of navigation, fishing, public access, and recreational opportunities.

s) extent of long term benefits or adverse impacts.

Guideline 2.5- Impoundment levees shall only be constructed as part of approved water or marsh management projects or to prevent release of pollutants.

Guideline 7.5- Water or marsh management plans shall result in an overall benefit to the productivity of the area.

Guideline 7.6- Water control structures shall be assessed separately based on their individual merits and impact and in relation to their overall water or marsh management plan of which they are a part.

Guideline 7.7- Weirs and similar water control structures shall be designed and built using the best practical techniques to prevent "cut arounds," permit tidal exchange in tidal areas, and minimize obstruction of the migration of aquatic organisms.

Guideline 7.8- Impoundments which prevent normal tidal exchange and/or the migration of aquatic organisms shall not be constructed in brackish and saline areas to the maximum extent practicable.

In general, the Coastal Management Section would like marsh management plans to contain the following elements:

1.) Marsh Management Goals

The primary and secondary goals to be derived from the plan should be included.

2.) Area History

A brief history of the area and its problems should be presented.

3.) Type of Habitat

A description of the types of vegetation to be affected by the plan should be included.

4.) Water Control Structure

The location, construction, and operation of water control structures, (i.e. weirs or flapgates) or other proposed modification (i.e. levees) of the marsh should clearly be outlined.

5.) Monitoring Plan

A monitoring plan should be included to evaluate whether the goals have been accomplishes and to what degree. Monitoring may be done by gathering information from: water quality sampling, vegetational change analysis, aerial photography, hunting or trapping records or other similar methods.

6.) Non-Marsh Management Activities

A statement of policy should be included concerning activities other than those involved with marsh management which may occur within the management area (i.e. the dredging of oil and gas canals and the placement of spoil). In addition, a statement of policy should be included concerning restoration of areas impacted by non-marsh management activities (i.e the plugging or backfilling of abandoned canals).

7.) In addition, the following specific information should be provided where applicable.

a. The length and cross section (with scale) of any levee(s) to be constructed or reconstructed.
b. The amount of fill material or dredging necessary for levee or water control structure construction.
c. Present elevation of existing levees.
d. The location of any tidal creeks which may be closed by this activity.
e. Allowances for the ingress and egress of estuarine organisms.

SCS Environmental Policy and Technical Assistance Guidelines

The SCS mission is to provide assistance that will allow use and management of ecological, cultural, natural, physical, social and economic resources by striving for a balance between use, management, conservation, and preservation of the Nation's natural resource base. The SCS will conduct and coordinate its plans, functions, programs, and recommendations on resource use so that stewards of the environment for succeeding generation:

(1) Can maintain safe, healthful, productive, and aesthetically and culturally pleasing surroundings that support diversity of individual choices; and

(2) Are encouraged to attain the widest range of beneficial uses of soil, water, and related resources without degradation of the environment, risk to health or safety, or other undesirable and unintended consequences.

SCS Environmental Policy

SCS is to administer federal assistance within the following overall environmental policies:

(1) Provide assistance to landowners and users that will motivate them to

maintain equilibrium among their ecological, cultural, natural, physical, social, and economic resources by striving for a balance between conserving and preserving the Nation's natural resource base.

(2) Provide technical and financial assistance through a systematic interdisciplinary approach to planning and decision making to insure a balance between the natural, physical and social sciences.

(3) Consider environmental quality equal to economic, social, and other factors in decision-making.

(4) Insure that plans satisfy identified needs and at the same time minimize adverse effects of planned actions on the human environment through interdisciplinary planning before providing technical and financial assistance.

(5) Counsel with highly qualified and experienced specialists from within and outside SCS in many technical fields as needed.

(6) Encourage broad public participation in defining environmental quality objectives and needs.

(7) Identify and make provisions for detailed survey, recovery, protection, or preservation of unique cultural resources that otherwise may be irrevocably lost or destroyed by SCS-assisted project actions, as required by Historic Preservation legislation and/or Executive Order.

(8) Encourage local sponsors to review with interested publics the operation and maintenance programs of completed projects to insure that environmental quality is not degraded.

(9) Advocate the retention of important farmlands and forestlands, prime farmlands, rangeland, wetlands, or other lands designated by state or local governments. Whenever proposed conversions are caused or encouraged by actions or programs of a federal agency, licensed by or require approval by a federal agency, or are inconsistent with local or state government plants, provisions are to be sought to insure that such lands are not irreversibly converted to other uses unless other national interests override the importance of preservation or otherwise outweigh the environmental benefits derived from their protection. In addition, the preservation of farmland in general provides the benefits of open space, protection of scenery, wildlife habitat, and in some cases, recreation opportunities and controls on urban sprawl.

(10) Advocate actions that reduce the risk of flood loss, minimize effects of floods on human safety, health and welfare, and restore and preserve the natural and beneficial functions and values of flood plains.

(11) Advocate and assist in the reclamation of abandoned surface-mined lands and in planning for the extraction of coal and other non-renewable resources to facilitate restoration of the land to its prior productivity as mining is completed.

(12) Advocate the protection of valuable wetlands, threatened and endangered animal and plant species and their habitats, and designated ecosystems.

(13) Advocate the conservation of natural and man-made scenic resources to insure that SCS-assisted programs or activities protect and enhance the visual quality of the landscape.

(14) Advocate and assist in actions to preserve and enhance the quality of the Nation's waters.

Threatened and Endangered Species of Plants and Animals

Background

(1) A variety of plant and animal species of the United States are so reduced in numbers that they are threatened with extinction. The disappearance of any of these would be a biological, cultural, and in some instances an economic loss. Their existence contributes to scientific knowledge and understanding, and their presence adds interest and variety to life.

(2) The principal hazard to threatened and endangered species is the destruction or deterioration of their habitats by human activities such as industrialization, urbanization, agriculture, lumbering, recreation, exploration and extraction, and transportation. These activities of man will continue, but the necessity of recognizing their impacts and selecting practices or actions that minimize or eliminate such impacts on threatened and endangered species is imperative.

(3) The Endangered Species Act of 1973, as amended, (PL 93-205, 87 Stat. 884 (16 U.S.C. 1531 et seq.)) provides a means whereby the ecosystems upon which threatened and endangered species depend, may be maintained, as well as a program for the conservation of such species. The Act also provides that, in addition to the Department of the Interior all other federal departments and agencies shall, in consultation with and with the assistance of the Secretary of the Department of the Interior, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of threatened and endangered species listed pursuant to Section 4 of this Act. Each federal agency is to insure that its actions do not jeopardize the continued existence of threatened and endangered species or result in the destruction or adverse modification of their habitat. Critical habitats will be determined in consultation, as appropriate, with the affected states.

Policy

The SCS will assist in the conservation of threatened and endangered species and consistent with legal requirements, avoid or prevent activities detrimental to such species. SCS's concern for these species will not be limited to those listed by the Secretary of the Interior and published in the Federal Register, but will include species designated by state agencies as rare, threatened, endangered, etc.

Scenic Beauty

Background

Contributions to scenic beauty are a normal product of SCS work. Emphasis is given to those soil and water conservation measures that contribute to a productive and efficient agriculture, enhance wildlife, increase the attractiveness of rural landscapes and are in line with goals and objectives of conservation districts. This can be accomplished by considering the landscape visual resource when providing planning assistance to individual landowners, groups, units of government, and watershed and resource conservation development project sponsors.

Policy

SCS will:

(1) Provide technical assistance with full consideration of alternative management and development systems that preserve scenic beauty or improve the landscape;

(2) Emphasize the application of conservation practices having scenic beauty or landscape resource values particularly in waste management systems, field borders, field windbreaks, wildlife and wetland habitat management, access road, critical area treatment; design and management of ponds, stream margins, odd areas, and farmstead; siting or positioning of structures and buildings to be in harmony with the landscape while reducing the potential for erosion; using native and other adaptable plants for conservation which enhance scenic beauty and create variety while linking beauty with utility;

(3) Promote personal pride in landowners in the installation, maintenance, and appearance of conservation practices and their properties;

(4) Select suitable areas for waste products.

(5) Encourage conservation districts to include practices which promote scenic beauty in their annual and long-range programs.

Responsibility

SCS will provide technical assistance through conservation districts to landowners, operators, communities, and state and local governments in developing programs relating to scenic beauty.

APPENDIX B

MEMORANDA OF UNDERSTANDING

between

THE COASTAL MANAGEMENT DIVISION, LOUISIANA DEPARTMENT OF NATURAL RESOURCES

and

OFFICE OF CONSERVATION, LOUISIANA DEPARTMENT OF NATURAL RESOURCES

LOUISIANA DEPARTMENT OF WILDLIFE AND FISHERIES

ENVIRONMENTAL CONTROL COMMISSION OFFICE OF ENVIRONMENTAL AFFAIRS,
LOUISIANA DEPARTMENT OF NATURAL RESOURCES

LOUISIANA DEPARTMENT OF HEALTH AND HUMAN RESOURCES

LOUISIANA DEPARTMENT OF CULTURE, RECREATION AND TOURISM

THE DEPARTMENT OF STATE LANDS, LOUISIANA DEPARTMENT OF NATURAL RESOURCES

LOUISIANA DEPARTMENT OF AGRICULTURE

MEMORANDUM OF UNDERSTANDING BETWEEN THE
COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE OFFICE OF CONSERVATION OF THE DEPARTMENT OF NATURAL RESOURCES

It is the purpose of this Memorandum of Understanding between the Coastal Management Section of the Department of Natural Resources (CMS/DNR) and the Office of Conservation of the Department of Natural Resources (OC/DNR) to establish an agreement on the issues and procedures involved in implementing the provisions of Title 49 of the Louisiana Revised Statues of 1950, Sections 213.1 through 213.21, the State and Local Coastal Resources Management Act of 1978, as amended, in particular Sections 213.12 B, 213.13 B and D, and 213.14.

In order to assist OC/DNR and CMS/DNR in meeting their lawful responsibilities, implement the in-lieu permit system, reduce conflicting decisions by the two agencies, assure conformity of action with the Louisiana Coastal Resources Program and reduce duplication of effort by applicants for permits, it is agreed that:

GENERAL

1. In-lieu permits are to be implemented by OC/DNR. OC/DNR shall have the responsibility for permitting activities occurring within the boundary of the coastal zone as set forth in the Act for which OC/DNR issued permits as of January 1, 1979, for the location, drilling, exploration and production of oil, gas, sulphur and other minerals. It is the intent of Section 213.12 B of Louisiana R.S. 49 that coastal use permits are not required for these activities.

2. The following list delineates those activities subject to an in-lieu permit issued by OC/DNR.

- Oil & gas activities subject to regulation pursuant to La. R.S. 30:1-36 204, 205, 213, and 215 and as provided for in statewide orders 29-B, 29-E, 29-H, & 28-J.

- Subsurface injection activities subject to regulation pursuant to La. R.S. 30:1 (D), 3(C)(1), 4(C)(16) & the Louisiana Environmental Affairs Act, and as provided for in statewide order 29-N.

- Geothermal energy activities subject to regulation pursuant to La. R.S. 30:800-809, and as provided for in statewide 29-P.

- Uses of salt domes for storage subject to regulation pursuant to La. R.S. 30:22-23, and as provided for in statewide order 29-M.

- Letters of clearance for Intrastate Natural Gas Pipelines subject to regulation pursuant to La. R.S. 30:554, 555, 557 and 560, and as provided for in La. Reg 4-76.

OC/DNR will issue in-lieu permits only if the proposed activity is consistent with the Coastal Use Guidelines, the Louisiana Coastal Resources Program and affected approved local programs.

3. CMS/DNR shall issue coastal use permits for the following aspects of the above activities in accordance with the Louisiana Coastal Resources Program, the guidelines and approved local programs:

- Dredging of canals, slips and channels
- Filling of waterbottoms, marsh, or other wetlands
- Disposal of dredged spoil
- Building of board roads
- Designation of access routes
- Construction of auxiliary structures, such as wharfs, piers, bulkheads, etc., not presently regulated by a statewide order.
- Maintenance dredging

IN-LIEU PERMIT PROCEDURES

1. OC/DNR will forward copies of all in-lieu permit applications to CMS/DNR within two working days. CMS/DNR will distribute copies of the application to other affected governmental agencies. OC/DNR will give public notice of all in-lieu permit applications in a manner similar to that provided for by CMS/DNR regulations and will provide an opportunity for public comment and public hearing.

2. CMS/DNR will review the in-lieu permit application and comments received from other agencies and the public to make a determination as to whether or not the activities comply with the Coastal Use Guidelines, the Coastal Resources Program and any affected approved local program. CMS/DNR will notify OC/DNR of its determination within thirty days of receipt of

the application.

3. The Administrator of CMS/DNR, or his designee, and the Commissioner of Conservation, or his designee, shall meet when necessary to resolve conflicts between the two agencies on in-lieu permits. In the event they cannot mutually resolve the conflicts, the Secretary of the Department of Natural Resources will be notified, and the process set forth in Section 213.13 D of Louisiana R.S. 49 shall be initiated. Upon receipt of the written comments stating the basis for the decision, from the Secretaries acting jointly, CMS/DNR and OC/DNR shall take the actions recommended by the Secretaries.

4. OC/DNR and CMS/DNR will coordinate closely in establishing typical permit conditions for activities requiring an in-lieu permit in the coastal zone in order to assure that those activities are conducted consistently with the Coastal Resources Program and the guidelines, to reduce permit review time and increase predictability.

5. OC/DNR will notify CMS/DNR of any work permits or abandonments and will assure that such activities are in compliance with the Coastal Resources Program, the guidelines and affected approved local programs.

6. OC/DNR will notify CMS/DNR of any public hearings held regarding activities requiring an in-lieu permit and will provide CMS/DNR with copies of all available materials regarding the matters at issue upon request. CMS/DNR staff may testify at any such hearing for purposes of making known the views of CMS/DNR regarding the use. OC/DNR will

oil and gas activities requiring in-lieu permits, coastal use permits and Corps of Engineers permits for Section 404(b)(1) of the Clean Water Act of 1977.

Signed this 8th day of July, 1980.

RAY SUTTON, COMMISSIONER, Office of Conservation of the Department of Natural Resources

FRANK A. ASHBY, JR., SECRETARY Department of Natural Resources

MEMORANDUM OF AGREEMENT BETWEEN THE
COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE ENVIRONMENTAL CONTROL COMMISSION AND THE OFFICE OF
ENVIRONMENTAL AFFAIRS OF THE DEPARTMENT OF NATURAL RESOURCES

It is the purpose of this Memorandum of Understanding between the Coastal Management Section of the Department of Natural Resources (CMS/DNR) and the Environmental Control Commission and the Office of Environmental Affairs of the Department of Natural Resources (ECC-OEA/DNR) to establish an agreement on the issues and procedures involved in implementing the provisions of Title 49, of the Louisiana Revised Statutes of 1950, particularly all or parts of the following sections: 213.2, 213.6, 213.8, 213.13 and 213.14, the State and Local Coastal Resources Management Act of 1978, as amended.

In order to assist ECC-OEA/DNR and CMS/DNR in meeting their lawful responsibilities, reduce conflicting decisions by the two agencies, assure conformity of action with the Louisiana Coastal Resources Program (LCRP) and reduce duplication of effort by applicants for permits, it is agreed that:

Permit Procedures

1. CMS/DNR will provide ECC-OEA/DNR notice of all coastal use permit applications and decisions for activities within the coastal zone as established by Louisiana R. S. 49 on a regular basis.
2. ECC-OEA/DNR, on a regular basis, will provide CMS/DNR notice of all permit applications, decisions, hearings, enforcement proceedings and similar administrative actions for the following

activities in the coastal zone, and notice of such applications and decisions for activities outside the coastal zone which may have significant impacts on the coastal zone or coastal waters:

- Transportation, storage and disposal of hazardous waste pursuant in general to Louisiana R. S. 30:1061-1067 and in particular pursuant to Louisiana R. S. 30:1131-1147, and regulations promulgated thereunder.
- Transportation of out-of-state waste materials for storage or disposal (other than those generated by offshore mineral operations) pursuant to Louisiana R. S. 40:1299.36.
- Activities requiring air quality permits pursuant in general to Louisiana R. S. 30:1061-1067 and in particular, 30:1081-1087, and regulations promulgated thereunder.
- Activities requiring water quality permits pursuant in general to Louisiana R. S. 30:1061-1067 and in particular to Louisiana R. S. 30:1091-1096, 38:216, and regulations promulgated thereunder.
- Use and disposal of radioactive materials pursuant in general to Louisiana R. S. 30:1061-1067 and in particular Louisiana R. S. 30:1101-1116.

3. ECC-OEA/DNR will provide CMS/DNR appropriate comments on coastal use permit applications regarding impacts on matters subject to ECC-OEA/DNR authority. Such comments shall be provided to CMS/DNR within 25 days of receipt of the copy of the application. All comments will be reviewed by CMS/DNR and incorporated in permit decisions to the maximum extent practicable.

Permit Consistency

1. CMS/DNR will condition the approval of all coastal use permits and all consistency decisions on compliance with the rules and regulations of ECC-OEA/DNR and the applicant obtaining all permits required by ECC-OEA/DNR and complying with the terms and conditions thereof. Failure to obtain a required ECC-OEA/DNR permit or to comply with its terms will be a basis for revocation of the coastal use permit.
2. ECC-OEA/DNR will condition issuance of permits for uses and activities in the coastal zone on the applicant's first obtaining any required coastal use permit or permit from an approved local program and on complying with all terms and conditions thereof.

Interagency Coordination

1. CMS/DNR and ECC-OEA/DNR agree that the two agencies will meet formally and informally as frequently as necessary and as needed to share reports on activities in the coastal zone, review all aspects of the agencies' relationship, determine the adequacy of the existing Memorandum of Understanding and the need for expanding and/or revising the existing Memorandum of Understanding and to discuss with an intent to resolve any conflicts which may arise.
2. CMS/DNR and ECC-OEA/DNR agree that the two agencies will meet and develop a coordinated coastal permitting process as set forth in Section 213.14 of Louisiana R. S. 49.

Conflict Resolution

1. In the event that CMS/DNR should find that ECC-OEA/DNR is issuing permits which are not consistent to the maximum extent practicable with the state coastal management program or approved local program, and which might significantly affect land and water resources within the coastal zone, CMS/DNR shall report this to the Secretary of DNR for his review and determination as to whether the actions of ECC-OEA/DNR are consistent. If the Secretary of DNR determines there is an inconsistency, the process set forth in Section 213.13 D of Louisiana R. S. 49 shall be initiated. Upon receipt of the written comments stating the basis for the decisions from the secretaries acting jointly, ECC-OEA/DNR and CMS/DNR shall take the actions recommended by the secretaries.

Effective Date and Termination Consent

1. This agreement will be effective when signed and dated by the parties hereto and may be terminated, with approval of the Governor, by mutual consent of the parties hereto or by either party after 60 days notice of intent to terminate.

Signed this 11th day of July, 1980.

Frank A. Ashby Jr.

FRANK A. ASHBY, JR., CHAIRMAN
Environmental Control Commission
Department of Natural Resources

B. Jim Porter

B. JIM PORTER, ASSISTANT SECRETARY
Office of Environmental Affairs,
Department of Natural Resources

MEMORANDUM OF UNDERSTANDING BETWEEN
THE COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE DEPARTMENT OF HEALTH AND HUMAN RESOURCES

It is the purpose of this Memorandum of Understanding between the Coastal Management Section of the Department of Natural Resources (CMS/DNR) and the Department of Health and Human Resources (DHHR) to establish an agreement on the issues and procedures involved in implementing the provisions of Louisiana Revised Statute 49, the State and Local Coastal Resources Management Act of 1978, as amended, particularly all or parts of the following sections applicable to DHHR: 213.2, 213.5, 213.8, 213.10, 213.11, 213.12, 213.13, and 213.14.

In order to assist DHHR and CMS/DNR in meeting their lawful responsibilities, reduce conflicting decisions by the two agencies, assure conformity of action with the Louisiana Coastal Resources Program, and reduce duplication of effort by applicants for permits, it is agreed that:

<u>Permit Procedures</u>

1. CMS/DNR will provide DHHR with notification of all applications received for activities within the coastal zone as established by La. R.S. 49 and CMS/DNR will notify DHHR of all permit decisions.
2. DHHR will provide CMS/DNR notice of all request of approvals received for activities in the coastal zone and DHHR will provide CMS/DNR copies of all final permits or grants for activities in the coastal zone.

3. DHHR will provide appropriate comments on coastal use permit applications, after review, for those that impact public health. Such comments shall be provided to CMS/DNR within 25 days of receipt of the copy of the application. All comments will be reviewed by CMS/DNR and incorporated in permit decisions to the maximum extent practicable.

Permit Consistency

1. CMS/DNR will condition the granting of approved coastal use permits for uses and activities in the coastal zone so that they conform with the rules and regulations of DHHR.
2. DHHR agrees that any activities directly affecting the coastal zone that it undertakes, conducts, supports or permits will be consistent to the maximum extent practicable with the State Coastal Resources Program and affected approved local programs having geographical jurisdiction over the action. DHHR will condition its permits for activities in the coastal zone on the applicant obtaining and complying with the terms of a coastal use permit, if one is required.
3. DHHR will coordinate all grant activities, federal or state, with CMS/DNR in either the preliminary planning or the pre-grant stage to assure that works affecting the coastal zone which are constructed pursuant to these grants are consistent with the Coastal Resources Program and all affected approved local programs.

Interagency Coordination

1. CMS/DNR and DHHR agree that the two agencies will meet formally and informally as frequently as necessary and as needed to share field reports on activities in the coastal zone, review all aspects of the agency's relationship, determine the adequacy of the present Memorandum of Understanding and the need for expanding and/or revising the present Memorandum of Understanding, and to discuss with an intent to resolve any conflicts which may arise.
2. CMS/DNR and DHHR agree that the two agencies will meet and develop a unified coastal permitting process as set forth in Section 213.14 of La. R.S. 49.

Conflict Resolution

1. In the event that CMS/DNR should find that DHHR is issuing permits, conducting activities or providing funds for activities which are not consistent to the maximum extent practicable with the state coastal management program, CMS/DNR shall report this to the Secretary of DNR for his review and determination as to whether the actions of DHHR are consistent. The Secretary of DNR and the Secretary of DHHR will then meet to determine a proper course of action to insure consistency.

Effective Date and Termination Consent

1. This agreement will be effective when signed and dated by the parties hereto and may be terminated at any time, with approval

of the Governor, by mutual consent of the parties hereto or by either party after 60 days notice of intent to terminate.

Signed this 28th day of July, 1980.

FRANK A. ASHBY, JR., SECRETARY
Department of Natural Resources

GEORGE A. FISCHER, SECRETARY
Department of Health and Human Resources

MEMORANDUM OF UNDERSTANDING BETWEEN
THE COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE DEPARTMENT OF CULTURE, RECREATION AND TOURISM

It is the purpose of this Memorandum of Understanding between the Coastal Management Section of the Department of Natural Resources (CMS/DNR) and the Department of Culture, Recreation and Tourism (DCRT) to establish an agreement on the issues and procedures involved in implementing the provisions of Louisiana Revised Statute 49, the State and Local Coastal Resources Management Act of 1978, as amended, particularly all or parts of the following sections applicable to DCRT: 213.2, 213.5, 213.8, 213.10, 213.11, 213.12, 213.13 and 213.14.

In order to assist DCRT and CMS/DNR in meeting their lawful responsibilities, reduce conflicting decisions by the two agencies, assure conformity of action with the Louisiana Coastal Resources Program and reduce duplication of effort by applicants for permits, it is agreed that:

Permit Procedures

1. CMS/DNR will provide DCRT with notification of all applications received for activities within the coastal zone which might impact state parks or recreational resources or state cultural or historic resources and CMS/DNR will notify DCRT of all permit decisions.
2. DCRT will provide CMS/DNR copies of all applications received for activities in the coastal zne and DCRT will provide

CMS/DNR copies of all final permits or grants for activities in the coastal zone.

3. CMS/DNR will require applicants to submit sufficient information on coastal use permit applications for DCRT to adequately review them for impacts on state parks, recreational, historic and cultural resources.

4. DCRT will provide appropriate comments on coastal use permit applications, after review of impacts to the state parks, recreational, historical and cultural resources. Such comments shall include those of the Office of State Parks and the State Historic Preservation Officer and shall be provided to CMS/DNR within 21 days of receipt of the copy of the application. If no comments are provided within the 21 day period, it shall be presumed that DCRT and the Office of State Parks and the State Historic Preservation Officer have no objections to the proposed activity. All comments will be reviewed by CMS/DNR and incorporated in permit decisions to the maximum extent practicable.

Permit Consistency

1. CMS/DNR will condition the granting of approved coastal use permits for uses and activities in or impacting on state parks, recreational, state cultural and historical resources so that they are in compliance with terms of any permit or approval required by DCRT.

2. CMS/DNR will condition the approval of coastal use permits on compliance with DCRT's Cultural Resources Code requirements after its promulgation.
3. DCRT agrees that any activities directly affecting the coastal zone it undertakes, conducts, supports or permits, including state parks and recreational facilities in the planning and/or development stages, will be consistent to the maximum extent practicable with the State Coastal Resources Program and affected local programs having geographical jurisdiction over the action. DCRT will condition its permits for activities in the coastal zone on the applicant obtaining and complying with the terms of a coastal use permit, if one is required.

Interagency Coordinaton

1. DCRT will share with and/or provide to CMS/DNR information on known park, recreational, cultural and historic resources when requested by CMS/DNR and will notify CMS/DNR of all state park, recreational and park access development in preliminary planning stages.
2. CMS/DNR and DCRT agree that the two agencies will meet formally and informally as frequently as necessary and as needed to review all aspects of the agency's relationship, determine the adequacy of existing Memorandum of Understanding, and the need for expanding and/or revising

the present Memorandum of Understanding, and to discuss with intent to resolve, any conflicts which may arise.

3. CMS/DNR and DCRT agree that the two agencies will meet and develop a united coastal permitting process as set forth in Section 213.14 of La. R.S. 49.

Conflict Resolution

1. In the event CMS/DNR should find that DCRT is issuing permits, conducting activities or providing funds for activities which are not consistent to the maximum extent practicable with the State Coastal Management Program, CMS/DNR shall report this to the Secretary of DNR for his review and determination as to whether the actions of DCRT are consistent. The Secretary of DNR and the Secretary of DCRT will then meet to determine a proper course of action to insure consistency.

Effective Date and Termination Consent

1. This agreement will be effective when signed and dated by the parties hereto and may be terminated at any time, with approval of the Governor, by mutual consent of the parties hereto or by either party after 60 days notice of intent to terminate.

Frank A. Ashby Jr
FRANK A. ASHBY, JR., SECRETARY
Department of Natural Resources

Signed this 31st. day of July 1980.

Mrs. Lawrence V. Fox
MRS. LAWRENCE FOX, SECRETARY
Department of Culture, Recreation and Tourism

MEMORANDUM OF UNDERSTANDING BETWEEN
THE COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF
NATURAL RESOURCES AND THE DIVISION OF STATE LANDS
OF THE DEPARTMENT OF NATURAL RESOURCES

It is the purpose of this Memorandum of Understanding between the Coastal Management Section of the Department of Natural Resources (CMS/DNR) and the Division of State Lands of the Department of Natural Resources (DSL/DNR) to establish an agreement on the issues and procedures involved in implementing the provisions of Title 49 of the Louisiana Revised Statutes of 1950, the State and Local Coastal Resources Act of 1978, as amended, and the State Water Bottoms Act, Louisiana Revised Statutes 49:1172(d).

In order to assist DSL/DNR and CMS/DNR in meeting their lawful responsibilities, reduce conflicting decisions by the two agencies, assure conformity of action with the Louisiana Coastal Resources Program and reduce duplication of effort by applicants for permits, it is agreed that:

<u>Permit Procedures</u>

1. CMS/DNR will provide DSL/DNR with notice of all coastal use permit applications and decisions for activities within the coastal zone on a regular basis.

2. DSL/DNR will provide CMS/DNR notice of all applications and final permits or leases for the following activities within the coastal zone on a regular basis:
reclamation of lands lost through erosion, construction of wharfs, piers, bulkheads, fills or other encroachments requiring

class A, B, C, D, and E permits pursuant to the State Water Bottoms Management Act, Louisiana R. S. 41:1131, 41:1701-1714, 9:1101, 5 Louisiana Reg. 8.

Pipelines and other structures on or under state waterbottoms subject to regulation pursuant to Louisiana R. S. 30:4-H and 30:24.

- Leasing of state lands for storage and transportation of hydrocarbons pursuant to Louisiana R. S. 41:1261-1269, 41:1173-74.
- Leasing of state lands for purposes other than mineral operations pursuant to Louisiana R. S. 41:1211-1223, 41:1501-1506.
- Leasing of state lands for oil, gas, and other mineral operations pursuant to Louisiana R. S. 30:151-156, 158-159, 171, 208, 209, 209.1, 3 Louisiana Reg. 473, 4 Louisiana Reg. 210.

3. CMS/DNR will notify applicants for coastal use permits for activities comtemplated to take place on state owned lands or waterbottoms that a lease and permit from DSL/DNR may be required and that a processing fee will be required to be paid directly to DSL/DNR. DSL/DNR will notify applicants for permits and leases that a coastal use permit may be required.
4. In the event that opportunity for public hearing is deemed necessary by either agency, all efforts will be made to accommodate the applicant by holding one hearing on all permit or lease applications required for the proposed activity.

Coordination on Permit Decisions

1. DSL/DNR will provide appropriate comments on coastal use permit applications after review of impacts to state owned

properties. CMS/DNR will provide appropriate comments on applications for DSL/DNR permits and surface leases after review for consistency with the Louisiana Coastal Resources Program (LCRP). The comments shall be provided within 25 days of receipt of the copy of the application. If no comments are provided within the 25 day period, it shall be presumed that there is no objection to the proposed use. CMS/DNR and DSL/DNR will confer on permit and surface lease applications when useful. Comments received will be incorporated into the permit or surface lease decision to the maximum practicable extent.

2. CMS/DNR will condition the issuance of coastal use permits upon the applicant obtaining all required surface leases and permits from DSL/DNR and on complying with all terms and conditions thereof. Failure to obtain a required DSL/DNR surface lease or permit or to comply with its terms will be a basis for revocation of the coastal use permit.

3. DSL/DNR will condition the issuance of its surface leases and permits upon the applicant obtaining a coastal use permit, if required, and on complying with all terms and conditions thereof. Failure to obtain a required coastal use permit or to comply with its terms will be a basis for revocation of the surface lease or permit.

4. DSL/DNR will consider, and decisions on surface leases and permits shall be consistent with, the coastal use guidelines, the state program and affected approved local programs.

5. No work shall commence until the applicant has obtained all

required leases and permits from CMS/DNR, approved local coastal programs, and DSL/DNR.

Monitoring and Enforcement

1. CMS/DNR and DSL/DNR will assist each other in monitoring permitted uses for permit violations. If violations are noted, the other agency will be notified. The agencies will thereafter assist each other and will coordinate enforcement actions as appropriate, to avoid duplication of effort.
2. Joint enforcement actions will be undertaken whenever practical, including the filing of civil and criminal actions.
3. CMS/DNR and DSL/DNR will assist each other in assuring that all legislative and administrative requirements of their respective programs are met.

Interagency Coordination

1. CMS/DNR and DSL/DNR agree that the two agencies will meet formally and informally as frequently as necessary and as needed to review all aspects of the agency's relationships, determine the adequacy of existing Memorandum of Understanding, and the need for expanding and/or revising the present Memorandum of Understanding, and to discuss, with an intent to resolve, any conflicts which may arise.

Conflict Resolution

1. In the event that CMS/DNR should find that DSL/DNR is issuing

permits which are not consistent to the maximum extent practicable with the state coastal management program or approved local program, CMS/DNR shall report this to the Secretary of DNR for his review and determination as to whether the actions of DSL/DNR are consistent. If the Secretary of DNR determines there is an inconsistency, the process set forth in Section 213.13 D of Louisiana R.S. 49 shall be initiated. Upon receipt of the written comments stating the basis for the decision from the secretaries acting jointly, DSL/DNR and CMS/DNR shall take the actions recommended by the secretaries.

Effective Date and Termination Consent

1. This agreement will be effective when signed and dated by the parties hereto and may be terminated at any time, with approval of the Governor, by mutual consent of the parties hereto or by either party after 60 days notice of intent to terminate.

Signed this 8th day of July, 1980.

FRANK A. ASHBY, JR. SECRETARY
Department of Natural Resources

MIKE BOURGEOIS
Department of Natural Resources
Division of State Lands

MEMORANDUM OF UNDERSTANDING BETWEEN
THE COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE DEPARTMENT OF AGRICULTURE

It is the purpose of this Memorandum of Understanding between the Coastal Management Section of the Department of Natural Resources (CMS/DNR) and the Department of Agriculture (DOA) to establish an agreement on the issues and procedures involved in implementing the provisions of Louisiana Revised Statute 49, the State and Local Coastal Resource Management Act of 1978, as amended, particularly all or parts of the sections applicable to DOA.

Permit Procedures

1. CMS/DNR will provide DOA a notice of all applications for coastal use permits and will provide copies of those applications which would impact agricultural resources and the uses of pesticides.
2. DOA will provide appropriate comments on coastal use permit applications, after review of impacts to agricultural resources. Such comments shall be provided to CMS/DNR within 25 days of receipt of the copy of the application. If no comments are received within 25 days, it shall be presumed that DOA has no objection to the proposed activity. All comments will be reviewed by CMS/DNR and incorporated in permit decisions to the maximum extent practicable.

Permit Consistency

1. DOA agrees that any grant activities, and other activities, including investigations of misuse of pesticides, directly affecting the coastal zone that it undertakes, conducts, approves, supports or permits, will be consistent to the maximum extent practicable with the State Coastal Resources Program and affected approved local programs having geographical jurisdiction over the action.

Interagency Coordination

1. DOA will share with and/or provide CMS/DNR information on agricultural resources when requested by CMS/DNR and will notify CMS/DNR on any new agricultural developments in the coastal zone when it is in its preliminary planning stages.
2. CMS/DNR and DOA agree that the two agencies will meet formally and informally as frequently as necessary and as needed to review all aspects of the agency's relationships, determine adequacy of existing Memorandum of Understanding, and the need for expanding and/or revising the present Memorandum of Understanding, and to discuss with an intent to resolve, any conflicts which may arise.

Conflict of Interest

1. In the event that CMS/DNR should find that DOA is issuing permits, conducting activities or providing funds for activities which are not consistent to the maximum extent practicable with the State Coastal Management Program, CMS/DNR

shall report this to the Secretary of DNR for his review and determination as to whether the actions of DOA are consistent. The Secretary of DNR and the Commissioner of Agriculture will then meet to determine a proper course of action to insure consistency.

Effective Date and Termination Consent

1. This agreement will be effective when signed and dated by the parties hereto and may be terminated at any time, with approval of the Governor, by mutual consent of the parties hereto or by either party after 60 days notice of intent to terminate.

Signed this 10th day of July, 1980.

FRANK A. ASHBY, JR., SECRETARY
Department of Natural Resources

ROBERT ODOM, COMMISSIONER
Department of Agriculture

MEMORANDUM OF UNDERSTANDING BETWEEN THE
COASTAL MANAGEMENT SECTION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE DEPARTMENT OF WILDLIFE AND FISHERIES

In order to insure a clear regulatory mandate from the State of Louisiana concerning activities within the Coastal Zone of Louisiana it is agreed that:

1. Comments of the Department of Wildlife and Fisheries on 404 and coastal use permit applications inside the coastal zone will be given to the Coastal Management Section, Department of Natural Resources.

2. Department of Wildlife and Fisheries comments will be given full consideration in the coastal use permit decision process, and summarized and responded to in the actual permit document.

3. The commenting authority of the Department of Wildlife and Fisheries required by the Fish and Wildlife Coordination Act (PL 85-624, August 12, 1958) on activities inside the Coastal Zone will be exercised through the Coastal Use permitting process, except that the provisions of this paragraph shall not apply to those lands owned or administered by the Department of Wildlife and Fisheries for the purposes of wildlife and fisheries management and/or conservation.

4. The Department of Wildlife and Fisheries comments relative to 404 and coastal use permits dealing with Department owned or administered lands and waterbottoms shall comply with all stipulations in the Deeds of Donation or acts of sale applicable to those lands, and the Department shall have full authority in the exploration, extraction and development of all minerals so as to cause the least disturbance to the wildlife and fishery resources on such lands or waterbottoms.

5. Should there be a conflict between the Department of Wildlife and Fisheries and the Coastal Management Section concerning a decision, this conflict will be brought before the Secretaries of the Departments of Wildlife and Fisheries and Natural Resources, pursuant to 213.13D of Act 361.

In the event that a resolution is still not reached, the conflict will be brought to the Governor for final resolution.

Signed this 29th day of September, 1981.

JESSE J. GUIDRY, SECRETARY
Department of Wildlife and Fisheries

FRANK A. ASHBY, JR., SECRETARY
Department of Natural Resources

APPENDIX C

MEMORANDA OF AGREEMENT BETWEEN

THE U.S. ARMY CORPS OF ENGINEERS

and

U.S. DEPARTMENT OF THE INTERIOR

U.S. ENVIRONMENTAL PROTECTION AGENCY

U.S. DEPARTMENT OF COMMERCE

LOUISIANA DEPARTMENT OF NATURAL RESOURCES

MEMORANDUM OF AGREEMENT BETWEEN THE DEPARTMENT OF THE INTERIOR AND THE DEPARTMENT OF THE ARMY

1. Authority: Section 404(q) of the Clean Water Act. (33 USC 1344(q)).

2. Purpose: The purpose of this agreement is to establish policies and procedures to implement Section 404(q) of the Clean Water Act to "minimize, to the maximum extent practicable, duplication, needless paperwork and delays in the issuance of permits."

3. Applicability: This agreement shall apply to applications for permits to be issued by the Department of the Army under:

   a. Section 10 of the River and Harbor Act of 1899.

   b. Section 404 of the Clean Water Act.

   c. Section 103 of the Marine Protection, Research and Sanctuaries Act, except as pertains to compliance with EPA established ocean dumping criteria.

4. General rules: Policy and procedures for review of permit applications are established in 33 CFR 320 through 330, The Fish and Wildlife Coordination Act, and 40 CFR 1508.20.

5. Policy for Interagency Coordination:

   a. The final permit decision will be made by the District Engineer (DE) in the vast majority of cases, and the need for reopening the record of a case developed by the DE will be minimized.

   b. The Assistant Secretary for Fish and Wildlife and Parks (AS/FWP) will request review of a district engineer's decision only when he finds that (1) the case involves the development of significant new information, (2) there is necessity for policy-level review of issues of national significance, or (3) there has been insufficient interagency coordination at the district level.

   If full consideration to the recommendations of the Fish and Wildlife Service (FWS) including recommended permit conditions is not given, it will constitute insufficient coordination at the district level. This may result in a request for elevation when, in the opinion of the AS/FWP, the project would result in sufficient adverse environmental effects to warrant such a request.

In all these instances, the AS/FWP will state how the matters of concern are clearly within the Department of the Interior's (DOI) authority.

c. For projects of other Federal agencies, Army and DOI will accept, where appropriate and legally permissible, the environmental documentation and decisions of those agencies.

d. Where DOI is the applicant, DOI will be the lead agency for environmental documentation. Both agencies will cooperate fully in early and continuing coordination during development of projects, environmental documentation, and public involvement processes, including joint public notices and, if required, joint hearings. As referenced in paragraph 5.c., the Army will, where appropriate and legally permissible, accept DOI's findings on all environmental and regulatory matters or activities requiring an Army permit.

6. Procedures at the initial decision-making levels:

a. The FWS will be the point of contact for coordination at DOI.

b. In order to be eligible for referral under the procedures provided for under paragraph 7, FWS comment letters including recommended permit denial letters, letters recommending project modifications, or requests for extensions of the comment period, shall be signed by the Habitat Resources Field Supervisor (FS).

c. The DE will take reasonable steps to ensure that public notices are promptly transmitted to the appropriate FS. FWS will submit its comments, if any, during the basic comment period specified in the public notice. FWS will comment only on matters clearly and directly within DOI's authority. Where the basic comment period is less than 30 calendar days, the Corps shall upon request of the FS extend the comment period to 30 calendar days. Otherwise, extensions of the basic or extended comment period will be authorized only upon written request to the DE from the FS. The request must be received during the period sought to be extended and must demonstrate the reason for the extension. The DE will respond in writing to the request within five calendar days of the date of the letter of request. Transmittal provisions of paragraph 7.f. will apply to this response.

d. The DE's and FS's will develop local procedures at the field level to resolve differences, where possible, prior to the Notice of Intent to Issue. These local procedures will include informal consultation, initiated by the DE or designee, after the close of the comment period to alert the FS of an upcoming decision which will be contrary to a recommendation by FWS for permit or project modification. At the request of the FS, consultations will consist of such actions as telephone calls, electronic mail messages, visits, meetings, or other actions. The consultation should not exceed 10 working days from the time the DE or designee initiates the consultation unless the DE extends it and will include a discussion of the anticipated decision and of the rationale leading to that decision. It is incumbent on FWS to ensure that any additional views regarding the action are finalized and communicated to the DE as expeditiously as possible. In specific cases, the DE or designee and FS may determine that the informal consultation should include the applicant. If the applicant is not included, and the consultation results in any substantive action on the application, the DE or designee will inform the applicant of the substance of the consultation and will provide the opportunity for the applicant to comment. This consultation will not affect the time requirements specified in other parts of this MOA or in 33 CFR 320-330.

e. If, at the conclusion of the consultation identified at 6.d. above, the DE intends to issue the permit over FWS objections or to issue it without conditions recommended by FWS, the DE will formally notify the FS. When requested by the Regional Director (RD) within 7 calendar days of such notification, the DE will not issue a Notice of Intent until after the RD has had the opportunity to discuss the application with the appropriate Division Engineer during a mutually agreed to meeting. If no meeting has been scheduled within 14 calendar days of the RD's request to delay the Notice of Intent letter and no conference call occurs where there has been a reasonable opportunity for discussion within such 14 days, the DE may proceed to issue his Notice of Intent letter pursuant to subparagraph 7.c.

f. Meetings may be scheduled between the RD and Division Engineer by mutual agreement to discuss issues of mutual interest including problems involving individual permit decisions or patterns of concern such as consistently inappropriate comment letters, to ensure proper coordination on enforcement matters, to review the nature and frequency of elevation requests, and to monitor program implementation to minimize duplication and red tape. This consultation is intended to reduce potential delays in the permit process by raising major issues to the RD/Division Engineer level during the permit process thereby shortening or eliminating the time required for additional consultation and review.

g. The agencies agree to cooperate fully in the transfer of all information necessary for the agencies to carry out their respective responsibilities. In special cases requiring copying of voluminous documentation, the parties shall make mutually agreeable arrangements to ensure prompt and effective transfer of required information.

h. Both parties will transmit this document to their DE's and FS's and will take the internal measures necessary to assure that the letter and spirit of this agreement are understood at all levels within their agency.

7. Procedures for Referral:

a. General. In the vast majority of cases, the entire process of consultation and referral outlined in this paragraph, when activated, should be completed within 90 calendar days of the DE's notice of intent to issue a permit; in no cases should the elevation process exceed 120 calendar days.

b. If during the comment period, FWS recommends that a proposed permit be denied or that the activity be modified as a condition of the permit and the matter has not been resolved under the consultation process provided at subparagraphs 6.c. through 6.f. above, the DE will so notify the FS by letter (Notice of Intent to Issue) and will defer final action pending completion of the procedures in subparagraphs 7.c. and 7.d. The DE's letter to the FS will include a brief summary of how FWS comments were considered, together with a copy of the findings of the DE in support of his decision.

c. Within 20 working days of the DE's Notice of Intent to Issue, if the case has not been resolved to the satisfaction of the AS/FWP and he determines that it meets the criteria in paragraph 5.b., the AS/FWP may request of the Assistant Secretary of the Army (Civil Works) (ASA(CW)) that the permit decision be made at a higher level in the Department of the Army. The AS/FWP will identify those items of the district engineer's statement of findings with which he takes issue including items relating to:

(1) the affected fish and wildlife resources;

(2) the impacts of the applicant's proposed project on such resources;

(3) the net resource losses expected by project implementation as proposed by the district engineer and why the DE's proposals will not offset environmental losses;

(4) the mitigation proposed by the FWS and how FWS's proposal will offset environmental losses; and

(5) specify in what specific ways the mitigation recommended by the FWS did not receive full consideration in the DE's decision.

The AS/FWP will also state the way in which acceptance of the AS/FWP recommendations would result in a better decision.

It is acknowledged by the parties that the final determination of mitigation is the responsibility of the Corps.

d. Within 15 working days of the date of the letter of the AS/FWP, the ASA(CW) will decide whether or not the permit decision will be made at a level higher than the DE and, if so, at what level the final decision will be made. He will notify in writing the agency officials involved. Should the ASA(CW) decide that the permit decision will not be made at a higher level, he will respond to the AS/FWP in writing presenting the results of his evaluation. His notification will include specific discussions of each of the items with which the AS/FWP took issue. He will state his position (concurrence or nonconcurrence) with the AS/FWP's positions on each of these items, and will include relevant supporting data.

e. The official designated by the ASA(CW) to decide a referred case will reach his decision within the time specified in paragraph 7.a. above and will immediately notify the applicant and appropriate officials of both agencies.

f. Each agency will ensure that all letters to the other agency as required by this paragraph will be received within one day of signature using messenger, electronic transmittal or other appropriate means.

g. DOI and Army desire to avoid the use of duplicative review mechanisms. A permit decision will not be subject to the elevation process when Army and DOI agree in advance that an adequate separate review mechanism exists and has been invoked.

8. This agreement is effective immediately upon the last signature date below and will continue in effect until modified or revoked by agreement of both parties, or revoked by either party alone upon 30 days written notice.

9. The Memorandum of Agreement between the Secretary of DOI and the Secretary of the Army on permit processing dated July 2, 1982, is terminated. Those permit applications which have already been referred to the ASA(CW) under the July 2, 1982, MOA shall be processed according to its terms. Those permit applications for which Notices of Intent to Issue have been sent by the DE within 20 days prior to the effective date of this MOA, but which have not yet been referred to the ASA(CW) shall be governed by this agreement, except that the time periods specified in subparagraphs 7.c. and 7.d. shall run from the date of this agreement rather than from the date of the DE's letter.

Donald Paul Hodel	John O. Marsh, Jr.
Secretary of the Interior	Secretary of the Army
NOV 6 1985	8 NOV 1985
Date	Date
William P. Horn	[signature]
Assistant Secretary for Fish and Wildlife and Parks	Assistant Secretary of the Army (Civil Works) (Acting)
10/25/85	October 25, 1985
Date	Date

MEMORANDUM OF AGREEMENT BETWEEN THE ENVIRONMENTAL PROTECTION AGENCY AND THE DEPARTMENT OF THE ARMY

1. Authority: Section 404(q) of the Clean Water Act, 33 U.S.C. §1344(q).

2. Purpose: The purpose of this agreement is to establish policies and procedures to implement Section 404(q) of the Clean Water Act to "minimize, to the maximum extent practicable, duplication, needless paperwork and delays in the issuance of permits."

3. Applicability: This agreement shall apply to applications for permits to be issued by the Department of the Army under:

   a. Section 10 of the River and Harbor Act of 1899.

   b. Section 404 of the Clean Water Act.

   c. Section 103 of the Marine Protection, Research and Sanctuaries Act, except as pertains to compliance with the Environmental Protection Agency (EPA) established ocean dumping criteria.

4. General Rules: Policy and procedures for review of permit applications are established in 33 CFR 320 through 330, and 40 CFR 230.

5. Policy for Interagency Coordination:

   a. The final permit decision will be made by the District Engineer (DE) in the vast majority of cases, and the need for reopening the record of a case developed by the DE will be minimized.

   b. The Administrator has designated the Assistant Administrator, Office of External Affairs (AAEA), as the EPA official having authority to request that the Army review a DE's decision to issue a permit under Section 404. It is agreed that EPA will request such review only if the AAEA finds the following instances:

      (1) That there has been insufficient interagency coordination at the District and Division levels including a procedural failure to coordinate or a failure to resolve stated EPA concerns regarding compliance with the Section 404(b)(1) Guidelines; or

      (2) That significant new information has been developed which was not previously available; or

      (3) That the project raises environmental issues of national importance requiring policy level review.

In all these instances, the AAEA will state how the matters of concern are clearly within the Agency's authority.

c. For projects of other Federal agencies, Army and EPA will accept, where appropriate and legally permissible, the environmental documentation and decisions of those agencies.

d. This agreement does not diminish either Army's authority to decide whether a particular permit application should be granted, including determining whether the project is in compliance with the Section 404(b)(1) Guidelines, or the Administrator's authority under Section 404(c) of the Clean Water Act.

6. Procedures at the initial decision-making levels:

a. In order to be eligible for referral under the procedures provided for under paragraph 7, EPA comment letters including recommended permit denial letters, letters recommending project modification, or requests for extensions of the comment period, shall be signed by the Regional Administrator (RA) or his specified designee (such designee will not be below the level of Division Director; two officials will be designated in Region X to provide for special circumstances in Alaska). Where the RA has delegated such signature authority to a regional official, the RA shall provide in writing, to each Division and District Engineer in his Region, the title of the designated official.

b. The DE will take reasonable steps to ensure that public notices are promptly transmitted to the appropriate EPA office. EPA will submit its comments, if any, during the basic comment period specified in the public notice. Where the basic comment period is less than 30 calendar days, the DE shall upon request of the EPA extend the comment period to 30 calendar days. Otherwise, extensions of the basic or extended comment period will not exceed 30 calendar days and will be authorized only upon written request to the DE from the EPA. The request must be received during the period sought to be extended and must demonstrate the reason for the extension. The DE will respond to the request in writing within five calendar days of the letter of request. Transmittal provisions of subparagraph 7.e. will apply to this response.

c. The agencies will develop techniques at the field level to ensure that formal referral procedures are started only when warranted. These techniques will include an informal consultation procedure initiated by the DE after the close of the comment period to alert the RA (or designee) of an upcoming decision which will be contrary to a recommendation by EPA for permit denial or project modification. The consultation will consist of such actions as telephone calls, electronic mail messages, visits, or other informal techniques. It should include a discussion of the anticipated decision and of the rationale leading to that decision. It is incumbent on EPA to ensure that any additional views regarding the action are finalized and communicated to the DE as expeditiously as possible. In specific cases, the DE and RA (or designee) may determine that the informal consultation should include the applicant. If the applicant is not included, and the consultation results in any substantive action on the application, the DE will inform the applicant of the substance of the consultation and will provide the opportunity for the applicant to comment. Such consultation will occur immediately after the close of the comment period and prior to the DE's Notice of Intent to Issue a permit. This consultation will not affect the time requirements specified in other parts of this MOA or in 33 CFR 320-330.

d. If at the conclusion of the consultation identified at 6.c. above, the DE subsequently finds the proposed permit is in the public interest and complies with the Section 404(b)(1) Guidelines, and intends to issue the permit over EPA objections or to issue it without conditions specified by EPA, he will so notify EPA. When requested by the RA within 7 calender days of such notification, the DE will not issue a Notice of Intent letter until after the RA has had the opportunity to discuss the application with the appropriate Division Engineer during the regular meetings identified at subparagraph 6.e. If no regular meeting has been scheduled within 14 calendar days of the RA's request to delay the Notice of Intent letter and no special meeting or conference call occurs where there has been a reasonable opportunity for discussion within such 14 days, the DE may proceed to issue his Notice of Intent letter pursuant to subparagraph 7.c.

e. Frequent and regular meetings (it is suggested they be monthly, but sooner if appropriate to expedite the permit process) will be scheduled between the RA and Division Engineer by mutual agreement, to discuss issues of mutual interest including problems involving individual permit decisions or patterns of concern such as consistently inappropriate comment letters or regular misinterpretation of the Section 404(b)(1) Guidelines, to ensure proper coordination on enforcement matters, to review the nature and frequency of letters of intent to elevate, and to monitor program implementation to minimize duplication and red tape. This consultation is intended to reduce potential delays in the permit process by raising major issues to the RA/Division Engineer level during the permit process, thereby shortening or eliminating the time required for additional consultation and review.

f. The agencies agree to cooperate fully in the transfer of all information necessary for the agencies to carry out their respective responsibilities. In special cases involving copying of voluminous documentation the parties shall make mutually agreeable arrangements to ensure prompt and effective transfer of required information.

g. Both parties will take the internal measures necessary to assure that the letter and spirit of this agreement are understood at all levels within their agency.

Procedures for Referral:

a. General: In the vast majority of cases, the entire process of consultation and referral outlined in this paragraph, when activated, should be completed within 90 calendar days of the DE's Notice of Intent to Issue a permit; in no cases should the process exceed 120 calendar days.

b. If during the comment period EPA recommends that a proposed permit be denied or that the activity be modified as a condition of the permit and the matter has not been resolved under the consultation process provided at subparagraphs 6.c. through 6.e. above, the DE will so notify the RA by letter (Notice of Intent to Issue) and will defer final action pending completion of the procedures in subparagraphs 7.c. and 7.d. The DE's letter to the RA will include a brief summary of how EPA's comments were considered, together with a copy of the DE's findings in support of the decision.

c. Within 20 working days of the DE's Notice of Intent to Issue, if the case has not been resolved to the satisfaction of the AAEA and he determines that it meets the criteria in paragraph 5.b., the AAEA may request of the Assistant Secretary of the Army (Civil Works) (ASA(CW)) that the permit decision be made at a higher level in the Department of the Army. This request will be written, cite the issues invoved as stated at subparagraph 5.b., and describe:

   1) the affected natural resource;

   2) the impacts of the applicant's proposed project on such resources; and

   3) where the request is based on insufficient interagency coordination, the coordination problem, including when applicable, a discussion of why he believes the DE's response is inadequate with respect to project compliance with the Section 404(b)(1) Guidelines.

d. Within 15 working days of the date of the letter of the AAEA, the ASA(CW) will decide whether or not the permit decision will be made at a level higher than the DE and, if so, at what level the final decision will be made. He will notify in writing the agency officials involved. Should the ASA(CW) decide that the permit decision will not be made at a higher level, he will respond to the AAEA in writing presenting the results of his evaluation which will include a discussion of the following:

   1) the issues raised by the AAEA under subparagraph 7.c.;

   2) his position on these issues and supporting bases; and

   3) any administrative action taken by the ASA(CW) to improve program implementation which resulted from the AAEA request.

e. Each agency will ensure that all letters to the other agency required by this paragraph will be received within one day of signature using messenger, electronic transmittal or other appropriate means.

f. EPA and the Department of the Army desire to avoid the use of duplicative review mechanisms. A permit decision will not be subject to the referral process when the Department of the Army and EPA agree in advance that an adequate separate review mechanism exists and has been invoked.

3. For any permit where EPA has invoked the referral procedures of paragraph 7 and where at the end of such procedures Army intends to issue the permit in a form that does not meet all of EPA's objections, the ASA(CW) will so notify the AAEA in writing. This letter will include the discussion required in subparagraph 7.d. To assist the EPA in reaching a decision on whether to exercise its Section 404(c) authority, the ASA(CW) will also provide a copy of the Statement of Findings/Record of Decision prepared in support of the permit decision. The permit shall not be issued during a period of 10 working days after such notice unless it contains a condition that no activity may take place pursuant to the permit until such 10th day or, if EPA has initiated a Section 404(c) proceeding during such 10 day period, until the Section 404(c) proceeding is concluded and subject to the final determination in such proceeding.

This agreement is effective immediately upon the last signature date below and will continue in effect until modified or revoked by agreement of both parties, or revoked by either party alone upon six months written notice.

0. The Memorandum of Agreement between the Administrator of EPA and the Secretary of the Army on permit processing dated July 7, 1982 is terminated. Those permit applications which have already been referred to the ASA(CW) under the July 7, 1982 MOA shall be processed according to its terms. Those permit applications for which Notices of Intent to Issue have been sent by the DE since 20 days prior to the effective date of this MOA, but which have not yet been referred to the ASA(CW) shall be governed by this agreement, except that the time periods specified in subparagraphs 7.c. and 7.d. shall run from the date of this agreement rather than from the date of the DE's letter.

Lee M. Thomas
Administrator of the Environmental Protection Agency

Nov 6, 1985
Date

John O. Marsh, Jr.
Secretary of the Army

12 NOV 1985
Date

MEMORANDUM OF AGREEMENT BETWEEN THE DEPARTMENT OF COMMERCE AND THE DEPARTMENT OF THE ARMY

1. Authority: Section 404(q) of the Clean Water Act. (33 USC 1344(q)).

2. Purpose: The purpose of this agreement is to establish policies and procedures to implement Section 404(q) of the Clean Water Act to "minimize, to the maximum extent practicable, duplication, needless paperwork and delays in the issuance of permits."

3. Applicability: This agreement shall apply to applications for permits to be issued by the Department of the Army under:

   a. Section 10 of the River and Harbor Act of 1899.

   b. Section 404 of the Clean Water Act.

   c. Section 103 of the Marine Protection, Research and Sanctuaries Act, except as pertains to compliance with EPA established ocean dumping criteria.

4. General rules: Policy and procedures for review of permit applications are established in 33 CFR 320 through 330.

5. Policy for Interagency Coordination:

   a. The final permit decision will be made by the District Engineer (DE) in the vast majority of cases, and the need for reopening the record of a case developed by the DE will be minimized.

   b. The Administrator, National Oceanic and Atmospheric Administration (NOAA) will request review of a district engineer's decision only when the Administrator finds that (1) the case involves the development of significant new information, (2) there is necessity for policy-level review of issues of national significance, or (3) there has been insufficient interagency coordination at the district level.

If full consideration to the recommendations of NOAA, including recommended permit conditions, is not given by the DE, it will constitute insufficient coordination at the district level. This may result in a request for elevation when, in the opinion of the Administrator, NOAA, the project would result in sufficient adverse environmental effects to warrant such a request.

In all these instances, the Administrator, NOAA will state how the matters of concern are clearly within the Department of Commerce's (DOC) authority.

c. For projects of other Federal agencies, Army and DOC will accept, where appropriate and legally permissible, the environmental documentation and decisions of those agencies.

d. Where DOC is the applicant, DOC will be the lead agency for environmental documentation. Both agencies will cooperate fully in early and continuing coordination during development of projects, environmental documentation, and public involvement processes, including joint public notices and, if required, joint hearings. As referenced in paragraph 5.c., the Army will, where appropriate and legally permissible, accept DOC's findings on all environmental and regulatory matters or activities requiring an Army permit.

6. Procedures at the initial decisionmaking levels:

a. The National Marine Fisheries Service (NMFS) will be the point of contact for initial level coordination at DOC.

b. In order to be eligible for referral under the procedures provided for under paragraph 7, DOC comment letters including recommended permit denial letters, letters recommending project modifications, or requests for extensions of the comment period, shall be signed by the Regional Director (RD) or a specified designee (such designee will not be below the level of Division Director). Where the RD has delegated such signature authority to a regional official, the RD shall provide in writing, to each Division and District Engineer in the region, the title of the designated official.

c. The DE will take reasonable steps to ensure that public notices are promptly transmitted to the appropriate NMFS office. NMFS will submit its comments, if any, during the basic comment period specified in the public notice. NMFS will comment only on matters clearly and directly within its authority. Where the basic comment period is less than 30 calendar days, the DE shall upon request of the RD or designee extend the comment period to 30 calendar days. Otherwise, extensions of the basic or extended comment period will be authorized only upon written request to the DE from the RD or designee. The request must be received during the comment period sought to be extended and must provide the reason for the extension. The DE will respond in writing to the request within five calendar days of the date of the letter of request. Transmittal provisions of paragraph 7.f. will apply to this response.

d. The DE's and RD's will develop local procedures at the field level to resolve differences, where possible, prior to the Notice of Intent to Issue. These local procedures will include informal consultation, initiated by the DE, after the close of the comment period to alert the RD or designee of an upcoming decision which will be contrary to a recommendation by NMFS for permit or project modification. At the request of the RD or designee, consultations will consist of such actions as telephone calls, electronic mail messages, visits, meetings, or other actions. The consultation period should not exceed 10 working days from the time the DE initiates the consultation unless the DE extends it and will include a discussion of the anticipated decision and of the rationale leading to that decision. It is incumbent on NMFS to ensure that any additional views regarding the action are finalized and communicated to the DE as expeditiously as possible. In specific cases, the DE and RD or designee may determine that the informal consultation should include the applicant. If the applicant is not included, and the consultation results in any substantive action on the application, the DE or designee will inform the applicant of the substance of the consultation and will provide the opportunity for the applicant to comment. This consultation will not affect the time requirements specified in other parts of this MOA or in 33 CFR 320-330.

e. If, at the conclusion of the consultation identified at 6.d. above, the DE intends to issue the permit over NMFS's objections or to issue it without conditions recommended by NMFS, the DE will formally notify the RD. When requested by the RD within 7 calendar days of such notification, the DE will not issue a Notice of Intent until after the RD has had the opportunity to discuss the application with the appropriate Division Engineer during a mutually agreed to meeting. If no meeting has been scheduled within 14 calendar days of the RD's request to delay the Notice of Intent letter and no conference call occurs where there has been a reasonable opportunity for discussion within such 14 days, the DE may proceed to issue the Notice of Intent letter pursuant to subparagraph 7.c.

f. Meetings may be scheduled between the RD and Division Engineer as necessary to discuss issues of mutual interest including problems involving individual permit decisions or patterns of concern such as the consistency and appropriateness of comment letters, to ensure proper coordination on enforcement matters, to review the nature and frequency of elevation requests, and to monitor program implementation to minimize duplication and red tape. This consultation is intended to reduce potential delays in the permit process by raising major issues to the RD/Division Engineer level during the permit process thereby shortening or eliminating the time required for additional consultation and review.

g. The agencies agree to cooperate fully in the transfer of all information necessary for the agencies to carry out their respective responsibilities. In special cases requiring copying of voluminous documentation, the parties shall make mutually agreeable arrangements to ensure prompt and effective transfer of required information.

h. Both parties will transmit this document to their DE's and RD's and will take the internal measures necessary to assure that the letter and spirit of this agreement are understood at all levels within their agency.

7. Procedures for Referral:

a. General. In the vast majority of cases, the entire process of consultation and referral outlined in this paragraph, when activated, should be completed within 90 calendar days of the DE's notice of intent to issue a permit; in no cases should the elevation process exceed 120 calendar days.

b. If during the comment period, NMFS recommends that a proposed permit be denied or that the activity be modified as a condition of the permit and the matter has not been resolved under the consultation process provided at subparagraphs 6.c. through 6.f. above, the DE will so notify the RD by letter (Notice of Intent to Issue) and will defer final action pending completion of the procedures in subparagraphs 7.c. and 7.d. The DE's letter to the RD will include a brief summary of how NMFS comments were considered, together with a copy of the Statement of Findings of the DE in support of his decision.

c. Within 20 working days of the DE's Notice of Intent to Issue, if the case has not been resolved to the satisfaction of the Administrator, NOAA and the Administrator determines that it meets the criteria in paragraph 5.b., the Administrator, NOAA may request of the Assistant Secretary of the Army (Civil Works) (ASA(CW)) that the permit decision be made at a higher level in the Department of the Army. The Administrator, NOAA will identify those items of the district engineer's statement of findings with which NOAA takes issue including items relating to:

(1) the affected fish and wildlife resources;

(2) the impacts of the applicant's proposed project on such resources;

(3) the net resource losses expected by project implementation as proposed by the district engineer and why the DE's proposals will not offset environmental losses;

(4) the mitigation proposed by the NMFS and how NMFS's proposal will offset environmental losses.

(5) specify in what ways the mitigation recommended by the NMFS did not receive full consideration in the DE's decision.

The Administrator, NOAA will also state the way in which acceptance of the Administrator's, NOAA, recommendations would result in a better decision.

d. Within 15 working days of the date of the letter of the Administrator, NOAA, the ASA(CW) will decide whether or not the permit decision will be made at a level higher than the DE and, if so, at what level the final decision will be made. The ASA(CW) will notify in writing the agency officials involved. Should the ASA(CW) decide that the permit decision will not be made at a higher level, the ASA(CW) will respond to the Administrator, NOAA in writing presenting the results of the evaluation. The ASA(CW) notification will include specific discussions of each of the items with which the Administrator, NOAA took issue. The ASA(CW) will state Army's position (concurrence or nonconcurrence) with the Administrator, NOAA's positions on each of these items, and will include relevant supporting data. The parties acknowledge that the final determination of mitigation is the responsiblity of the Corps.

e. The official designated by the ASA(CW) to decide a referred case will reach a decision within the time specified in paragraph 7.a. above and will immediately notify the applicant and appropriate officials of both agencies. The Statement of Findings of the deciding official will include a discussion of items raised by the Administrator and will be furnished to the Administrator by the ASA(CW).

f. Each agency will ensure that all letters and other notifications to the other agency as required by this paragraph will be received within one day of signature using messenger, electronic transmittal or other appropriate means.

g. DOC and Army desire to avoid the use of duplicative review mechanisms. A permit decision will not be subject to the elevation process when Army and DOC agree in advance that an adequate separate review mechanism exists and has been invoked.

8. This agreement is effective immediately upon the last signature date below and will continue in effect until modified or revoked by agreement of both parties, or revoked by either party alone upon 30 days written notice.

9. The Memorandum of Agreement between the Secretary of DOC and the Secretary of the Army on permit processing dated July 2, 1982, is terminated. Those permit applications which have already been referred to the ASA(CW) under the July 2, 1982, MOA shall be processed according to its terms. Those permit applications for which Notices of Intent to Issue have been sent by the DE within 20 days prior to the effective date of this MOA, but which have not yet been referred to the ASA(CW) shall be governed by this agreement, except that the time periods specified in subparagraphs 7.c. and 7.d. shall run from the date of this agreement rather than from the date of the DE's letter.

Malcolm Baldrige
Secretary of Commerce

MAR 03 1986
Date

John O. Marsh Jr.
Secretary of the Army

25 March '86
Date

Anthony J. Calio
Administrator, National Oceanic and Atmospheric Administration

2/18/86
Date

Assistant Secretary of the Army (Civil Works)

1/17/86
Date

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

MAY - 5 1986

F/SER1:RJH
(813) 893-3503

Colonel Eugene S. Witherspoon
District Engineer, New Orleans District
Department of the Army, Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

Dear Colonel Witherspoon:

Please reference the new Memorandum of Agreement (MOA) between the Departments of the Army and Commerce regarding Section 404(q) of the Clean Water Act. In accordance with Paragraph 6.b., I am notifying you of my designee for signature authority on letters of comment and extensions of comment period. The regional official I have designated to have that authority is Richard J. Hoogland, Assistant Regional Director for Habitat Conservation.

Regarding Paragraph 6.d. of the MOA requiring joint development of local procedures to resolve differences, I feel it is prudent that the initial attempts be conducted between the personnel most knowledgeable of the local issues. This would be your Regulatory Functions Chief and our Area Office Supervisor. I would appreciate your views on this matter. Mr. Hoogland or I will gladly get involved and meet with you personally should there be any complications.

We are looking forward to coordinating with you under the new MOA and are optimistic that our working relationship will continually improve.

Sincerely yours,

Jack T. Brawner
Regional Director

JOINT AGREEMENT BETWEEN THE COASTAL
MANAGEMENT DIVISION OF THE DEPARTMENT OF NATURAL RESOURCES
AND THE U. S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT

PURPOSE

This Joint Agreement details the manner in which the Regulatory Functions Branch of the New Orleans District Corps of Engineers (COE) and the Coastal Management Division of the Department of Natural Resources (CMD/DNR), State of Louisiana have established a joint public notice system to process permit applications for activities in those areas coincident to both the New Orleans District and the Louisiana Coastal Zone.

PROCEDURES

The agreement dictates that the New Orleans District will utilize the State's public notice system by having the Coastal Management Division publish and distribute public notices for permit applications submitted to the Corps of Engineers for all the subject activities in the coincident areas. The CMD/DNR will send a copy of applicable permit applications via express mail service to the Regulatory Functions Branch, New Orleans District. For those activities determined to need a permit, a permit application number will be given and the CMD/DNR will be notified telephonically of the permit number.

When required, a joint public notice will be printed and distributed to each name on the CMD/DNR mailing list.

REIMBURSEMENT

CMD/DNR will be reimbursed for the cost of printing and mailing of public notices on the following basis:

a. Joint CMD/DNR - Corps public notices - The COE shall share the cost based on the percentage of additional cost incurred by CMD/DNR to print and distribute public notices compared to the previous cost for the public notice program. These expenses will include cost of express mail, clerical salaries, and other incidential costs, provided CMD/DNR and the COE agree on the basis of unit and hourly costs and that the costs are the result of increased work loads to CMD/DNR because of the joint public notice program. This amount cannot exceed $200,000 annually, the approximate cost to the New Orleans District for: 1) printing and mailing public notices for applications of activities in the coastal zone, and 2) the Joint Public Notice Coordinator and Student Aid positions. In the event that the number of permit applications submitted and effects of inflation cause the annual cost to exceed $200,000 this agreement may be re-negotiated.

b. CMD/DNR public notices - The COE shall not participate in cost sharing for public notice printing and mailing exclusively for CMD/DNR public notices.

c. Corps public notices - The COE shall reimburse the state for the full cost of printing and mailing of Corp's public notices.

d. Joint Public Notice Coordinator - The COE shall reimburse the State for the full cost of the Joint Public Notice Coordinator service contract and/or Civil Service, and Student Aid positions.

Initially Regulatory Functions Branch will fill out and send a DA form 2544 to CMD/DNR. This form will show the amount of money to be committed for the fiscal year. For subsequent years, additional forms will be sent. The 2544 will be signed by the head of the CMD/DNR as Accepting Officer thus accepting the order and a copy returned to the Finance and Accounting Office.

Next the CMD/DNR will submit a bill to the Finance and Accounting Office, New Orleans District on a monthly basis. The bill will be processed within the District and a check will be made out to the State of Louisiana and sent to the Department of Natural Resources ATTN Chief Accountant. The bill must include the total dollar amount, number of manhours, and number of public notices and number of copies of each notice distributed (joint and Corps-only notices).

EFFECTIVE DATE AND TERMINATION

This agreement will be effective when signed, and may be terminated at any time by mutual consent of the parties here to or by either party after 60 days notice of intent to terminate. Signed this 1 day of August 1985.

B. Jim Porter
Department of Natural Resources

Eugene S. Witherspoon
Colonel, Corps of Engineers
District Engineer

APPENDIX D

GUIDELINES FOR SPECIFICATION OF DISPOSAL SITES FOR DREDGED OR FILL MATERIAL

pursuant to
Section 404(b)(1) of the Federal Water Pollution Control Act

(5) Disposal of these vessels shall take place in a site designated on current nautical charts for the disposal of wrecks or no closer than 22 kilometers (12 miles) from the nearest land and in water no less than 50 fathoms (300 feet) deep, and all necessary measures shall be taken to insure that the vessels sink to the bottom rapidly and that marine navigation is not otherwise impaired.

(6) Disposal shall not take place in established shipping lanes unless at a designated wreck site, nor in a designated marine sanctuary, nor in a location where the hulk may present a hazard to commercial trawling or national defense (see 33 CFR Part 205).

(7) Except in emergency situations, as determined by the U.S. Army Corps of Engineers and/or the U.S. Coast Guard, disposal of these vessels shall be performed during daylight hours only.

(8) Except in emergency situations, as determined by the U.S. Army Corps of Engineers and/or the District Commander of the U.S. Coast Guard, the Captain-of-the-Port (COTP), U.S. Coast Guard, and the EPA Regional Administrator shall be notified forty-eight (48) hours in advance of the proposed disposal. In addition, the COTP and the EPA Regional Administrator shall be notified by telephone at least twelve (12) hours in advance of the vessel's departure from port with such details as the proposed departure time and place, disposal site location, estimated time of arrival on site, and the name and communication capability of the towing vessel. Schedule changes are to be reported to the COTP as rapidly as possible.

(9) The National Ocean Survey, NOAA, 6010 Executive Blvd., Rockville, MD 20852, shall be notified in writing, within 1 week, of the exact coordinates of the disposal site so that it may be marked on appropriate charts.

PART 230—SECTION 404(b)(1) GUIDELINES FOR SPECIFICATION OF DISPOSAL SITES FOR DREDGED OR FILL MATERIAL

Subpart A—General

Subpart B—Compliance With the Guidelines

Subpart C—Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem

Subpart D—Potential Impacts on Biological Characteristics of the Aquatic Ecosystem

Subpart E—Potential Impacts on Special Aquatic Sites

Subpart F—Potential Effects on Human Use Characteristics

AUTHORITY: Secs. 404(b) and 501(a) of the Clean Water Act of 1977 (33 U.S.C. 1344(b) and 1361(a)).

SOURCE: 45 FR 85344, Dec. 24, 1980, unless otherwise noted.

Subpart A—General

§ 230.1 Purpose and policy.

(a) The purpose of these Guidelines is to restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of discharges of dredged or fill material.

(b) Congress has expressed a number of policies in the Clean Water Act. These Guidelines are intended to be consistent with and to implement those policies.

(c) Fundamental to these Guidelines is the precept that dredged or fill material should not be discharged into the aquatic ecosystem, unless it can be demonstrated that such a discharge will not have an unacceptable adverse impact either individually or in combination with known and/or probable impacts of other activities affecting the ecosystems of concern.

(d) From a national perspective, the degradation or destruction of special aquatic sites, such as filling operations in wetlands, is considered to be among the most severe environmental impacts covered by these Guidelines. The guiding principle should be that degradation or destruction of special sites may represent an irreversible loss of valuable aquatic resources.

§ 230.2 Applicability.

(a) These Guidelines have been developed by the Administrator of the Environmental Protection Agency in conjunction with the Secretary of the Army acting through the Chief of Engineers under section 404(b)(1) of the Clean Water Act (33 U.S.C. 1344). The Guidelines are applicable to the specification of disposal sites for discharges of dredged or fill material into waters of the United States. Sites may be specified through:

(1) The regulatory program of the U.S. Army Corps of Engineers under sections 404(a) and (e) of the Act (see 33 CFR Parts 320, 323 and 325);

(2) The civil works program of the U.S. Army Corps of Engineers (see 33 CFR 209.145 and section 150 of Pub. L. 94-587, Water Resources Development Act of 1976);

(3) Permit programs of States approved by the Administrator of the Environmental Protection Agency in accordance with section 404(g) and (h) of the Act (see 40 CFR Parts 122, 123 and 124);

(4) Statewide dredged or fill material regulatory programs with best management practices approved under section 208(b)(4)(B) and (C) of the Act (see 40 CFR 35.1560);

(5) Federal construction projects which meet criteria specified in section 404(r) of the Act.

(b) These Guidelines will be applied in the review of proposed discharges of dredged or fill material into navigable waters which lie inside the baseline from which the territorial sea is measured, and the discharge of fill material into the territorial sea, pursuant to the procedures referred to in paragraphs (a)(1) and (2) of this section.

The discharge of dredged material into the territorial sea is governed by the Marine Protection, Research, and Sanctuaries Act of 1972, Pub. L. 92-532, and regulations and criteria issued pursuant thereto (40 CFR Parts 220 through 228).

(c) Guidance on interpreting and implementing these Guidelines may be prepared jointly by EPA and the Corps at the national or regional level from time to time. No modifications to the basic application, meaning, or intent of these Guidelines will be made without rulemaking by the Administrator under the Administrative Procedure Act (5 U.S.C. 551 *et seq.*).

§ 230.3 Definitions.

For purposes of this part, the following terms shall have the meanings indicated:

(a) The term "Act" means the Clean Water Act (also known as the Federal Water Pollution Control Act or FWPCA) Pub. L. 92-500, as amended by Pub. L. 95-217, 33 U.S.C. 1251, *et seq.*

(b) The term "adjacent"means bordering, contiguous, or neighboring. Wetlands separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes, and the like are "adjacent wetlands."

(c) The terms "aquatic environment" and "aquatic ecosystem" mean waters of the United States, including wetlands, that serve as habitat for interrelated and interacting communities and populations of plants and animals.

(d) The term "carrier of contaminant" means dredged or fill material that contains contaminants.

(e) The term "contaminant" means a chemical or biological substance in a form that can be incorporated into, onto or be ingested by and that harms aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment, and includes but is not limited to the substances on the 307(a)(1) list of toxic pollutants promulgated on January 31, 1978 (43 FR 4109).

(f)—(g) [Reserved]

(h) The term "discharge point" means the point within the disposal site at which the dredged or fill material is released.

(i) The term "disposal site" means that portion of the "waters of the United States" where specific disposal activities are permitted and consist of a bottom surface area and any overlying volume of water. In the case of wetlands on which surface water is not present, the disposal site consists of the wetland surface area.

(j) [Reserved]

(k) The term "extraction site" means the place from which the dredged or fill material proposed for discharge is to be removed.

(l) [Reserved]

(m) The term "mixing zone" means a limited volume of water serving as a zone of initial dilution in the immediate vicinity of a discharge point where receiving water quality may not meet quality standards or other requirements otherwise applicable to the receiving water. The mixing zone should be considered as a place where wastes and water mix and not as a place where effluents are treated.

(n) The term "permitting authority" means the District Engineer of the U.S. Army Corps of Engineers or such other individual as may be designated by the Secretary of the Army to issue or deny permits under section 404 of the Act; or the State Director of a permit program approved by EPA under section 404(g) and section 404(h) or his delegated representative.

(o) The term "pollutant" means dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials not covered by the Atomic Energy Act, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. The legislative history of the Act reflects that "radioactive materials" as included within the definition of "pollutant" in section 502 of the Act means only radioactive materials which are not encompassed in the definition of source, byproduct, or special nuclear materials as defined by the Atomic Energy Act of 1954, as amended, and regulated under the Atomic Energy Act. Examples of radioactive materials not covered by the Atomic Energy Act and, therefore, included within the term "pollutant", are radium and accelerator produced isotopes. See *Train* v. *Colorado Public Interest Research Group, Inc.*, 426 U.S. 1 (1976).

(p) The term "pollution" means the man-made or man-induced alteration of the chemical, physical, biological or radiological integrity of an aquatic ecosystem.

(q) The term "practicable" means available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

(q-1) "Special aquatic sites" means those sites identified in Subpart E. They are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region. (See § 230.10(a)(3))

(r) The term "territorial sea" means the belt of the sea measured from the baseline as determined in accordance with the Conventon on the Territorial Sea and the Contiguous Zone and extending seaward a distance of three miles.

(s) The term "waters of the United States" means:

(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(2) All interstate waters including interstate wetlands;

(3) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:

(i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or

(ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(iii) Which are used or could be used for industrial purposes by industries in interstate commerce;

(4) All impoundments of waters otherwise defined as waters of the United States under this definition;

(5) Tributaries of waters identified in paragraphs (s)(1) through (4) of this section;

(6) The territorial sea;

(7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11(m) which also meet the criteria of this definition) are not waters of the United States.

(t) The term "wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

§ 230.4 Organization.

The Guidelines are divided into eight subparts. Subpart A presents those provisions of general applicability, such as purpose and definitions. Subpart B establishes the four conditions which must be satisfied in order to make a finding that a proposed discharge of dredged or fill material complies with the Guidelines. Section 230.11 of Subpart B, sets forth factual determinations which are to be considered in determining whether or not a proposed discharge satisfies the Subpart B conditions of compliance. Subpart C describes the physical and chemical components of a site and provides guidance as to how proposed discharges of dredged or fill material may affect these components. Subparts D through F detail the special characteristics of particular aquatic ecosystems in terms of their values, and the possible loss of these values due to discharges of dredged or fill material. Subpart G prescribes a number of physical, chemical, and biological evaluations and testing procedures to be used in reaching the required factual determinations. Subpart H details the means to prevent or mimimize adverse effects. Subpart I concerns advanced identification of disposal areas.

§ 230.5 General procedures to be followed.

In evaluating whether a particular discharge site may be specified, the permitting authority should use these Guidelines in the following sequence:

(a) In order to obtain an overview of the principal regulatory provisions of the Guidelines, review the restrictions on discharge in § 230.10(a) through (d), the measures to mimimize adverse impact of Subpart H, and the required factual determinations of § 230.11.

(b) Determine if a General permit (§ 230.7) is applicable; if so, the applicant needs merely to comply with its terms, and no further action by the permitting authority is necessary. Special conditions for evaluation of proposed General permits are contained in § 230.7. If the discharge is not covered by a General permit:

(c) Examine practicable alternatives to the proposed discharge, that is, not discharging into the waters of the U.S. or discharging into an alternative aquatic site with potentially less damaging consequences (§ 230.10(a)).

(d) Delineate the candidate disposal site consistent with the criteria and evaluations of § 230.11(f).

(e) Evaluate the various physical and chemical components which characterize the non-living environment of the candidate site, the substrate and the water including its dynamic characteristics (Subpart C).

(f) Identify and evaluate any special or critical characteristics of the candidate disposal site, and surrounding areas which might be affected by use of such site, related to their living communities or human uses (Subparts D, E, and F).

(g) Review Factual Determinations in § 230.11 to determine whether the information in the project file is sufficient to provide the documentation required by § 230.11 or to perform the pre-testing evaluation described in § 230.60, or other information is necessary.

(h) Evaluate the material to be discharged to determine the possibility of chemical contamination or physical incompatibility of the material to be discharged (§ 230.60).

(i) If there is a reasonable probability of chemical contamination, conduct the appropriate tests according to the section on Evaluation and Testing (§ 230.61).

(j) Identify appropriate and practicable changes to the project plan to minimize the environmental impact of the discharge, based upon the specialized methods of minimization of impacts in Subpart H.

(k) Make and document Factual Determinations in § 230.11.

(l) Make and document Findings of Compliance (§ 230.12) by comparing Factual Determinations with the requirements for discharge of § 230.10.

This outline of the steps to follow in using the Guidelines is simplified for purposes of illustration. The actual process followed may be iterative, with the results of one step leading to a reexamination of previous steps. The permitting authority must address all of the relevant provisions of the Guidelines in reaching a Finding of Compliance in an individual case.

§ 230.6 Adaptability.

(a) The manner in which these Guidelines are used depends on the physical, biological, and chemical nature of the proposed extraction site, the material to be discharged, and the candidate disposal site, including any other important components of the ecosystem being evaluated. Documentation to demonstrate knowledge about the extraction site, materials to be extracted, and the candidate disposal site is an essential component of guideline application. These Guidelines allow evaluation and documentation for a variety of activities, ranging from those with large, complex impacts on the aquatic environment to those for which the impact is likely to be innocuous. It is unlikely that the Guidelines will apply in their entirety to any one activity, no matter how complex. It is anticipated that substantial numbers of permit applications will be for minor, routine activities that have little, if any, potential for significant degradation of the aquatic environment. It generally is not intended or expected that extensive testing, evaluation or analysis will be needed to make findings of compliance in such routine cases. Where the conditions for General permits are met, and where numerous applications for similar activities are likely, the use of General permits will eliminate repetitive evaluation and documentation for individual discharges.

(b) The Guidelines user, including the agency or agencies responsible for implementing the Guidelines, must recognize the different levels of effort that should be associated with varying degrees of impact and require or prepare commensurate documentation. The level of documentation should reflect the significance and complexity of the discharge activity.

(c) An essential part of the evaluation process involves making determinations as to the relevance of any portion(s) of the Guidelines and conducting further evaluation only as needed. However, where portions of the Guidelines review procedure are "short form" evaluations, there still must be sufficient information (including consideration of both individual and cumulative impacts) to support the decision of whether to specify the site for disposal of dredged or fill material and to support the decision to curtail or abbreviate the evaluation process. The presumption against the discharge in § 230.1 applies to this decision-making.

(d) In the case of activities covered by General permits or section 208(b)(4)(B) and (C) Best Management Practices, the analysis and documentation required by the Guidelines will be performed at the time of General permit issuance or section 208(b)(4)(B) and (C) Best Management Practices promulgation and will not be repeated when activities are conducted under a General permit or section 208(b)(4)(B) and (C) Best Management Practices control. These Guidelines do not require reporting or formal written communication at the time individual activities are initiated under a General permit or section 208(b)(4)(B) and (C) Best Management Practices. However, a particular General permit may require appropriate reporting.

§ 230.7 General permits.

(a) *Conditions for the issuance of General permits.* A General permit for a category of activities involving the discharge of dredged or fill material complies with the Guidelines if it meets the applicable restrictions on the discharge in § 230.10 and if the permitting authority determines that:

(1) The activities in such category are similar in nature and similar in their impact upon water quality and the aquatic environment;

(2) The activities in such category will have only minimal adverse effects when performed separately; and

(3) The activities in such category will have only minimal cumulative adverse effects on water quality and the aquatic environment.

(b) *Evaluation process.* To reach the determinations required in paragraph (a) of this section, the permitting authority shall set forth in writing an evaluation of the potential individual and cumulative impacts of the category of activities to be regulated under the General permit. While some of the information necessary for this evaluation can be obtained from potential permittees and others through the proposal of General permits for public review, the evaluation must be completed before any General permit is issued, and the results must be published with the final permit.

(1) This evaluation shall be based upon consideration of the prohibitions listed in § 230.10(b) and the factors listed in § 230.10(c), and shall include documented information supporting each factual determination in § 230.11 of the Guidelines (consideration of alternatives in § 230.10(a) are not directly applicable to General permits);

(2) The evaluation shall include a precise description of the activities to be permitted under the General permit, explaining why they are sufficiently similar in nature and in envi-

ronmental impact to warrant regulation under a single General permit based on Subparts C through F of the Guidelines. Allowable differences between activities which will be regulated under the same General permit shall be specified. Activities otherwise similar in nature may differ in environmental impact due to their location in or near ecologically sensitive areas, areas with unique chemical or physical characteristics, areas containing concentrations of toxic substances, or areas regulated for specific human uses or by specific land or water management plans (e.g., areas regulated under an approved Coastal Zone Management Plan). If there are specific geographic areas within the purview of a proposed General permit (called a draft General permit under a State 404 program), which are more appropriately regulated by individual permit due to the considerations cited in this paragraph, they shall be clearly delineated in the evaluation and excluded from the permit. In addition, the permitting authority may require an individual permit for any proposed activity under a General permit where the nature or location of the activity makes an individual permit more appropriate.

(3) To predict cumulative effects, the evaluation shall include the number of individual discharge activities likely to be regulated under a General permit until its expiration, including repetitions of individual discharge activities at a single location.

Subpart B—Compliance With the Guidelines

§ 230.10 Restrictions on discharge.

NOTE: Because other laws may apply to particular discharges and because the Corps of Engineers or State 404 agency may have additional procedural and substantive requirements, a discharge complying with the requirement of these Guidelines will not automatically receive a permit.

Although all requirements in § 230.10 must be met, the compliance evaluation procedures will vary to reflect the seriousness of the potential for adverse impacts on the aquatic ecosystems posed by specific dredged or fill material discharge activities.

(a) Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.

(1) For the purpose of this requirement, practicable alternatives include, but are not limited to:

(i) Activities which do not involve a discharge of dredged or fill material into the waters of the United States or ocean waters;

(ii) Discharges of dredged or fill material at other locations in waters of the United States or ocean waters;

(2) An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded or managed in order to fulfill the basic purpose of the proposed activity may be considered.

(3) Where the activity associated with a discharge which is proposed for a special aquatic site (as defined in Subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not "water dependent"), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge which do not involve a discharge into a special aquatic site are presumed to have less adverse impact on the aquatic ecosystem, unless clearly demostrated otherwise.

(4) For actions subject to NEPA, where the Corps of Engineers is the permitting agency, the analysis of alternatives required for NEPA environmental documents, including supplemental Corps NEPA documents, will in most cases provide the information for the evaluation of alternatives under these Guidelines. On occasion,

these NEPA documents may address a broader range of alternatives than required to be considered under this paragraph or may not have considered the alternatives in sufficient detail to respond to the requirements of these Guidelines. In the latter case, it may be necessary to supplement these NEPA documents with this additional information.

(5) To the extent that practicable alternatives have been identified and evaluated under a Coastal Zone Management program, a section 208 program, or other planning process, such evaluation shall be considered by the permitting authority as part of the consideration of alternatives under the Guidelines. Where such evaluation is less complete than that contemplated under this subsection, it must be supplemented accordingly.

(b) No discharge of dredged or fill material shall be permitted if it:

(1) Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard;

(2) Violates any applicable toxic effluent standard or prohibition under section 307 of the Act;

(3) Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, or results in likelihood of the destruction or adverse modification of a habitat which is determined by the Secretary of Interior or Commerce, as appropriate, to be a critical habitat under the Endangered Species Act of 1973, as amended. If an exemption has been granted by the Endangered Species Committee, the terms of such exemption shall apply in lieu of this subparagraph;

(4) Violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.

(c) Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States. Findings of significant degradation related to the proposed discharge shall be based upon appropriate factual determinations, evaluations, and tests required by Subparts B and G, after consideration of Subparts C through F, with special emphasis on the persistence and permanence of the effects outlined in those subparts. Under these Guidelines, effects contributing to significant degradation considered individually or collectively, include:

(1) Significantly adverse effects of the discharge of pollutants on human health or welfare, including but not limited to effects on municipal water supplies, plankton, fish, shellfish, wildlife, and special aquatic sites.

(2) Significantly adverse effects of the discharge of pollutants on life stages of aquatic life and other wildlife dependent on aquatic ecosystems, including the transfer, concentration, and spread of pollutants or their byproducts outside of the disposal site through biological, physical, and chemical processes;

(3) Significantly adverse effects of the discharge of pollutants on aquatic ecosystem diversity, productivity, and stability. Such effects may include, but are not limited to, loss of fish and wildlife habitat or loss of the capacity of a wetland to assimilate nutrients, purify water, or reduce wave energy; or

(4) Significantly adverse effects of discharge of pollutants on recreational, aesthetic, and economic values.

(d) Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem. Subpart H identifies such possible steps.

§ 230.11 Factual determinations.

The permitting authority shall determine in writing the potential short-term or long-term effects of a proposed discharge of dredged or fill material on the physical, chemical, and biological components of the aquatic environment in light of Subparts C through F. Such factual determinations shall be used in § 230.12 in making findings of compliance or non-compliance with the restrictions on discharge in § 230.10. The evaluation and testing procedures described in § 230.60 and § 230.61 of Subpart G shall be used as necessary to make, and shall be described in, such determination. The determinations of effects of each proposed discharge shall include the following:

(a) *Physical substrate determinations.* Determine the nature and degree of effect that the proposed discharge will have, individually and cumulatively, on the characteristics of the substrate at the proposed disposal site. Consideration shall be given to the similarity in particle size, shape, and degree of compaction of the material proposed for discharge and the material constituting the substrate at the disposal site, and any potential changes in substrate elevation and bottom contours, including changes outside of the disposal site which may occur as a result of erosion, slumpage, or other movement of the discharged material. The duration and physical extent of substrate changes shall also be considered. The possible loss of environmental values (§ 230.20) and actions to minimize impact (Subpart H) shall also be considered in making these determinations. Potential changes in substrate elevation and bottom contours shall be predicted on the basis of the proposed method, volume, location, and rate of discharge, as well as on the individual and combined effects of current patterns, water circulation, wind and wave action, and other physical factors that may affect the movement of the discharged material.

(b) *Water circulation, fluctuation, and salinity determinations.* Determine the nature and degree of effect that the proposed discharge will have individually and cumulatively on water, current patterns, circulation including downstream flows, and normal water fluctuation. Consideration shall be given to water chemistry, salinity, clarity, color, odor, taste, dissolved gas levels, temperature, nutrients, and eutrophication plus other appropriate characteristics. Consideration shall also be given to the potential diversion or obstruction of flow, alterations of bottom contours, or other significant changes in the hydrologic regime. Additional consideration of the possible loss of environmental values (§§ 230.23 through 230.25) and actions to minimize impacts (Subpart H), shall be used in making these determinations. Potential significant effects on the current patterns, water circulation, normal water fluctuation and salinity shall be evaluated on the basis of the proposed method, volume, location, and rate of discharge.

(c) *Suspended particulate/turbidity determinations.* Determine the nature and degree of effect that the proposed discharge will have, individually and cumulatively, in terms of potential changes in the kinds and concentrations of suspended particulate/turbidity in the vicinity of the disposal site. Consideration shall be given to the grain size of the material proposed for discharge, the shape and size of the plume of suspended particulates, the duration of the discharge and resulting plume and whether or not the potential changes will cause violations of applicable water quality standards. Consideration should also be given to the possible loss of environmental values (§ 230.21) and to actions for minimizing impacts (Subpart H). Consideration shall include the proposed method, volume, location, and rate of discharge, as well as the individual and combined effects of current patterns, water circulation and fluctuations, wind and wave action, and other physical factors on the movement of suspended particulates.

(d) *Contaminant determinations.* Determine the degree to which the material proposed for discharge will introduce, relocate, or increase contaminants. This determination shall consider the material to be discharged, the aquatic environment at the proposed disposal site, and the availability of contaminants.

(e) *Aquatic ecosystem and organism determinations.* Determine the nature and degree of effect that the proposed discharge will have, both individually and cumulatively, on the structure and function of the aquatic ecosystem and organisms. Consideration shall be given to the effect at the proposed disposal site of potential changes in substrate characteristics and elevation, water or substrate chemistry, nutrients, currents, circulation, fluctuation, and salinity, on the recolonization and existence of indigenous aquatic organisms or communities. Possible loss of environmental values (§ 230.31), and actions to minimize impacts (Subpart H) shall be examined. Tests as described in § 230.61 (Evaluation and Testing), may be required to provide information on the effect of the discharge material on communities or populations of organisms expected to be exposed to it.

(f) *Proposed disposal site determinations.* (1) Each disposal site shall be specified through the application of these Guidelines. The mixing zone shall be confined to the smallest practicable zone within each specified disposal site that is consistent with the type of dispersion determined to be appropriate by the application of these Guidelines. In a few special cases under unique environmental conditions, where there is adequate justification to show that widespread dispersion by natural means will result in no significantly adverse environmental effects, the discharged material may be intended to be spread naturally in a very thin layer over a large area of the substrate rather than be contained within the disposal site.

(2) The permitting authority and the Regional Administrator shall consider the following factors in determining the acceptability of a proposed mixing zone:

(i) Depth of water at the disposal site;

(ii) Current velocity, direction, and variability at the disposal site;

(iii) Degree of turbulence;

(iv) Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site;

(v) Discharge vessel speed and direction, if appropriate;

(vi) Rate of discharge;

(vii) Ambient concentration of constituents of interest;

(viii) Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay, etc.) and settling velocities;

(ix) Number of discharge actions per unit of time;

(x) Other factors of the disposal site that affect the rates and patterns of mixing.

(g) *Determination of cumulative effects on the aquatic ecosystem.* (1) Cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems.

(2) Cumulative effects attributable to the discharge of dredged or fill material in waters of the United States should be predicted to the extent reasonable and practical. The permitting authority shall collect information and solicit information from other sources about the cumulative impacts on the aquatic ecosystem. This information shall be documented and considered during the decision-making process concerning the evaluation of individual permit applications, the issuance of a General permit, and monitoring and enforcement of existing permits.

(h) *Determination of secondary effects on the aquatic ecosystem.* (1) Secondary effects are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered prior to the time final section 404 action is taken by permitting authorities.

(2) Some examples of secondary effects on an aquatic ecosystem are fluctuating water levels in an impoundment and downstream associated with the operation of a dam, septic tank leaching and surface runoff from residential or commercial developments on fill, and leachate and runoff from a sanitary landfill located in waters of the U.S. Activities to be conducted on fast land created by the discharge of dredged or fill material in waters of the United States may have secondary

impacts within those waters which should be considered in evaluating the impact of creating those fast lands.

§ 230.12 Findings of compliance or non-compliance with the restrictions on discharge.

(a) On the basis of these Guidelines (Subparts C through G) the proposed disposal sites for the discharge of dredged or fill material must be:

(1) Specified as complying with the requirements of these Guidelines; or

(2) Specified as complying with the requirements of these Guidelines with the inclusion of appropriate and practicable discharge conditions (see Subpart H) to minimize pollution or adverse effects to the affected aquatic ecosystems; or

(3) Specified as failing to comply with the requirements of these Guidelines where:

(i) There is a practicable alternative to the proposed discharge that would have less adverse effect on the aquatic ecosystem, so long as such alternative

Subpart C—Potential Impacts on Physical and Chemical Characteristics of the Aquatic Ecosystem

NOTE: The effects described in this subpart should be considered in making the factual determinations and the findings of compliance or non-compliance in Subpart B.

§ 230.20 Substrate.

(a) The substrate of the aquatic ecosystem underlies open waters of the United States and constitutes the surface of wetlands. It consists of organic and inorganic solid materials and includes water and other liquids or gases that fill the spaces between solid particles.

(b) Possible loss of environmental characteristics and values: The discharge of dredged or fill material can result in varying degrees of change in the complex physical, chemical, and biological characteristics of the substrate. Discharges which alter substrate elevation or contours can result in changes in water circulation, depth, current pattern, water fluctuation and ing dredging and filling. Particulates may remain suspended in the water column for variable periods of time as a result of such factors as agitation of the water mass, particulate specific gravity, particle shape, and physical and chemical properties of particle surfaces.

(b) Possible loss of environmental characteristics and values: The discharge of dredged or fill material can result in greatly elevated levels of suspended particulates in the water column for varying lengths of time. These new levels may reduce light penetration and lower the rate of photosynthesis and the primary productivity of an aquatic area if they last long enough. Sight-dependent species may suffer reduced feeding ability leading to limited growth and lowered resistance to disease if high levels of suspended particulates persist. The biological and the chemical content of the suspended material may react with the dissolved oxygen in the water, which can result in oxygen depletion. Toxic metals and organics, pathogens, and viruses absorbed or adsorbed to fine-grained particulates in the material may become biologically available to organisms either in the water column or on the substrate. Significant increases in suspended particulate levels create turbid plumes which are highly visible and aesthetically displeasing. The extent and persistence of these adverse impacts caused by discharges depend upon the relative increase in suspended particulates above the amount occurring naturally, the duration of the higher levels, the current patterns, water level, and fluctuations present when such discharges occur, the volume, rate, and duration of the discharge, particulate deposition, and the seasonal timing of the discharge.

§ 230.22 Water.

(a) Water is the part of the aquatic ecosystem in which organic and inorganic constituents are dissolved and suspended. It constitutes part of the liquid phase and is contained by the substrate. Water forms part of a dynamic aquatic life-supporting system. Water clarity, nutrients and chemical content, physical and biological content, dissolved gas levels, pH, and temperature contribute to its life-sustaining capabilities.

(b) Possible loss of environmental characteristics and values: The discharge of dredged or fill material can change the chemistry and the physical characteristics of the receiving water at a disposal site through the introduction of chemical constituents in suspended or dissolved form. Changes in the clarity, color, odor, and taste of water and the addition of contaminants can reduce or eliminate the suitability of water bodies for populations of aquatic organisms, and for human consumption, recreation, and aesthetics. The introduction of nutrients or organic material to the water column as a result of the discharge can lead to a high biochemical oxygen demand (BOD), which in turn can lead to reduced dissolved oxygen, thereby potentially affecting the survival of many aquatic organisms. Increases in nutrients can favor one group of organisms such as algae to the detriment of other more desirable types such as submerged aquatic vegetation, potentially causing adverse health effects, objectionable tastes and odors, and other problems.

§ 230.23 Current patterns and water circulation.

(a) Current patterns and water circulation are the physical movements of water in the aquatic ecosystem. Currents and circulation respond to natural forces as modified by basin shape and cover, physical and chemical characteristics of water strata and masses, and energy dissipating factors.

(b) Possible loss of environmental characteristics and values: The discharge of dredged or fill material can modify current patterns and water circulation by obstructing flow, changing the direction or velocity of water flow, changing the direction or velocity of water flow and circulation, or otherwise changing the dimensions of a water body. As a result, adverse changes can occur in: Location, structure, and dynamics of aquatic communities; shoreline and substrate erosion and depositon rates; the deposition of suspended particulates; the rate and extent of mixing of dissolved and suspended components of the water body; and water stratification.

§ 230.24 Normal water fluctuations.

(a) Normal water fluctuations in a natural aquatic system consist of daily, seasonal, and annual tidal and flood fluctuations in water level. Biological and physical components of such a system are either attuned to or characterized by these periodic water fluctuations.

(b) Possible loss of environmental characteristics and values: The discharge of dredged or fill material can alter the normal water-level fluctuation pattern of an area, resulting in prolonged periods of inundation, exaggerated extremes of high and low water, or a static, nonfluctuating water level. Such water level modifications may change salinity patterns, alter erosion or sedimentation rates, aggravate water temperature extremes, and upset the nutrient and dissolved oxygen balance of the aquatic ecosystem. In addition, these modifications can alter or destroy communities and populations of aquatic animals and vegetation, induce populations of nuisance organisms, modify habitat, reduce food supplies, restrict movement of aquatic fauna, destroy spawning areas, and change adjacent, upstream, and downstream areas.

§ 230.25 Salinity gradients.

(a) Salinity gradients form where salt water from the ocean meets and mixes with fresh water from land.

(b) Possible loss of environmental characteristics and values: Obstructions which divert or restrict flow of either fresh or salt water may change existing salinity gradients. For example, partial blocking of the entrance to an estuary or river mouth that significantly restricts the movement of the salt water into and out of that area can effectively lower the volume of salt water available for mixing within that estuary. The downstream migration of the salinity gradient can occur, displacing the maximum sedimentation zone and requiring salinity-dependent aquatic biota to adjust to the new conditions, move to new locations if possible, or perish. In the freshwater zone, discharge operations in the upstream regions can have equally adverse impacts. A significant reduction in the volume of fresh water moving into an estuary below that which is considered normal can affect the location and type of mixing thereby changing the characteristic salinity patterns. The resulting changed circulation pattern can cause the upstream migration of the salinity gradient displacing the maximim sedimentation zone. This migration may affect those organisms that are adapted to freshwater environments. It may also affect municipal water supplies.

NOTE: Possible actions to minimize adverse impacts regarding site characteristics can be found in Subpart H.

Subpart D—Potential Impacts on Biological Characteristics of the Aquatic Ecosystem

NOTE: The impacts described in this subpart should be considered in making the factual determinations and the findings of compliance or non-compliance in Subpart B.

§ 230.30 Threatened and endangered species.

(a) An endangered species is a plant or animal in danger of extinction throughout all or a significant portion of its range. A threatened species is one in danger of becoming an endangered species in the foreseeable future throughout all or a significant portion of its range. Listings of threatened and endangered species as well as critical habitats are maintained by some individual States and by the U.S. Fish and Wildlife Service of the Department of the Interior (codified annually at 50 CFR 17.11). The Department of Commerce has authority over some threatened and endangered marine mammals, fish and reptiles.

(b) Possible loss of values: The major potential impacts on threatened or endangered species from the discharge of dredged or fill material include:

(1) Covering or otherwise directly killing species;

(2) The impairment or destruction of habitat to which these species are limited. Elements of the aquatic habitat which are particularly crucial to the

continued survival of some threatened or endangered species include adequate good quality water, spawning and maturation areas, nesting areas, protective cover, adequate and reliable food supply, and resting areas for migratory species. Each of these elements can be adversely affected by changes in either the normal water conditions for clarity, chemical content, nutrient balance, dissolved oxygen, pH, temperature, salinity, current patterns, circulation and fluctuation, or the physical removal of habitat; and

(3) Facilitating incompatible activities.

(c) Where consultation with the Secretary of the Interior occurs under section 7 of the Endangered Species Act, the conclusions of the Secretary concerning the impact(s) of the discharge on threatened and endangered species and their habitat shall be considered final.

§ 230.31 Fish, crustaceans, mollusks, and other aquatic organisms in the food web.

(a) Aquatic organisms in the food web include, but are not limited to, finfish, crustaceans, mollusks, insects, annelids, planktonic organisms, and the plants and animals on which they feed and depend upon for their needs. All forms and life stages of an organism, throughout its geographic range, are included in this category.

(b) Possible loss of values: The discharge of dredged or fill material can variously affect populations of fish, crustaceans, mollusks and other food web organisms through the release of contaminants which adversely affect adults, juveniles, larvae, or eggs, or result in the establishment or proliferation of an undesirable competitive species of plant or animal at the expense of the desired resident species. Suspended particulates settling on attached or buried eggs can smother the eggs by limiting or sealing off their exposure to oxygenated water. Discharge of dredged and fill material may result in the debilitation or death of sedentary organisms by smothering, exposure to chemical contaminants in dissolved or suspended form, exposure to high levels of suspended particulates, reduction in food supply, or alteration of the substrate upon which they are dependent. Mollusks are particularly sensitive to the discharge of material during periods of reproduction and growth and development due primarily to their limited mobility. They can be rendered unfit for human consumption by tainting, by production and accumulation of toxins, or by ingestion and retention of pathogenic organisms, viruses, heavy metals or persistent synthetic organic chemicals. The discharge of dredged or fill material can redirect, delay, or stop the reproductive and feeding movements of some species of fish and crustacea, thus preventing their aggregation in accustomed places such as spawning or nursery grounds and potentially leading to reduced populations. Reduction of detrital feeding species or other representatives of lower trophic levels can impair the flow of energy from primary consumers to higher trophic levels. The reduction or potential elimination of food chain organism populations decreases the overall productivity and nutrient export capability of the ecosystem.

§ 230.32 Other wildlife.

(a) Wildlife associated with aquatic ecosystems are resident and transient mammals, birds, reptiles, and amphibians.

(b) Possible loss of values: The discharge of dredged or fill material can result in the loss or change of breeding and nesting areas, escape cover, travel corridors, and preferred food sources for resident and transient wildlife species associated with the aquatic ecosystem. These adverse impacts upon wildlife habitat may result from changes in water levels, water flow and circulation, salinity, chemical content, and substrate characteristics and elevation. Increased water turbidity can adversely affect wildlife species which rely upon sight to feed, and disrupt the respiration and feeding of certain aquatic wildlife and food chain organisms. The availability of contaminants from the discharge of dredged or fill material may lead to the bioaccumulation of such contaminants in wildlife. Changes in such physical and chemical factors of the environment may favor the introduction of undesirable plant and animal species at the expense of resident species and communities. In some aquatic environments lowering plant and animal species diversity may disrupt the normal functions of the ecosystem and lead to reductions in overall biological productivity.

NOTE: Possible actions to minimize adverse impacts regarding characteristics of biological components of the aquatic ecosystem can be found in Subpart H.

Subpart E—Potential Impacts on Special Aquatic Sites

NOTE: The impacts described in this subpart should be considered in making the factual determinations and the findings of compliance or non-compliance in Subpart B. The definition of special aquatic sites is found in § 230.3(q-1).

§ 230.40 Sanctuaries and refuges.

(a) Sanctuaries and refuges consist of areas designated under State and Federal laws or local ordinances to be managed principally for the preservation and use of fish and wildlife resources.

(b) Possible loss of values: Sanctuaries and refuges may be affected by discharges of dredged or fill material which will:

(1) Disrupt the breeding, spawning, migratory movements or other critical life requirements of resident or transient fish and wildlife resources;

(2) Create unplanned, easy and incompatible human access to remote aquatic areas;

(3) Create the need for frequent maintenance activity;

(4) Result in the establishment of undesirable competitive species of plants and animals;

(5) Change the balance of water and land areas needed to provide cover, food, and other fish and wildlife habitat requirements in a way that modifies sanctuary or refuge management practices;

(6) Result in any of the other adverse impacts discussed in Subparts C and D as they relate to a particular sanctuary or refuge.

§ 230.41 Wetlands.

(a)(1) Wetlands consist of areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

(2) Where wetlands are adjacent to open water, they generally constitute the transition to upland. The margin between wetland and open water can best be established by specialists familiar with the local environment, particularly where emergent vegetation merges with submerged vegetation over a broad area in such places as the lateral margins of open water, headwaters, rainwater catch basins, and groundwater seeps. The landward margin of wetlands also can best be identified by specialists familiar with the local environment when vegetation from the two regions merges over a broad area.

(3) Wetland vegetation consists of plants that require saturated soils to survive (obligate wetland plants) as well as plants, including certain trees, that gain a competitive advantage over others because they can tolerate prolonged wet soil conditions and their competitors cannot. In addition to plant populations and communities, wetlands are delimited by hydrological and physical characteristics of the environment. These characteristics should be considered when information about them is needed to supplement information available about vegetation, or where wetland vegetation has been removed or is dormant.

(b) Possible loss of values: The discharge of dredged or fill material in wetlands is likely to damage or destroy habitat and adversely affect the biological productivity of wetlands ecosystems by smothering, by dewatering, by permanently flooding, or by altering substrate elevation or periodicity of water movement. The addition of dredged or fill material may destroy wetland vegetation or result in advancement of succession to dry land species. It may reduce or eliminate nutrient exchange by a reduction of the system's productivity, or by altering current patterns and velocities. Disruption or elimination of the wetland system can degrade water quality by obstructing circulation patterns that flush large expanses of wetland systems, by interfering with the filtration function of wetlands, or by changing the aquifer recharge capability of a wetland. Discharges can also change the wetland habitat value for fish and wildlife as discussed in Subpart D. When disruptions in flow and circulation patterns occur, apparently minor loss of wetland acreage may result in major losses through secondary impacts. Discharging fill material in wetlands as part of municipal, industrial or recreational development may modify the capacity of wetlands to retain and store floodwaters and to serve as a buffer zone shielding upland areas from wave actions, storm damage and erosion.

§ 230.42 Mud flats.

(a) Mud flats are broad flat areas along the sea coast and in coastal rivers to the head of tidal influence and in inland lakes, ponds, and riverine systems. When mud flats are inundated, wind and wave action may resuspend bottom sediments. Coastal mud flats are exposed at extremely low tides and inundated at high tides with the water table at or near the surface of the substrate. The substrate of mud flats contains organic material and particles smaller in size than sand. They are either unvegetated or vegetated only by algal mats.

(b) Possible loss of values: The discharge of dredged or fill material can cause changes in water circulation patterns which may permanently flood or dewater the mud flat or disrupt periodic inundation, resulting in an increase in the rate of erosion or accretion. Such changes can deplete or eliminate mud flat biota, foraging areas, and nursery areas. Changes in inundation patterns can affect the chemical and biological exchange and decomposition process occurring on the mud flat and change the deposition of suspended material affecting the productivity of the area. Changes may reduce the mud flat's capacity to dissipate storm surge runoff.

§ 230.43 Vegetated shallows.

(a) Vegetated shallows are permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as turtle grass and eelgrass in estuarine or marine systems as well as a number of freshwater species in rivers and lakes.

(b) Possible loss of values: The discharge of dredged or fill material can smother vegetation and benthic organisms. It may also create unsuitable conditions for their continued vigor by: (1) Changing water circulation patterns; (2) releasing nutrients that increase undesirable algal populations; (3) releasing chemicals that adversely affect plants and animals; (4) increasing turbidity levels, thereby reducing light penetration and hence photosynthesis; and (5) changing the capacity of a vegetated shallow to stabilize bottom materials and decrease channel shoaling. The discharge of dredged or fill material may reduce the value of vegetated shallows as nesting, spawning, nursery, cover, and forage areas, as well as their value in protecting shorelines from erosion and wave actions. It may also encourage the growth of nuisance vegetation.

§ 230.44 Coral reefs.

(a) Coral reefs consist of the skeletal deposit, usually of calcareous or silicaceous materials, produced by the vital activities of anthozoan polyps or other invertebrate organisms present in growing portions of the reef.

(b) Possible loss of values: The discharge of dredged or fill material can adversely affect colonies of reef building organisms by burying them, by releasing contaminants such as hydrocarbons into the water column, by reducing light penetration through the water, and by increasing the level of suspended particulates. Coral organisms are extremely sensitive to even slight reductions in light penetration or increases in suspended particulates. These adverse effects will cause a loss of productive colonies which in turn provide habitat for many species of highly specialized aquatic organisms.

§ 230.45 Riffle and pool complexes.

(a) Steep gradient sections of streams are sometimes characterized by riffle and pool complexes. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a coarse substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. Pools are characterized by a slower stream velocity, a steaming flow, a smooth surface, and a finer substrate. Riffle and pool complexes are particularly valuable habitat for fish and wildlife.

(b) Possible loss of values: Discharge of dredged or fill material can eliminate riffle and pool areas by displacement, hydrologic modification, or sedimentation. Activities which affect riffle and pool areas and especially riffle/pool ratios, may reduce the aeration and filtration capabilities at the discharge site and downstream, may reduce stream habitat diversity, and may retard repopulation of the disposal site and downstream waters through sedimentation and the creation of unsuitable habitat. The discharge of dredged or fill material which alters stream hydrology may cause scouring or sedimentation of riffles and pools. Sedimentation induced through hydrological modification or as a direct result of the deposition of unconsolidated dredged or fill material may clog riffle and pool areas, destroy habitats, and create anaerobic conditions. Eliminating pools and meanders by the discharge of dredged or fill material can reduce water holding capacity of streams and cause rapid runoff from a watershed. Rapid runoff can deliver large quantities of flood water in a short time to downstream areas resulting in the destruction of natural habitat, high property loss, and the need for further hydraulic modification.

NOTE: Possible actions to minimize adverse impacts on site or material characteristics can be found in Subpart H.

Subpart F—Potential Effects on Human Use Characteristics

NOTE: The effects described in this subpart should be considered in making the factual determinations and the findings of compliance or non-compliance in Subpart B.

§ 230.50 Municipal and private water supplies.

(a) Municipal and private water supplies consist of surface water or ground water which is directed to the intake of a municipal or private water supply system.

(b) Possible loss of values: Discharges can affect the quality of water supplies with respect to color, taste, odor, chemical content and suspended particulate concentration, in such a way as to reduce the fitness of the water for consumption. Water can be rendered unpalatable or unhealthy by the addition of suspended particulates, viruses and pathogenic organisms, and dissolved materials. The expense of removing such substances before the water is delivered for consumption can be high. Discharges may also affect the quantity of water available for municipal and private water supplies. In addition, certain commonly used water treatment chemicals have the potential for combining with some suspended or dissolved substances from dredged or fill material to form other products that can have a toxic effect on consumers.

§ 230.51 Recreational and commercial fisheries.

(a) Recreational and commercial fisheries consist of harvestable fish, crustaceans, shellfish, and other aquatic organisms used by man.

(b) Possible loss of values: The discharge of dredged or fill materials can affect the suitability of recreational and commercial fishing grounds as habitat for populations of consumable aquatic organisms. Discharges can result in the chemical contamination of recreational or commercial fisheries. They may also interfere with the reproductive success of recreational and commercially important aquatic species through disruption of migration and spawning areas. The introduction of pollutants at critical times in their life cycle may directly reduce populations of commercially important aquatic organisms or indirectly reduce them by reducing organisms upon which they depend for food. Any of these impacts can be of short duration or prolonged, depending upon the physical and chemical impacts of the discharge and the biological availability of contaminants to aquatic organisms.

§ 230.52 Water-related recreation.

(a) Water-related recreation encompasses activities undertaken for amusement and relaxation. Activities encompass two broad categories of use: consumptive, e.g., harvesting resources by hunting and fishing; and non-comsumptive, e.g. canoeing and sight-seeing.

(b) Possible loss of values: One of the more important direct impacts of dredged or fill disposal is to impair or destroy the resources which support recreation activities. The disposal of dredged or fill material may adversely modify or destroy water use for recreation by changing turbidity, suspended particulates, temperature, dissolved oxygen, dissolved materials, toxic materials, pathogenic organisms, quality of habitat, and the aesthetic qualities of sight, taste, odor, and color.

§ 230.53 Aesthetics.

(a) Aesthetics associated with the aquatic ecosystem consist of the perception of beauty by one or a combination of the senses of sight, hearing, touch, and smell. Aesthetics of aquatic ecosystems apply to the quality of life enjoyed by the general public and property owners.

(b) Possible loss of values: The discharge of dredged or fill material can mar the beauty of natural aquatic ecosystems by degrading water quality, creating distracting disposal sites, inducing inappropriate development, encouraging unplanned and incompatible human access, and by destroying vital elements that contribute to the compositional harmony or unity, visual distinctiveness, or diversity of an area. The discharge of dredged or fill material can adversely affect the particular features, traits, or characteristics of an aquatic area which make it valuable to property owners. Activities which degrade water quality, disrupt natural substrate and vegetational characteristics, deny access to or visibility of the resource, or result in changes in odor, air quality, or noise levels may reduce the value of an aquatic area to private property owners.

§ 230.54 Parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves.

(a) These preserves consist of areas designated under Federal and State laws or local ordinances to be managed for their aesthetic, educational, historical, recreational, or scientific value.

(b) Possible loss of values: The discharge of dredged or fill material into such areas may modify the aesthetic, educational, historical, recreational and/or scientific qualities thereby reducing or eliminating the uses for which such sites are set aside and managed.

NOTE: Possible actions to minimize adverse impacts regarding site or material characteristics can be found in Subpart H.

Subpart G—Evaluation and Testing

§ 230.60 General evaluation of dredged or fill material.

The purpose of these evaluation procedures and the chemical and biological testing sequence outlined in § 230.61 is to provide information to reach the determinations required by § 230.11. Where the results of prior evaluations, chemical and biological tests, scientific research, and experience can provide information helpful in making a determination, these should be used. Such prior results may make new testing unnecessary. The information used shall be documented. Where the same information applies to more than one determination, it may be documented once and referenced in later determinations.

(a) If the evaluation under paragraph (b) indicates the dredged or fill material is not a carrier of contaminants, then the required determinations pertaining to the presence and effects of contaminants can be made without testing. Dredged or fill material is most likely to be free from chemical, biological, or other pollutants where it is composed primarily of sand, gravel, or other naturally occurring inert material. Dredged material so composed is generally found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels. However, when such material is discolored or contains other indications that contaminants may be present, further inquiry should be made.

(b) The extraction site shall be examined in order to assess whether it is sufficiently removed from sources of pollution to provide reasonable assurance that the proposed discharge material is not a carrier of contaminants. Factors to be considered include but are not limited to:

(1) Potential routes of contaminants or contaminated sediments to the extraction site, based on hydrographic or other maps, aerial photography, or other materials that show watercourses, surface relief, proximity to tidal movement, private and public roads, location of buildings, municipal and industrial areas, and agricultural or forest lands.

(2) Pertinent results from tests previously carried out on the material at the extraction site, or carried out on similar material for other permitted projects in the vicinity. Materials shall be considered similar if the sources of contamination, the physical configuration of the sites and the sediment composition of the materials are comparable, in light of water circulation and stratification, sediment accumulation and general sediment characteristics. Tests from other sites may be relied on only if no changes have occurred at the extraction sites to render the results irrelevant.

(3) Any potential for significant introduction of persistent pesticides from land runoff or percolation;

(4) Any records of spills or disposal of petroleum products or substances designated as hazardous under section 311 of the Clean Water Act (See 40 CFR Part 116);

(5) Information in Federal, State and local records indicating significant introduction of pollutants from industries, municipalities, or other sources, including types and amounts of waste materials discharged along the potential routes of contaminants to the extraction site; and

(6) Any possibility of the presence of substantial natural deposits of minerals or other substances which could be released to the aquatic environment in harmful quantities by man-induced discharge activities.

(c) To reach the determinations in § 230.11 involving potential effects of the discharge on the characteristics of the disposal site, the narrative guidance in Subparts C through F shall be used along with the general evaluation procedure in § 230.60 and, if necessary, the chemical and biological testing sequence in § 230.61. Where the discharge site is adjacent to the extraction site and subject to the same sources of contaminants, and materials at the two sites are substantially similar, the fact that the material to be discharged may be a carrier of contaminants is not likely to result in degradation of the disposal site. In such circumstances, when dissolved material and suspended particulates can be controlled to prevent carrying pollutants to less contaminated areas, testing will not be required.

(d) Even if the § 230.60(b) evaluation (previous tests, the presence of polluting industries and information about their discharge or runoff into waters of the U.S., bioinventories, etc.) leads to the conclusion that there is a high probability that the material proposed for discharge is a carrier of contaminants, testing may not be necessary if constraints are available to reduce contamination to acceptable levels within the disposal site and to prevent contaminants from being transported beyond the boundaries of the disposal site, if such constraints are acceptable to the permitting authority and the Regional Administrator, and if the potential discharger is willing and able to implement such constraints. However, even if tests are not performed, the permitting authority must still determine the probable impact of the operation on the receiving aquatic ecosys-

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tem. Any decision not to test must be explained in the determinations made under § 230.11.

§ 230.61 Chemical, biological, and physical evaluation and testing.

NOTE: The Agency is today proposing revised testing guidelines. The evaluation and testing procedures in this section are based on the 1975 section 404(b)(1) interim final Guidelines and shall remain in effect until the revised testing guidelines are published as final regulations.

(a) No single test or approach can be applied in all cases to evaluate the effects of proposed discharges of dredged or fill materials. This section provides some guidance in determining which test and/or evaluation procedures are appropriate in a given case. Interim guidance to applicants concerning the applicability of specific approaches or procedures will be furnished by the permitting authority.

(b) *Chemical-biological interactive effects.* The principal concerns of discharge of dredged or fill material that contain contaminants are the potential effects on the water column and on communities of aquatic organisms.

(1) *Evaluation of chemical-biological interactive effects.* Dredged or fill material may be excluded from the evaluation procedures specified in paragraphs (b) (2) and (3) of this section if it is determined, on the basis of the evaluation in § 230.60, that the likelihood of contamination by contaminants is acceptably low, unless the permitting authority, after evaluating and considering any comments received from the Regional Administrator, determines that these procedures are necessary. The Regional Administrator may require, on a case-by-case basis, testing approaches and procedures by stating what additional information is needed through further analyses and how the results of the analyses will be of value in evaluating potential environmental effects.

If the General Evaluation indicates the presence of a sufficiently large number of chemicals to render impractical the identification of all contaminants by chemical testing, information may be obtained from bioassays in lieu of chemical tests.

(2) *Water column effects.* (i) Sediments normally contain constituents that exist in various chemical forms and in various concentrations in several locations within the sediment. An elutriate test may be used to predict the effect on water quality due to release of contaminants from the sediment to the water column. However, in the case of fill material originating on land which may be a carrier of contaminants, a water leachate test is appropriate.

(ii) Major constituents to be analyzed in the elutriate are those deemed critical by the permitting authority, after evaluating and considering any comments received from the Regional Administrator, and considering results of the evaluation in § 230.60. Elutriate concentrations should be compared to concentrations of the same constituents in water from the disposal site. Results should be evaluated in light of the volume and rate of the intended discharge, the type of discharge, the hydrodynamic regime at the disposal site, and other information relevant to the impact on water quality. The permitting authority should consider the mixing zone in evaluating water column effects. The permitting authority may specify bioassays when such procedures will be of value.

(3) *Effects on benthos.* The permitting authority may use an appropriate benthic bioassay (including bioaccumulation tests) when such procedures will be of value in assessing ecological effects and in establishing discharge conditions.

(c) Procedure for comparison of sites.

(1) When an inventory of the total concentration of contaminants would be of value in comparing sediment at the dredging site with sediment at the disposal site, the permitting authority may require a sediment chemical analysis. Markedly different concentrations of contaminants between the excavation and disposal sites may aid in making an environmental assessment of the proposed disposal operation. Such differences should be interpreted in terms of the potential for harm as supported by any pertinent scientific literature.

(2) When an analysis of biological community structure will be of value to assess the potential for adverse environmental impact at the proposed disposal site, a comparison of the biological characteristics between the excavation and disposal sites may be required by the permitting authority. Biological indicator species may be useful in evaluating the existing degree of stress at both sites. Sensitive species representing community components colonizing various substrate types within the sites should be identified as possible bioassay organisms if tests for toxicity are required. Community structure studies should be performed only when they will be of value in determining discharge conditions. This is particularly applicable to large quantities of dredged material known to contain adverse quantities of toxic materials. Community studies should include benthic organisms such as microbiota and harvestable shellfish and finfish. Abundance, diversity, and distribution should be documented and correlated with substrate type and other appropriate physical and chemical environmental characteristics.

(d) Physical tests and evaluation. The effect of a discharge of dredged or fill material on physical substrate characteristics at the disposal site, as well as on the water circulation, fluctuation, salinity, and suspended particulates content there, is important in making factual determinations in § 230.11. Where information on such effects is not otherwise available to make these factual determinations, the permitting authority shall require appropriate physical tests and evaluations as are justified and deemed necessary. Such tests may include sieve tests, settleability tests, compaction tests, mixing zone and suspended particulate plume determinations, and site assessments of water flow, circulation, and salinity characteristics.

Subpart H—Actions To Minimize Adverse Effects

NOTE: There are many actions which can be undertaken in response to § 203.10(d) to minimize the adverse effects of discharges of dredged or fill material. Some of these, grouped by type of activity, are listed in this subpart.

§ 230.70 Actions concerning the location of the discharge.

The effects of the discharge can be minimized by the choice of the disposal site. Some of the ways to accomplish this are by:

(a) Locating and confining the discharge to minimize smothering of organisms;

(b) Designing the discharge to avoid a disruption of periodic water inundation patterns;

(c) Selecting a disposal site that has been used previously for dredged material discharge;

(d) Selecting a disposal site at which the substrate is composed of material similar to that being discharged, such as discharging sand on sand or mud on mud;

(e) Selecting the disposal site, the discharge point, and the method of discharge to minimize the extent of any plume;

(f) Designing the discharge of dredged or fill material to minimize or prevent the creation of standing bodies of water in areas of normally fluctuating water levels, and minimize or prevent the drainage of areas subject to such fluctuations.

§ 230.71 Actions concerning the material to be discharged.

The effects of a discharge can be minimized by treatment of, or limitations on the material itself, such as:

(a) Disposal of dredged material in such a manner that physiochemical conditions are maintained and the potency and availability of pollutants are reduced.

(b) Limiting the solid, liquid, and gaseous components of material to be discharged at a particular site;

(c) Adding treatment substances to the discharge material;

(d) Utilizing chemical flocculants to enhance the deposition of suspended particulates in diked disposal areas.

§ 230.72 Actions controlling the material after discharge.

The effects of the dredged or fill material after discharge may be controlled by:

(a) Selecting discharge methods and disposal sites where the potential for erosion, slumping or leaching of materials into the surrounding aquatic ecosystem will be reduced. These sites or methods include, but are not limited to:

(1) Using containment levees, sediment basins, and cover crops to reduce erosion;

(2) Using lined containment areas to reduce leaching where leaching of chemical constituents from the discharged material is expected to be a problem;

(b) Capping in-place contaminated material with clean material or selectively discharging the most contaminated material first to be capped with the remaining material;

(c) Maintaining and containing discharged material properly to prevent point and nonpoint sources of pollution;

(d) Timing the discharge to minimize impact, for instance during periods of unusual high water flows, wind, wave, and tidal actions.

§ 230.73 Actions affecting the method of dispersion.

The effects of a discharge can be minimized by the manner in which it is dispersed, such as:

(a) Where environmentally desirable, distributing the dredged material widely in a thin layer at the disposal site to maintain natural substrate contours and elevation;

(b) Orienting a dredged or fill material mound to minimize undesirable obstruction to the water current or circulation pattern, and utilizing natural bottom contours to minimize the size of the mound;

(c) Using silt screens or other appropriate methods to confine suspended particulate/turbidity to a small area where settling or removal can occur;

(d) Making use of currents and circulation patterns to mix, disperse and dilute the discharge;

(e) Minimizing water column turbidity by using a submerged diffuser system. A similar effect can be accomplished by submerging pipeline discharges or otherwise releasing materials near the bottom;

(f) Selecting sites or managing discharges to confine and minimize the release of suspended particulates to give decreased turbidity levels and to maintain light penetration for organisms;

(g) Setting limitations on the amount of material to be discharged per unit of time or volume of receiving water.

§ 230.74 Actions related to technology.

Discharge technology should be adapted to the needs of each site. In determining whether the discharge operation sufficiently minimizes adverse environmental impacts, the applicant should consider:

(a) Using appropriate equipment or machinery, including protective devices, and the use of such equipment or machinery in activities related to the discharge of dredged or fill material;

(b) Employing appropriate maintenance and operation on equipment or machinery, including adequate training, staffing, and working procedures;

(c) Using machinery and techniques that are especially designed to reduce damage to wetlands. This may include machines equipped with devices that scatter rather than mound excavated materials, machines with specially designed wheels or tracks, and the use of mats under heavy machines to reduce wetland surface compaction and rutting;

(d) Designing access roads and channel spanning structures using culverts, open channels, and diversions that will pass both low and high water flows, accommodate fluctuating water levels, and maintain circulation and faunal movement;

(e) Employing appropriate machinery and methods of transport of the material for discharge.

§ 230.75 Actions affecting plant and animal populations.

Minimization of adverse effects on populations of plants and animals can be achieved by:

(a) Avoiding changes in water current and circulation patterns which would interfere with the movement of animals;

(b) Selecting sites or managing discharges to prevent or avoid creating habitat conducive to the development of undesirable predators or species which have a competitive edge ecologically over indigenous plants or animals;

(c) Avoiding sites having unique habitat or other value, including habitat of threatened or endangered species;

(d) Using planning and construction practices to institute habitat development and restoration to produce a new or modified environmental state of higher ecological value by displacement of some or all of the existing environmental characteristics. Habitat development and restoration techniques can be used to minimize adverse impacts and to compensate for destroyed habitat. Use techniques that have been demonstrated to be effective in circumstances similar to those under consideration wherever possible. Where proposed development and restoration techniques have not yet advanced to the pilot demonstration stage, initiate their use on a small scale to allow corrective action if unanticipated adverse impacts occur;

(e) Timing discharge to avoid spawning or migration seasons and other biologically critical time periods;

(f) Avoiding the destruction of remnant natural sites within areas already affected by development.

§ 230.76 Actions affecting human use.

Minimization of adverse effects on human use potential may be achieved by:

(a) Selecting discharge sites and following discharge procedures to prevent or minimize any potential damage to the aesthetically pleasing features of the aquatic site (e.g. viewscapes), particularly with respect to water quality;

(b) Selecting disposal sites which are not valuable as natural aquatic areas;

(c) Timing the discharge to avoid the seasons or periods when human recreational activity associated with the aquatic site is most important;

(d) Following discharge procedures which avoid or minimize the disturbance of aesthetic features of an aquatic site or ecosystem;

(e) Selecting sites that will not be detrimental or increase incompatible human activity, or require the need for frequent dredge or fill maintenance activity in remote fish and wildlife areas;

(f) Locating the disposal site outside of the vicinity of a public water supply intake.

§ 230.77 Other actions.

(a) In the case of fills, controlling runoff and other discharges from activities to be conducted on the fill;

(b) In the case of dams, designing water releases to accommodate the needs of fish and wildlife;

(c) In dredging projects funded by Federal agencies other than the Corps of Engineers, maintain desired water quality of the return discharge through agreement with the Federal funding authority on scientifically defensible pollutant concentration levels in addition to any applicable water quality standards;

(d) When a significant ecological change in the aquatic environment is proposed by the discharge of dredged or fill material, the permitting authority should consider the ecosystem that will be lost as well as the environmental benefits of the new system.

Subpart I—Planning To Shorten Permit Processing Time

§ 230.80 Advanced identification of disposal areas.

(a) Consistent with these Guidelines, EPA and the permitting authority, on their own initiative or at the request of any other party and after consultation with any affected State that is not the permitting authority, may identify sites which will be considered as:

(1) Possible future disposal sites, including existing disposal sites and non-sensitive areas; or

(2) Areas generally unsuitable for disposal site specification;

(b) The identification of any area as a possible future disposal site should not be deemed to constitute a permit for the discharge of dredged or fill material within such area or a specification of a disposal site. The identification of areas that generally will not be available for disposal site specification should not be deemed as prohibiting applications for permits to discharge dredged or fill material in such areas. Either type of identification constitutes information to facilitate individual or General permit application and processing.

(c) An appropriate public notice of the proposed identification of such areas shall be issued;

(d) To provide the basis for advanced identification of disposal areas, and areas unsuitable for disposal, EPA and the permitting authority shall consider the likelihood that use of the area in question for dredged or fill material disposal will comply with these Guidelines. To facilitate this analysis, EPA and the permitting authority should review available water resources management data including data available from the public, other Federal and State agencies, and information from approved Coastal Zone Management programs and River Basin Plans;

(e) The permitting authority should maintain a public record of the identified areas and a written statement of the basis for identification.

PART 231—SECTION 404(c) PROCEDURES

AUTHORITY: 33 U.S.C. 1344(c).

SOURCE: 44 FR 58082, Oct. 9, 1979, unless otherwise noted.

§ 231.1 Purpose and scope.

(a) The Regulations of this part include the procedures to be followed by the Environmental Protection agency in prohibiting or withdrawing the specification, or denying, restricting, or withdrawing the use for specification, of any defined area as a disposal site for dredged or fill material pursuant to section 404(c) of the Clean Water Act ("CWA"), 33 U.S.C. 1344(c). The U.S. Army Corps of Engineers or a state with a 404 program which has been approved under section 404(h) may grant permits specifying disposal sites for dredged or fill material by determining that the section 404(b)(1) Guidelines (40 CFR Part 230) allow specification of a particular site to receive dredged or fill material. The Corps may also grant permits by determining that the discharge of dredged or fill material is necessary under the economic impact provision of section 404(b)(2). Under section 404(c), the Administrator may exercise a veto over the specification by the U.S. Army Corps of Engineers or by a state of a site for the discharge of dredged or fill material. The Administrator may also prohibit the specification of a site under section 404(c) with regard to any existing or potential disposal site before a permit application has been submitted to or approved by the Corps or a state. The Administrator is authorized to prohibit or otherwise restrict a site whenever he determines that the discharge of dredged or fill material is having or will have an "unacceptable adverse effect" on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. In making this determination, the Administrator will take into account all information available to him, including any written determination of compliance with the section 404(b)(1) Guidelines made in 40 CFR Part 230, and will consult with the Chief of Engineers or with the state.

(b) These regulations establish procedures for the following steps:

(1) The Regional Administrator's proposed determinations to prohibit or withdraw the specification of a defined area as a disposal site, or to deny, restrict or withdraw the use of any defined area for the discharge of any particular dredged or fill material;

(2) The Regional Administrator's recommendation to the Administrator for determination as to the specifica-

APPENDIX E

CURRENT AND DRAFT GUIDELINES FOR EVALUATING MARSH MANAGEMENT PERMIT APPLICATIONS

the Coastal Management Division
Louisiana Department of Natural Resources

State of Louisiana

GOVERNOR

DEPARTMENT OF NATURAL RESOURCES

SECRETARY

Coastal Management Division

MARSH MANAGEMENT PLAN GUIDELINES

The following specific information should be provided to the Coastal Management Division (CMD) by those applicants contemplating marsh management plans.

The criteria by which Coastal Management Division (CMD) reviews marsh management plans are established by the following Coastal Use Guidelines:

Guideline 1.6 Information regarding the following general factors shall be utilized by the permitting authority in evaluating whether the proposed use is in compliance with the guidelines.

c) techniques and materials used in construction, operation and maintenance of use.

d) existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity and salinity; and impacts on them.

e) availability of feasible alternative sites or methods for implementing the use.

h) extent of resulting public and private benefits.

k) extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited.

l) proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands.

o) the extent of impacts resulting from secondary or cumulative impacts.

q) extent of impacts on navigation, fishing, public access, and recreational opportunities.

s) extent of long term benefits or adverse impacts.

Guideline 2.5 Impoundment levees shall only be constructed in wetland areas as part of approved water or marsh management projects or to prevent release of pollutants.

Guideline 7.5 Water or marsh management plans shall result in an overall benefit to the productivity of the area.

Guideline 7.6 Water control structures shall be assessed separately based on their individual merits and impacts and in relation to their overall water or marsh management plan of which they are a part.

Guideline 7 7 Weirs and similar water control structures shall be designed and built using the best practical techniques to prevent "cut arounds", permit tidal exchange in tidal areas, and minimize obstruction of the migration of aquatic organisms.

Guideline 7.8 Impoundments which prevent normal tidal exchange and/or the migration of aquatic organisms shall not be constructed in brackish and saline areas to the maximum extent practicable.

In general, the CMD would like marsh management plans to contain the following elements:

1) Marsh Management Goals
The primary and secondary goals to be derived from the plan should be included. For example, the goals may be erosion prevention and/or increased wildlife and fisheries production.

2) Area History
A brief history of the problems of the wetland area should be presented. For example, if a hurricane introduced saltwater intrusion which damaged fresh marshes in the area the years and circumstances should be included.

3) Type of Habitat
A description of the dominant types and percent composition of vegetation to be affected by the plan should be included.

4) Water Control Structures
The location, construction, and operation of water control structures, (i.e. weirs or flapgates) or other proposed modifications (i.e. levees) of the marsh should be clearly outlined. A water control structure operational plan should be included if variable structures are included in the plan. This plan should include provisions for the access of the area by estuarine fishery organisms.

5) Monitoring Plan

A monitoring plan should be included to evaluate whether the goals have been accomplished and to what degree. Monitoring may be done by gathering information from; water quality sampling, vegetational change analysis, aerial photography, hunting or trapping records or other similar methods. Annual monitoring reports should be sent to the Coastal Management Division and other agencies.

6) Non-Marsh Management Activities

A statement of policy should be included concerning activities other than those involved with marsh management which may occur within the management area (i.e. the dredging of oil and gas canals and the placement of spoil). In addition, a statement of policy should be included concerning restoration of areas impacted by non-marsh management activities (i.e. the plugging or backfilling of abandoned canals). Information should be provided concerning the number, concentrations and volumes of brine discharges currently within the management area.

7) In addition, the following specific information should be provided where applicable:

a. The length and cross section (with scale) of any levee(s) to be constructed or reconstructed,
b. The amount of fill material or dredging necessary for levee or water control structure construction,
c. Present elevation of existing levees,
d. The location of any tidal creeks or bayous which may be closed by this activity, and
e. Allowances for the ingress and egress of estuarine organisms.

We will be glad to provide you with a copy of an approved marsh management plan should you desire. We would like to work with you to ensure that this activity complies with the La. Coastal Resources Program Guidelines. It may be desirable in the future to schedule a pre or post application conference to further discuss the above items and the various components of your management plan. Should you have any questions, please contact Darryl Clark or John deMond of the Wetland Resources Section.

C. G. Groat
Assistant to the Secretary

MARSH MANAGEMENT PLAN EVALUATION

Monitoring Plan Specifications

A monitoring plan should be included with all marsh management plan permit applications and with all subsequent permits. The monitoring plan should be included to evaluate whether the management goals have been accomplished and to what degree. Monitoring may be done by gathering and reporting information from; water quality sampling, vegetational change analyses, aerial photography, hunting and trapping records, hydrology, erosion control, overall productivity changes, or other similar types of data sources. In each case the stated managemnet goals are the major areas the monitoring effort should be focused.

Monitoring for specific types of marsh management plans:

A. Overall Marsh or Wetland Productivity.

1. Data should be gathered and evaluated concerning a wide range of vegetational and commerical and non-commercial organisms.

2. Net primary production measurements.

3. Secondary productivity. Waterfowl numbers (i.e. hunting success), trapping, aqua cultural success (i.e. numbers on pounds of crawfish).

4. Changes in the quality of vegetation (i.e. <u>Spartina patens</u> marshes changed to <u>Scirpus olneyi</u>).

5. Water control parameters; water levels, turbidity, salinity, etc.

6. Degree of estuarine organism access and productivity.

7. Degree of anti-erosion success. This could be done by aerial photography, success of transplantings, condition of anti-erosion materials (i.e. matting materials, plugs, levees, etc.).

8. Annual report of overall biological success by a professional biologist.

9. Monitor the degree which problems have been corrected by management plan components.

B. Saltwater Intrusion Retardation.

1. Sample or evaluate (by professional biologist) quarterly and at lease annually indicator plant species to monitor salinity changes.

2. Sample monthly or biweekly (or more often if landowner agrees) salinity on both sides (marsh and canal or areas outside of the management area) of water control structures or other structural components (i.e. levees or plugs).

C. Water Control Monitoring

1. Monitor turbidity at least monthly by secchi disc or turbidometer or by measuring the success of submerged vegetation (i.e. Ruppia maritima - widgeon grass).

2. Monitor salinity at least monthly by either direct measurement on both sides of water control structures (WCS) or by quantifying indicator plant species.

3. Monitor water levels at least biweekly or monthly especially if variable WCS are part of the plan.

4. Growth of submerged and to a degree emergent vegetation (if erosion control is a goal of the water control plan).

5. Monitor hydrologic changes, flow patterns, rates, etc.

6. Monitor erosion rates. Aerial photography, shoreline erosion (stakes placed along shoreline - measure shoreline retreat).

D. Waterfowl and Furbearer Production

1. Annual report of waterfowl and furbearer densities in the area including hunting and trapping records. Muskrat houses or nutria trails could be used to estimate densities.

E. Aquacultural Program Monitoring
Crawfish ponds, catfish, shrimp, bass/bluegill, etc.

1. Annual report of densities of organisms harvested or present.

2. Report indicating the present of food species.

F. Anti-Erosion Control Method Monitoring

1. Monitor erosion by aerial photography, shoreline retreat, etc.

2. Sedimentation rate data.

3. Success of vegetational plantings and/or anti-erosion structural materials (matting material, etc.).

G. Marsh Burning Monitoring

1. Sections of a marsh management area which are burned under a prescribed burning program should be monitored at least annually for changes in (a) plant species composition, (b) erosion (increase or decrease of open water areas), and (c) quality or existing vegetation.

DEPARTMENT OF NATURAL RESOURCES
COASTAL MANAGEMENT DIVISION
P. O. BOX 44124
BATON ROUGE, LOUISIANA 70804
(504) 342-7591

Draft

COASTAL USE PERMIT/CONSISTENCY DETERMINATION

C.U.P. No.

C.O.E. No.

NAME AND ADDRESS:

LOCATION: ST. MARY PARISH, LA: Secs. 32 and 33, T16S-R13E; SE Avoca Island, South from Morgan City, La.

PROJECT DESCRIPTION: Construct a levee & install two (2) water control structures for marsh management in an area about 800 acres large. 1) Place spoil to repair portions of a 7000 ft. long spoil bank to repair work will consist of spoil deposited to +4' MSL with a 20' wide base and an 8' crown (2.78 cu. yds./ft.; about 18,900 cu. yds.). About 3.2 acres of existing spoil bank & open water is to be impacted by the part of the project. 2) Construct a 3600' long new levee +4' MSL high & 30' wide at the base and 10' wide at the crown. (4.5 cu. yds./ft.; 29,500 cu. yds.). About 3.7 acres of shallow open water habitat is to be altered by this part of the project. Install two water control structures, one a minimum of 10' wide variable crest weir & the other a dual flap-gated culvert as diagrammed. The primary purposes for the management includes erosion abatement and water control in order to increase overall productivity and to improve waterfowl habitat.

In accordance with the rules and regulations of the Louisiana Coastal Resources Program and Louisiana R.S. 49, Sections 213.1 to 213.21, the State and Local Coastal Resources Management Act of 1978, as amended, the permittee agrees to:

1. Carry out or perform the use in accordance with the plans and specifications approved by Department of Natural Resources.
2. Comply with any permit conditions imposed by the Department of Natural Resources.
3. Adjust, alter, or remove any structure or other physical evidence of the permitted use if, in the opinion of the Department of Natural Resources, it proves to be beyond the scope of the use as approved or is abandoned.
4. Provide, if required by the Department of Natural Resources, an acceptable surety bond in an appropriate amount to ensure adjustment, alteration, or removal should the Department of Natural Resources determine it necessary.
5. Hold and save the State of Louisiana, the local government, the department, and their officers and employees harmless from any damage to persons or property which might result from the work, activity, or structure permitted.
6. Certify that any permitted construction has been completed in an acceptable and satisfactory manner and in accordance with the plans and specifications approved by the Department of Natural Resources. The Department of Natural Resources may, when appropriate, require such certification be given by a registered professional engineer.
7. All terms of the permit shall be subject to all applicable federal and state laws and regulations.
8. This permit, or a copy thereof, shall be available for inspection at the site of work at all times during operations.
9. The following special conditions must also be met in order for the project to meet the guidelines of the coastal resources program:

C.U.P. No. P850

C.O.E. No. LMNOD-SP (St. Mary Ph. Wetlands)

a) The Marsh Management Plan shall be conducted according to the approved revisions submitted in July, 1985.

b) An annual report which describes the degree to which the management plan is achieving the major goals of saltwater intrusion and erosion prevention and increasing wildlife and fisheries production especially waterfowl numbers shall be submitted to the Coastal Management Division (CMD), the Corps of Engineers (COE) and other agencies during the term of this permit. This annual report shall include the following elements:

1. Height of the variable crest weirs and flap gate positions for water control structures in the area.
2. Water elevation inside and outside of the area at water control structures.
3. Turbidity of the water, specified by visual inspection.
4. Percentage of area under water that has submergent vegetation specified by visual inspection.
5. Any relevant management information —e.g. whether vegetative plantings are taking place, progress of any plantings already done in the area.
6. During hunting seasons, waterfowl and trapping numbers.
7. Levee condition by visual inspection —e.g. erosion and control measures taken to alleviate it, condition of vegetation on slopes.
8. Any relevant non-marsh management activity in the area.
9. Results of surveys using aerial photographs, estimating percent vegetated, percent open water, percent in grassbeds.
10. Results of surveys of changes in marsh acreage using aerial photographs to track erosion control.
11. Results of visual surveys at the documented SCS pre-implementation sites to determine the types of vegetation present.

c) The management area should be monitored monthly for turbidity, general marsh conditions, water levels, and the condition and operation mode of each water control structure. The monthly monitoring results should be included in the annual report.

d) Water level gages should be established at each water control structure for monitoring water levels.

e) Water control structures shall be operated according to the following plan approved at the June 27, 1985 Interagency Meeting:

*PHASE 1 WATER CONTROL STRUCTURES OPERATING SCHEDULE

Dates	Flapgates		Weir Height	Activity
	Outside	Inside		
Sept.-Nov.	Open	Flapping	Marsh Elevation	Flooding
Nov.-Feb.	Closed	Closed	Marsh Elevation	Hunting Season
Feb.-April	Flapping	Open	Maximum Height	Drawdown
April-May	Flapping	Open	0.5 Ft. Below Marsh Elevation	Mimic Natural Hydrology
May-Sept.	Open	Open	0.5 Ft. Below Marsh Elevation	Free Exchange

*Manager discretion shall apply in case of emergencies caused by natural catastrophic events. Starting dates for water management activities have a one week latitude prior to or after specified dates.

C.U.P. No. P850

C.O.E. No. LMNOD-SP (St. Mary Ph.Wetlands)

f) An evaluation conducted approximately two years after implementation of the plan will be performed by an interagency team with Avoca, Inc. representation. Monitoring data, scientific information, and Avoca goals will be used to determine if a change in the water managment plan is warranted or even desirable. If a review of the preceding two years is not completed prior to beginning the third year of operation, the water management plan previously in effect will be continued.

g) Proposed modifications or additions to this plan shall be submitted to CMD for review.

h) All logs and stumps unearthed during dredging will be buried beneath the bottom of the waterway or removed to a disposal site on land.

i) The applicant will notify the CMD of the date on which approved work began on site using the enclosed green commencement card upon initial activity under this permit.

j) This Coastal Use Permit authorizes periodic maintenance including maintenance dredging for a period of five (5) years from the date of the Secretary's signature. All maintenance activities authorized by this permit shall be conducted pursuant to the specifications and conditions of this permit.

k) The expiration date of this permit is five (5) years from the date of the Secretary's signature. After this five year period, a new Coastal Use Permit must be acquired before any dredging (maintenance or otherwise) can be continued.

By accepting this permit, the applicant agrees to its terms, but reserves the right to appeal permit conditions.

I affix by signature and issue this permit this________day of______________________________, 19______.

Department of Natural Resources

____

SECRETARY B. JIM PORTER

This agreement becomes binding when signed by the Secretary of the Department of Natural Resources.

Draft

La. Dept. of Natural Resources
Wetland Management Policies and
Guidelines

The LDNR staff recognizes that the La. coastal zone is currently experiencing a land loss and erosion problem which may exceed a rate of 50 square miles per year. This land loss is caused by natural and man made sources. If it continues at the current rate, Louisiana's 2.9 million acres of coastal wetlands with their associated benefits to the state and the nation would disappear. Few options are available at the present time to be used by man to counteract this land loss problem. Some of these options include fresh water and sediment diversions where practical and wetland management plans which take advantage of these freshwater and sediment diversions when present.

Coastal Wetland Management Definition

Marsh management may be defined as the use of structural water control and non-structural activities in coastal wetlands for the purpose of increasing wetland productivity without significantly decreasing aquatic organism productivity, freshwater and sediment diversions, nutrient cycling and water quality, and wildlife production.

The La. Coastal Resources Program Marsh Management definition states that a marsh management plan is "A systematic development and control plan to improve and increase biological productivity, or to minimize land loss, saltwater intrusion, erosion or other such environmental problems, or to enhance recreation." (p65, Final Environmental Impact Statement).

The MMS - DNR Wetland Management Cooperative Agreement Technical Steering Committee definition states ...

"For the purpose of this study, marsh management is defined as the use of structures to manipulate local hydrology for the purpose of reducing or reversing wetland loss and/or enhancing the productivity of natural resources."

General Management Goals

The general DNR marsh management goals in coastal Louisiana should be toward the encouragement of plans which; (1.) reduce land loss, (2.) preserve habitat and habitat quality, (3.) increase overall wetland productivity, (4.) increase recreational and commercial natural resource availability, (5.) maintain aquatic organism access and productivity, (6.) maintain fresh water and sediment diversions, nutrient cycling and water quality, and (7.) create additional wetland acreage where possible.

General Policy

1. It is recognized that freshwater and sediment diversions and nutrient introduction can be used to reduce land loss and maintain habitat quality and productivity. These measures should be required in formulating management plans and should be incorporated to the maximum extent possible in the operation and development of these plans. Plans should be developed to take advantage of existing and planned diversions of freshwater, sediments and nutrients and should not be developed to block the beneficial effects of such activities.

2. The major goals of management should be toward decreasing land loss and increasing marsh productivity while at the same time providing for aquatic organism usage and movement into and out of the area. Management for one species or one species group (monoculture -ie. for waterfowl winter habitat) with no provisions for an increase in overall productivity should be discouraged.

3. Management plans should be developed to encourage the movement of sediment and fresh water in areas where this is practical. This can be accomplished by the development of "flow through" systems which encourages the movement of fresh water and sediment into the plan. The sediment is released as the water "flows through" in the next tidal cycle.

4. Management plans should be developed which promote the re-estab-lishment of vegetation in fresh to moderately brackish marshes. This aquatic submerged and emergent vegetation will then contribute to an organic "sediment" build-up of the marshes which would decrease land loss.

5. Marsh management should be and generally is limited to semi-impoundment areas, not to total impoundments. Total impoundments may be allowed in fastland or upland areas. Total impoundment levees with pumps or similar devices should be discouraged in all areas but fastland and upland areas.

6. Marsh management should recognized as being one of only a few tools available to the private coastal landowner for use in reducing land loss and in maintaining habitat quality and productivity. Other tools such as large freshwater and sediment diversions are the perview of government and may only be used successfully in areas near large freshwater and sediment sources.

7. A marsh management plan, using an approved format, should be submitted with every marsh management plan Coastal Use Permit Application.

8. Plans shall have the following components: Plan goals; history; habitat description; water control structure design operation and location; monitoring plan; treatment of non-management activities.

9. There should be no total impoundments in tidal areas unless the area was a fastland (or completely leveed area).

10. Variable or gated (culverted) control structures should be recommended in areas experiencing land loss for possible revegetation efforts except in higher salinity brackish and saline areas where revegetation is more difficult and estuarine organism populations are higher.

11. In fresh marshes there may be provisions for more impoundment to achieve management objection because of the greater ability of fresh vegetation to tolerate impoundment situations and because of the reduced presence of estuarine organisms accessing these areas as estuarine Nursery areas and the ability of fresh to intermediate marshes to build marsh levels by the deposition of organic material.

12. More provisions for wildlife benefits of management should be tolerated in fresh to intermediate marshes with a greater emphasis on fisheries benefits maintained in brackish and saline areas

13. Barricades are designed primarily as anti-tresspassing devices and do not come under the definition of marsh management as they do little for the improvement of the marsh habitat. Coastal Use Permits are normally not issued for barricades unless they are proposed to block navigable waters. The DNR Division of State Lands has prime jurisdiction over barricade construction in state navigable waters and such matters should be deferred to that agency for a determination. State lands

should be notified if any DNR agency suspects possible denial of free access to state waterbottoms.

14. Maricultural activities are performed for the prime purpose of raising certain fisheries species and do not normally include provisions for marsh management. In fact, the two activities may be contradictory with one not possible under the operation of the other. Maricultural activities should only be allowed on fastland or upland areas where they don't compete with marsh management goals. However some limited aquacultural activities could be allowed in northern fresh marsh areas where tidal influence and the presence of estuarine organisms is limited. Limited maricultural activities may be allowed in severely degraded coastal areas such as in portions of old access or pipeline canals or near total impoundments.

15. New levees in the marsh are to be discouraged and should only be allowed if they are relatively short (500-1000 ft) and if the purpose is to connect to existing canal spoil banks for purposes of water control by a variable or gated control structure.

16. Levees in shallow open water shall be allowed if the purpose is to gain water control over an area that has experienced significant land loss from that which was present in 1956. Significant land loss is defined as greater than 40% to 60% open water to marsh ratio (4:6).

17. Control structures should be operated in three year cycles with lowered water levels (drawdowns) for revegetation attempted one out of three years. The structures in the other years should be operated in a maintenance mode with the structures (culverts) open and any variable crest weirs set at the average depth of ponds in the marsh.

18. Fixed crest weirs without levees in the marsh are allowed in brackish to saline areas if the crest of the weirs are set not higher than the average depth of ponds in the marsh or if vertical slots or other modifications are placed in the weirs to increase tidal flow and estuarine organism access.

19. DNR should encourage the development of newer water control structures which allow for greater estuarine organism access while at the same time protect the marsh from saltwater intrusion and land loss.

20. A typical drawdown scenario for re-vegetation should be as follows: Spring drawdown for revegetation - structure set with outside gates closed and inside weir (stop logs) set 1-2ft. below marsh level; Summer to fall allowance for estuarine organism movement - inside and outside gates open and weir set at the average depth of ponds; winter impounding (or holding) water to close to marsh level for waterfowl and trapping - weir set at marsh level (there should be provisions for slot or hole in the weir for some estuarine organism movement).

21. A typical maintenance control structure schedule - Spring to Fall - open gates and set weirs to average bottom depths of ponds (1/2 - 1 ft. below marsh) for estuarine organism movement and saltwater intrusion prevention; Winter - impoundment for waterfowl and trapping - weir set at marsh level with both gates open (there should be provisions for a slot or opening in the weir for increased estuarine organism movement).

22. Safety provisions should be set for salinity and water level targets for each area and each season or operation phase to give the manager the flexibility to adjust structures to prevent high salinities and/or water levels not in keeping with the management plan. Salinity target levels should be based on a case by case analysis of salinity records for each area. Water level targets should be maintained at + 0.2 ft. for each respective operational phase.

23. Management plan coastal use permits should include statements and conditions concerning the following: (1.) plan goals; (2.) design, (3.) operational schedule and location of plan structural components, monitoring provisions; (4.) provisions for plan modification should be monitored by the landowner or government agency indicating modifications are needed; (5.) five year expiration date for maintenance activities; (6.) an anti-mariculture clause; (7.) provisions for abandonment of site; and (8.) post implementation evaluation clause.

24. Marsh management monitoring. Private landowners who receive permits for management plans will be expected to perform limited monitoring activities. These activities should include at a minimum: monthly salinity and water level monitoring, annual land-water ratios by aerial photography and annual wildlife harvest records. More detailed and scientific monitoring should be performed by government. These activities include; vegetation, land loss and habitat change by aerial photography, fisheries, sedimentation, and hydrology monitoring.

APPENDIX F

AGENCY GUIDELINES ON MARSH MANAGEMENT

MARSH MANAGEMENT PLAN GUIDELINES

COASTAL MANAGEMENT DIVISION

LOUISIANA DEPARTMENT OF NATURAL RESOURCES

MARSH MANAGEMENT PLAN GUIDELINES

The following specific information should be provided to the Coastal Management Division (CMD) by those applicants contemplating marsh management plans.

The criteria by which Coastal Management Division (CMD) reviews marsh management plans are established by the following Coastal Use Guidelines:

Guideline 1.6 Information regarding the following general factors shall be utilized by the permitting authority in evaluating whether the proposed use is in compliance with the guidelines.

c) techniques and materials used in construction, operation and maintenance of use.

d) existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity and salinity; and impacts on them.

e) availability of feasible alternative sites or methods for implementing the use.

h) extent of resulting public and private benefits.

k) extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited.

l) proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands.

o) the extent of impacts resulting from secondary or cumulative impacts.

q) extent of impacts on navigation, fishing, public access, and recreational opportunities.

s) extent of long term benefits or adverse impacts.

Guideline 2.5 Impoundment levees shall only be constructed in wetland areas as part of approved water or marsh management projects or to prevent release of pollutants.

Guideline 7.5 Water or marsh management plans shall result in an overall benefit to the productivity of the area.

Guideline 7.6 Water control structures shall be assessed separately based on their individual merits and impacts and in relation to their overall water or marsh management plan of which they are a part.

Guideline 7.7 Weirs and similar water control structures shall be designed and built using the best practical techniques to prevent "cut arounds", permit tidal exchange in tidal areas, and minimize obstruction of the migration of aquatic organisms.

Guideline 7.8 Impoundments which prevent normal tidal exchange and/or the migration of aquatic organisms shall not be constructed in brackish and saline areas to the maximum extent practicable.

In general, the CMD would like marsh management plans to contain the following elements:

1) Marsh Management Goals

   The primary and secondary goals to be derived from the plan should be included. For example, the goals may be erosion prevention and/or increased wildlife and fisheries production.

2) Area History

   A brief history of the problems of the wetland area should be presented. For example, if a hurricane introduced saltwater intrusion which damaged fresh marshes in the area the years and circumstances should be included.

3) Type of Habitat

   A description of the dominant types and percent composition of vegetation to be affected by the plan should be included.

4) Water Control Structures

   The location, construction, and operation of water control structures, (i.e. weirs or flapgates) or other proposed modifications (i.e. levees) of the marsh should be clearly outlined. A water control structure operational plan should be included if variable structures are included in the plan. This plan should include provisions for the access of the area by estuarine fishery organisms.

5) Monitoring Plan

A monitoring plan should be included to evaluate whether the goals have been accomplished and to what degree. Monitoring may be done by gathering information from; water quality sampling, vegetational change analysis, aerial photography, hunting or trapping records or other similar methods. Annual monitoring reports should be sent to the Coastal Management Division and other agencies.

6) Non-Marsh Management Activities

A statement of policy should be included concerning activities other than those involved with marsh management which may occur within the management area (i.e. the dredging of oil and gas canals and the placement of spoil). In addition, a statement of policy should be included concerning restoration of areas impacted by non-marsh management activities (i.e. the plugging or backfilling of abandoned canals). Information should be provided concerning the number, concentrations and volumes of brine discharges currently within the management area.

7) In addition, the following specific information should be provided where applicable:

a. The length and cross section (with scale) of any levee(s) to be constructed or reconstructed,
b. The amount of fill material or dredging necessary for levee or water control structure construction,
c. Present elevation of existing levees,
d. The location of any tidal creeks or bayous which may be closed by this activity, and
e. Allowances for the ingress and egress of estuarine organisms.

We will be glad to provide you with a copy of an approved marsh management plan should you desire. We would like to work with you to ensure that this activity complies with the La. Coastal Resources Program Guidelines. It may be desirable in the future to schedule a pre or post application conference to further discuss the above items and the various components of your management plan. Should you have any questions, please contact Darryl Clark or John deMond of the Wetland Resources Section.

C. G. Groat
Assistant to the Secretary

MARSH MANAGEMENT PLAN EVALUATION

Monitoring Plan Specifications

A monitoring plan should be included with all marsh management plan permit applications and with all subsequent permits. The monitoring plan should be included to evaluate whether the management goals have been accomplished and to what degree. Monitoring may be done by gathering and reporting information from; water quality sampling, vegetational change analyses, aerial photography, hunting and trapping records, hydrology, erosion control, overall productivity changes, or other similar types of data sources. In each case the stated managemnet goals are the major areas the monitoring effort should be focused.

Monitoring for specific types of marsh management plans:

A. Overall Marsh or Wetland Productivity.

1. Data should be gathered and evaluated concerning a wide range of vegetational and commerical and non-commercial organisms.

2. Net primary production measurements.

3. Secondary productivity. Waterfowl numbers (i.e. hunting success), trapping, aqua cultural success (i.e. numbers on pounds of crawfish).

4. Changes in the quality of vegetation (i.e. *Spartina patens* marshes changed to *Scirpus olneyi*).

5. Water control parameters; water levels, turbidity, salinity, etc.

6. Degree of estuarine organism access and productivity.

7. Degree of anti-erosion success. This could be done by aerial photography, success of transplantings, condition of anti-erosion materials (i.e. matting materials, plugs, levees, etc.).

8. Annual report of overall biological success by a professional biologist.

9. Monitor the degree which problems have been corrected by management plan components.

B. Saltwater Intrusion Retardation.

1. Sample or evaluate (by professional biologist) quarterly and at lease annually indicator plant species to monitor salinity changes.

2. Sample monthly or biweekly (or more often if landowner agrees) salinity on both sides (marsh and canal or areas outside of the management area) of water control structures or other structural components (i.e. levees or plugs).

C. Water Control Monitoring

1. Monitor turbidity at least monthly by secchi disc or turbidometer or by measuring the success of submerged vegetation (i.e. Ruppia maritima - widgeon grass).

2. Monitor salinity at least monthly by either direct measurement on both sides of water control structures (WCS) or by quantifying indicator plant species.

3. Monitor water levels at least biweekly or monthly especially if variable WCS are part of the plan.

4. Growth of submerged and to a degree emergent vegetation (if erosion control is a goal of the water control plan).

5. Monitor hydrologic changes, flow patterns, rates, etc.

6. Monitor erosion rates. Aerial photography, shoreline erosion (stakes placed along shoreline - measure shoreline retreat).

D. Waterfowl and Furbearer Production

1. Annual report of waterfowl and furbearer densities in the area including hunting and trapping records. Muskrat houses or nutria trails could be used to estimate densities.

E. Aquacultural Program Monitoring
Crawfish ponds, catfish, shrimp, bass/bluegill, etc.

1. Annual report of densities of organisms harvested or present.

2. Report indicating the present of food species.

F. Anti-Erosion Control Method Monitoring

1. Monitor erosion by aerial photography, shoreline retreat, etc.

2. Sedimentation rate data.

3. Success of vegetational plantings and/or anti-erosion structural materials (matting material, etc.).

G. Marsh Burning Monitoring

1. Sections of a marsh management area which are burned under a prescribed burning program should be monitored at least annually for changes in (a) plant species composition, (b) erosion (increase or decrease of open water areas), and (c) quality or existing vegetation.

DEPARTMENT OF NATURAL RESOURCES
COASTAL MANAGEMENT DIVISION
P. O. BOX 44124
BATON ROUGE, LOUISIANA 70804
(504) 342-7591

Draft

COASTAL USE PERMIT/CONSISTENCY DETERMINATION

C.U.P. No.

C.O.E. No.

NAME AND ADDRESS:

LOCATION: ST. MARY PARISH, LA: Secs. 32 and 33, T16S-R13E; SE Avoca Island, South from Morgan City, La.

PROJECT DESCRIPTION: Construct a levee & install two (2) water control structures for marsh management in an area about 800 acres large. 1) Place spoil to repair portions of a 7000 ft. long spoil bank to repair work will consist of spoil deposited to +4' MSL with a 20' wide base and an 8' crown (2.78 cu. yds./ft.; about 18,900 cu. yds.). About 3.2 acres of existing spoil bank & open water is to be impacted by the part of the project. 2) Construct a 3600' long new levee +4' MSL high & 30' wide at the base and 10' wide at the crown. (4.5 cu. yds./ft.; 29,500 cu. yds.). About 3.7 acres of shallow open water habitat is to be altered by this part of the project. Install two water control structures, one a minimum of 10' wide variable crest weir & the other a dual flap-gated culvert as diagrammed. The primary purposes for the management includes erosion abatement and water control in order to increase overall productivity and to improve waterfowl habitat.

In accordance with the rules and regulations of the Louisiana Coastal Resources Program and Louisiana R.S. 49, Sections 213.1 to 213.21, the State and Local Coastal Resources Management Act of 1978, as amended, the permittee agrees to:

1. Carry out or perform the use in accordance with the plans and specifications approved by Department of Natural Resources.
2. Comply with any permit conditions imposed by the Department of Natural Resources.
3. Adjust, alter, or remove any structure or other physical evidence of the permitted use if, in the opinion of the Department of Natural Resources, it proves to be beyond the scope of the use as approved or is abandoned.
4. Provide, if required by the Department of Natural Resources, an acceptable surety bond in an appropriate amount to ensure adjustment, alteration, or removal should the Department of Natural Resources determine it necessary.
5. Hold and save the State of Louisiana, the local government, the department, and their officers and employees harmless from any damage to persons or property which might result from the work, activity, or structure permitted.
6. Certify that any permitted construction has been completed in an acceptable and satisfactory manner and in accordance with the plans and specifications approved by the Department of Natural Resources. The Department of Natural Resources may, when appropriate, require such certification be given by a registered professional engineer.
7. All terms of the permit shall be subject to all applicable federal and state laws and regulations.
8. This permit, or a copy thereof, shall be available for inspection at the site of work at all times during operations.
9. The following special conditions must also be met in order for the project to meet the guidelines of the coastal resources program:

C.U.P. No. P850

C.O.E. No. LMNOD-SP (St. Mary Ph. Wetlands)

a) The Marsh Management Plan shall be conducted according to the approved revisions submitted in July, 1985.

b) An annual report which describes the degree to which the management plan is achieving the major goals of saltwater intrusion and erosion prevention and increasing wildlife and fisheries production especially waterfowl numbers shall be submitted to the Coastal Management Division (CMD), the Corps of Engineers (COE) and other agencies during the term of this permit. This annual report shall include the following elements:

1. Height of the variable crest weirs and flap gate positions for water control structures in the area.
2. Water elevation inside and outside of the area at water control structures.
3. Turbidity of the water, specified by visual inspection.
4. Percentage of area under water that has submergent vegetation specified by visual inspection.
5. Any relevant management information -e.g. whether vegetative plantings are taking place, progress of any plantings already done in the area.
6. During hunting seasons, waterfowl and trapping numbers.
7. Levee condition by visual inspection -e.g. erosion and control measures taken to alleviate it, condition of vegetation on slopes.
8. Any relevant non-marsh management activity in the area.
9. Results of surveys using aerial photographs, estimating percent vegetated, percent open water, percent in grassbeds.
10. Results of surveys of changes in marsh acreage using aerial photographs to track erosion control.
11. Results of visual surveys at the documented SCS pre-implementation sites to determine the types of vegetation present.

c) The management area should be monitored monthly for turbidity, general marsh conditions, water levels, and the condition and operation mode of each water control structure. The monthly monitoring results should be included in the annual report.

d) Water level gages should be established at each water control structure for monitoring water levels.

e) Water control structures shall be operated according to the following plan approved at the June 27, 1985 Interagency Meeting:

*PHASE 1 WATER CONTROL STRUCTURES OPERATING SCHEDULE

Dates	Flapgates Outside	Flapgates Inside	Weir Height	Activity
Sept.-Nov.	Open	Flapping	Marsh Elevation	Flooding
Nov.-Feb.	Closed	Closed	Marsh Elevation	Hunting Season
Feb.-April	Flapping	Open	Maximum Height	Drawdown
April-May	Flapping	Open	0.5 Ft. Below Marsh Elevation	Mimic Natural Hydrology
May-Sept.	Open	Open	0.5 Ft. Below Marsh Elevation	Free Exchange

*Manager discretion shall apply in case of emergencies caused by natural catastrophic events. Starting dates for water management activities have a one week latitude prior to or after specified dates.

C.U.P. No. P850

C.O.E. No. LMNOD-SP (St. Mary Ph.Wetlands)

f) An evaluation conducted approximately two years after implementation of the plan will be performed by an interagency team with Avoca, Inc. representation. Monitoring data, scientific information, and Avoca goals will be used to determine if a change in the water managment plan is warranted or even desirable. If a review of the preceding two years is not completed prior to beginning the third year of operation, the water management plan previously in effect will be continued.

g) Proposed modifications or additions to this plan shall be submitted to CMD for review.

h) All logs and stumps unearthed during dredging will be buried beneath the bottom of the waterway or removed to a disposal site on land.

i) The applicant will notify the CMD of the date on which approved work began on site using the enclosed green commencement card upon initial activity under this permit.

j) This Coastal Use Permit authorizes periodic maintenance including maintenance dredging for a period of five (5) years from the date of the Secretary's signature. All maintenance activities authorized by this permit shall be conducted pursuant to the specifications and conditions of this permit.

k) The expiration date of this permit is five (5) years from the date of the Secretary's signature. After this five year period, a new Coastal Use Permit must be acquired before any dredging (maintenance or otherwise) can be continued.

By accepting this permit, the applicant agrees to its terms, but reserves the right to appeal permit conditions.

I affix by signature and issue this permit this________day of________________________________, 19______.

Department of Natural Resources

____

SECRETARY B. JIM PORTER

This agreement becomes binding when signed by the Secretary of the Department of Natural Resources.

La. Dept. of Natural Resources
Wetland Management Policies and
Guidelines

The LDNR staff recognizes that the La. coastal zone is currently experiencing a land loss and erosion problem which may exceed a rate of 50 square miles per year. This land loss is caused by natural and man made sources. If it continues at the current rate, Louisiana's 2.9 million acres of coastal wetlands with their associated benefits to the state and the nation would disappear. Few options are available at the present time to be used by man to counteract this land loss problem. Some of these options include fresh water and sediment diversions where practical and wetland management plans which take advantage of these freshwater and sediment diversions when present.

Coastal Wetland Management Definition

Marsh management may be defined as the use of structural water control and non-structural activities in coastal wetlands for the purpose of increasing wetland productivity without significantly decreasing aquatic organism productivity, freshwater and sediment diversions, nutrient cycling and water quality, and wildlife production.

The La. Coastal Resources Program Marsh Management definition states that a marsh management plan is "A systematic development and control plan to improve and increase biological productivity, or to minimize land loss, saltwater intrusion, erosion or other such environmental problems, or to enhance recreation." (p65, Final Environmental Impact Statement).

The MMS - DNR Wetland Management Cooperative Agreement Technical Steering Committee definition states ...

"For the purpose of this study, marsh management is defined as the use of structures to manipulate local hydrology for the purpose of reducing or reversing wetland loss and/or enhancing the productivity of natural resources."

General Management Goals

The general DNR marsh management goals in coastal Louisiana should be toward the encouragement of plans which; (1.) reduce land loss, (2.) preserve habitat and habitat quality, (3.) increase overall wetland productivity, (4.) increase recreational and commercial natural resource availability, (5.) maintain aquatic organism access and productivity, (6.) maintain fresh water and sediment diversions, nutrient cycling and water quality, and (7.) create additional wetland acreage where possible.

General Policy

1. It is recognized that freshwater and sediment diversions and nutrient introduction can be used to reduce land loss and maintain habitat quality and productivity. These measures should be required in formulating management plans and should be incorporated to the maximum extent possible in the operation and development of these plans. Plans should be developed to take advantage of existing and planned diversions of freshwater, sediments and nutrients and should not be developed to block the beneficial effects of such activities.

2. The major goals of management should be toward decreasing land loss and increasing marsh productivity while at the same time providing for aquatic organism usage and movement into and out of the area. Management for one species or one species group (monoculture -ie. for waterfowl winter habitat) with no provisions for an increase in overall productivity should be discouraged.

3. Management plans should be developed to encourage the movement of sediment and fresh water in areas where this is practical. This can be accomplished by the development of "flow through" systems which encourages the movement of fresh water and sediment into the plan. The sediment is released as the water "flows through" in the next tidal cycle.

4. Management plans should be developed which promote the re-estab-lishment of vegetation in fresh to moderately brackish marshes. This aquatic submerged and emergent vegetation will then contribute to an organic "sediment" build-up of the marshes which would decrease land loss.

5. Marsh management should be and generally is limited to semi-impoundment areas, not to total impoundments. Total impoundments may be allowed in fastland or upland areas. Total impoundment levees with pumps or similar devices should be discouraged in all areas but fastland and upland areas.

6. Marsh management should recognized as being one of only a few tools available to the private coastal landowner for use in reducing land loss and in maintaining habitat quality and productivity. Other tools such as large freshwater and sediment diversions are the perview of government and may only be used successfully in areas near large freshwater and sediment sources.

7. A marsh management plan, using an approved format, should be submitted with every marsh management plan Coastal Use Permit Application.

8. Plans shall have the following components: Plan goals; history; habitat description; water control structure design operation and location; monitoring plan; treatment of non-management activities.

9. There should be no total impoundments in tidal areas unless the area was a fastland (or completely leveed area).

10. Variable or gated (culverted) control structures should be recommended in areas experiencing land loss for possible revegetation efforts except in higher salinity brackish and saline areas where revegetation is more difficult and estuarine organism populations are higher.

11. In fresh marshes there may be provisions for more impoundment to achieve management objection because of the greater ability of fresh vegetation to tolerate impoundment situations and because of the reduced presence of estuarine organisms accessing these areas as estuarine Nursery areas and the ability of fresh to intermediate marshes to build marsh levels by the deposition of organic material.

12. More provisions for wildlife benefits of management should be tolerated in fresh to intermediate marshes with a greater emphasis on fisheries benefits maintained in brackish and saline areas

13. Barricades are designed primarily as anti-tresspassing devices and do not come under the definition of marsh management as they do little for the improvement of the marsh habitat. Coastal Use Permits are normally not issued for barricades unless they are proposed to block navigable waters. The DNR Division of State Lands has prime jurisdiction over barricade construction in state navigable waters and such matters should be deferred to that agency for a determination. State lands

should be notified if any DNR agency suspects possible denial of free access to state waterbottoms.

14. Maricultural activities are performed for the prime purpose of raising certain fisheries species and do not normally include provisions for marsh management. In fact, the two activities may be contradictory with one not possible under the operation of the other. Maricultural activities should only be allowed on fastland or upland areas where they don't compete with marsh management goals. However some limited aquacultural activities could be allowed in northern fresn marsh areas where tidal influence and the presence of estuarine organisms is limited. Limited maricultural activities may be allowed in severely degraded coastal areas such as in portions of old access or pipeline canals or near total impoundments.

15. New levees in the marsh are to be discouraged and should only be allowed if they are relatively short (500-1000 ft) and if the purpose is to connect to existing canal spoil banks for purposes of water control by a variable or gated control structure.

16. Levees in shallow open water shall be allowed if the purpose is to gain water control over an area that has experienced significant land loss from that which was present in 1956. Significant land loss is defined as greater than 40% to 60% open water to marsh ratio (4:6).

17. Control structures should be operated in three year cycles with lowered water levels (drawdowns) for revegetation attempted one out of three years. The structures in the other years should be operated in a maintenance mode with the structures (culverts) open and any variable crest weirs set at the average depth of ponds in the marsh.

18. Fixed crest weirs without levees in the marsh are allowed in brackish to saline areas if the crest of the weirs are set not higher than the average depth of ponds in the marsh or if vertical slots or other modifications are placed in the weirs to increase tidal flow and estuarine organism access.

19. DNR should encourage the development of newer water control structures which allow for greater estuarine organism access while at the same time protect the marsh from saltwater intrusion and land loss.

20. A typical drawdown scenario for re-vegetation should be as follows: Spring drawdown for revegetation - structure set with outside gates closed and inside weir (stop logs) set 1-2ft. below marsh level; Summer to fall allowance for estuarine organism movement - inside and outside gates open and weir set at the average depth of ponds; winter impounding (or holding) water to close to marsh level for waterfowl and trapping - weir set at marsh level (there should be provisions for slot or hole in the weir for some estuarine organism movement).

21. A typical maintenance control structure schedule - Spring to Fall - open gates and set weirs to average bottom depths of ponds (1/2 - 1 ft. below marsh) for estuarine organism movement and saltwater intrusion prevention; Winter - impoundment for waterfowl and trapping - weir set at marsh level with both gates open (there should be provisions for a slot or opening in the weir for increased estuarine organism movement).

22. Safety provisions should be set for salinity and water level targets for each area and each season or operation phase to give the manager the flexibility to adjust structures to prevent high salinities and/or water levels not in keeping with the management plan. Salinity target levels should be based on a case by case analysis of salinity records for each area. Water level targets should be maintained at + 0.2 ft. for each respective operational phase.

23. Management plan coastal use permits should include statements and conditions concerning the following: (1.) plan goals; (2.) design, (3.) operational schedule and location of plan structural components, monitoring provisions; (4.) provisions for plan modification should be monitored by the landowner or government agency indicating modifications are needed; (5.) five year expiration date for maintenance activities; (6.) an anti-mariculture clause; (7.) provisions for abandonment of site; and (8.) post implementation evaluation clause.

24. Marsh management monitoring. Private landowners who receive permits for management plans will be expected to perform limited monitoring activities. These activities should include at a minimum: monthly salinity and water level monitoring, annual land-water ratios by aerial photography and annual wildlife harvest records. More detailed and scientific monitoring should be performed by government. These activities include; vegetation, land loss and habitat change by aerial photography, fisheries, sedimentation, and hydrology monitoring.

GUIDELINES FOR PROPOSED WETLAND ALTERATIONS

NATIONAL MARINE FISHERIES SERVICE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

GUIDELINES FOR PROPOSED

WETLAND[1] ALTERATIONS IN THE

SOUTHEAST REGION OF THE U.S.

Revised May 5, 1983

INTRODUCTION

The purpose of these guidelines is to provide uniform guidance to NMFS field biologists and contractors in reaching decisions on proposed water-development projects affecting habitat of the living marine resources, including anadromous and commercial freshwater species, for which NMFS is responsible. Objectives are to provide efficient and timely response to expedite the review process and to provide a reference for developers to surface potential environmental problems that should be taken into account during project planning. Prospective permit applicants are encouraged to consult with one of the following NMFS field offices prior to applying for a permit from the U.S. Army Corps of Engineers:

STATE	OFFICE
Florida Alabama Mississippi Puerto Rico Virgin Islands	Area Supervisor Environmental Assessment Branch National Marine Fisheries Service 3500 Delwood Beach Road Panama City, FL 32407 (Phone 904-234-5061)
Louisiana Texas	Area Supervisor Environmental Assessment Branch National Marine Fisheries Service 4700 Avenue U Galveston, TX 77550 (Phone 713-766-3699)

[1] For the purposes of this document, we have adopted the definition of wetland presented in the U.S. Fish and Wildlife Service December 1979 publication, "Classification of Wetlands and Deep-Water Habitats of the United States." Included are open-water estuarine systems and marine habitat out to the limits of the continental shelf.

STATE	OFFICE
North Carolina South Carolina Georgia	Area Supervisor Environmental Assessment Branch National Marine Fisheries Service Pivers Island, P.O. Box 570 Beaufort, NC 28516 (Phone 919-728-5090)

The following guidelines were formulated from a variety of published and unpublished documents by federal, state and priva organizations. They differ from most guidelines in that they a: directed solely to meeting the responsiblities of NMFS mandated by the Fish and Wildlife Cordination Act, i e., the protection and, where possible, the enhancement and restoration of habitat for living marine resources, especially those resources managed under the Magnuson Fishery Conservation and Management Act. Thus, they do not take into consideration socioeconomic factors other than those related to the fishing industry, in determinin public interest for a project; the balancing of socioeconomic factors with environmental factors in determining the overall public interest lies solely within the purview of regulatory agencies.

GENERAL CONSIDERATIONS:

In assessing the potential impacts of proposed projects, the NMI is guided by the following seven considerations:

1. The extent of precedent setting and existing or potential cumulative impacts of similar or other developments ir the project area;

2. The extent to which the activity would directly affect the production of fishery resources (e.g., dredging, filling marshland, reduced access, etc.);

3. The extent to which the activity would indirectly affec the production of fishery resources (e.g., alteration of circulation, salinity regimes and detrital export);

4. The extent of any adverse impact that can be avoided through project modification or other safeguards (e.g., piers ir lieu of channel dredging);

5. The extent of alternative sites available to reduce unavoidable project impacts;

6. The extent to which the activity requires a waterfront location if dredging or filling wetlands is involved;

7. The extent to which mitigation is possible to offset unavoidable habitat losses associated with a water-dependent project that clearly is in the public interest.

SPECIFIC PROJECT GUIDELINES:

I. Docks and Piers:

Docks and piers, whether built over or floating on the water, are generally acceptable methods of gaining access to deep water. However, the following should be used in constructing such facilities:

a. Docks and piers should be constructed in a manner that does not restrict waterflow and sunlight;

b. To avoid the necessity of dredging, docks and piers should be of sufficient length to reach adequate navigational depths;

c. Docks and piers should be constructed in areas where submerged grass beds or shellfish beds do not exist.

II. Boat Ramps:

a. Sites should be along shorelines containing no wetland vegetation and adjacent to waters of adequate navigational depths. Examples of acceptable sites include existing marinas, and other readily accessible areas such as existing bridge approaches and causeways;

b. Sites should be restricted to areas that do not require dredging to gain access to navigable waters.

c. When boat ramps are built in proximity to grassbeds, channel routes should be clearly marked to avoid damage to the grassbeds by propellers and propwash.

III. Marinas:

All marinas affect aquatic habitats to some degree, but adverse effects can be minimized with proper location and design. In addition to guidelines for bulkheads and seawalls, the following apply:

a. Marinas should be located in areas where maximum physical advantages exist (e.g., where the least initial and maintenance dredging will be required);

b. Design should not disrupt currents or restrict the tidal flow;

c. Marinas should be located at least 1,000 feet from shellfish harvesting areas, unless State regulations state otherwise;

d. Open dockage extending to deep water is a preferable alternative to the excavation of boat basins; where not possible, excavation of basins in uplands is generally preferred;

e. Turning basins and navigation channels should not be designed to create a sump that would result in long-term degradation of water quality. For example, the depth of boat basins and access channels should not exceed that of the receiving body of water, and should not be located in areas of poor water circulation;

f. Filling or dredging of vegetated wetlands for marina construction is unacceptable;

g. Marinas should not be sited in areas of known high siltation and shoaling rates;

h. Permanent spoil disposal sites should be set aside in non-wetland areas for use in initial construction and future maintenance dredging;

i. Marinas should be designed to ensure adequate flushing and should not create a sump; they should be no deeper than the parent body of water and aligned with prevailing summer winds to take advantage of wind-driven circulation.

j. When marinas are built in proximity to grassbeds, channel routes should be clearly marked to avoid damage to the grassbeds by propellers and propwash.

IV. <u>Bulkheads and Seawalls</u>:

Bulkheads are retaining structures used to protect adjacent shorelines from the action of currents or waves, or to make waterfront more accessible. A common practice has been to erect vertical seawalls in the water and then place fill material on the landward side of the structure. This technique has often been ineffective in terms of protection and is disruptive to marine productivity. To mitigate these environmental losses, the following criteria apply:

a. Except under special circumstances such as severely eroding shorelines from a recent storm, structures should be aligned no further waterward than the existing shoreline (upland boundary) and constructed so that reflective wave energy does not destroy adjacent fishery habitat or wetlands;

b. Where possible, sloping (3:1) rip-rap, gabions, or vegetation should be used rather than vertical seawalls.

V. Cables, Pipelines and Transmission Lines:

Excavating activities in wetland areas are sometimes required for the installation of submerged cables, pipelines, and transmission lines. Excavation and filling are sometimes required to construct foundation structures attendant to the installation of overhead transmission line crossings. To minimize adverse impacts, the following guidelines apply:

a. Pipelines should be aligned along the least environmentally damaging route (e.g., avoid submerged grass, shellfish beds, coral reefs, and hard banks.);

b. Creation of permanent open water canals in marshlands to install pipelines is generally unacceptable since such projects often interfere with drainage patterns, may adversely affect water quality, and destroy additional wetlands through accelerated bank erosion. An acceptable alternative is the push-ditch method;

c. Where dredging is required in marshland, all excavation should be backfilled with the excavated material after installation of the appropriate structure, while being careful to maintain the original marsh floor elevation, and where practicable restore the original vegetation to both the excavated area and spoil area. Spoil should be temporarily stockpiled in non-continuous banks to allow continuation of sheet flow. Topsoil should be stockpiled separately from other material and placed on the surface of the back filled area upon restoration;

d. In open-water areas, spoil should be deposited in non-continuous piles on opposite sides of the excavation. Back filling will be recommended if the spoil would alter circulation patterns or interfere with trawling;

e. Alignments of new projects should be designed to use existing rights-of-way where possible.

VI. Transporation:

Dredging and filling are sometimes required to construct land transportation projects. Adverse impacts can be minimized with the following criteria:

a. Roadways, railways, and airports should avoid wetlands where possible and be aligned along the least environmentally damaging route, preferably along existing rights-of-way;

b. In cases where wetlands cannot be avoided, bridging should be used rather than filling to create roadbeds and runways. Suitable erosion control and vegetation restoration methods should be used on bridge approaches;

c. Structures should be designed to prevent alteration of the natural waterflow and circulation regimes and the creation of excessive shoaling;

d. Construction of road improvement projects should follow the existing alignment in wetland areas. Existing causeway and fill areas should be used wherever possible.

e. Transportation facilities should be designed to accommodate other public utilities, thus avoiding other unnecessary wetland alteration. An example would be use of existing roadways and bridges to accommodate cables, transmission lines, or pipelines.

VII. Navigation Channels and Access Canals:

The creation and maintenance of navigation channels and access canals have a potential for severe environmental impacts. However, such projects may be acceptable with the following guidelines:

a. Alignments of channels and canals should make maximum use of natural or existing channels to minimize initial and maintenance dredging requirements;

b. Alignments should avoid sensitive habitats such as shellfish beds and areas of submerged and emergent vegetation to the extent possible;

c. Permanent spoil disposal sites should be set aside in non-wetland areas for initial construction as well as future maintenance dredging;

d. Access canals should be designed to ensure adequate flushing and should not create stagnant pockets; they should be of uniform depth, or become gradually shallower proceeding from the receiving body of water; should be no deeper than the parent body of water; and, aligned with prevailing summer winds to take advantage of wind-driven circulation;

e. Construction of channels and access canals should be conducted in a manner that minimizes turbidity and dispersal of dredged materials into adjacent senitive wetland areas (e.g., submerged grasses and shellfish beds) and on schedules that minimize interference with periods of fish and shellfish migration and spawning;

f. Designs should not alter tidal circulation patterns, create change in salinity regimes, or change related nutrient, aquatic life, and vegetative distribution patterns.

VIII. Disposition of Dredged Material:

The disposition of dredged materials resulting from numerous dredging activities along the coast has serious environmental effects separate from the original dredging activity. Thousands of acres of productive wetland habitat have been destroyed by such dispositions. Recognizing that most navigation channels and access canals require periodic maintenance dredging, it is important that long-range plans (preferably 50-year plans) be made and that such plans provide for mitigation of any unavoidable adverse impacts upon the environment.

The following are general criteria that would minimize adverse impacts associated with most disposal situations. Because of the varied and complex disposal problems in the southeast, we recognize there will be exceptions. Therefore, each project will be reviewed on a case-by-case basis:

a. All dredged material should be viewed as a potentially reusable resource, and all disposal plans should include provisions for access to such resources. For example, materials suitable for beach replenishment, construction, or other purposes (sanitary landfill, agricultural soil improvement, etc.) should be used immediately for such purposes or stockpiled in existing disposal areas or other non-wetland areas for later use;

b. Existing disposal areas should be used to the fullest extent possible. An example includes raising the height of containment embankments to increase the holding capacity of the disposal area, and application of the latest engineering techniques to render the spoil suitable for export for other useful purposes or the establishment of wetland vegetation;

c. Disposal dikes should be shaped and stabilized immediately to minimize erosion and dike failure and, where possible, position outfalls to empty back into the dredged area;

d. Permanent, upland disposal sites should always be sought in preference to wetland disposal;

e. Areas containing submerged vegetation and regularly flooded emergent vegetation should not be used for spoil disposal;

f. Open-water and deep-water disposal should be considered as alternatives only if upland sites and existing diked disposal areas are not available. Such alternatives should be seriously considered only after careful consultation with NMFS and other Federal and State agencies;

g. Toxic and highly organic materials should be disposed of in impervious containment basins in upland areas and effluent should be monitored routinely to ensure compliance with state and federal water quality criteria;

h. Sidecast hydraulic dredges should be used only in areas unsuitable for hopper or pipeline dredges.

IX. Impoundments and Other Water Level Controls:

A. Marsh impoundments:

Many thousands of acres of marshlands in the southeast have been impounded for a variety of reasons, including creation of waterfowl habitat, aquaculture, agriculture, flood control, hurricane protection, and mosquito control. In many cases, embankments and other structures have gone unmaintained. Proposals for marsh impoundment or water level control should contain water management plans of sufficient detail to allow NMFS to evaluate the accessiblity of impounded areas to marine organisms and the degree of detrital and nutrient export to adjacent estuarine areas. Because of the importance of marshlands to the continued production of fishery resources (e.g., detrital production, maintenance of water quality, and nursery habitat) the following guidelines apply:

a. Marsh impoundments without tidal exchange:

(1) any proposal for impounding previously unimpounded marshland is unacceptable;

(2) proposals to reimpound previously impounded marshland that is now tidally influenced are generally unacceptable but will be considered on a case-by-case basis.

b. Marsh impoundments with limited tidal exchange:

(1) proposals for impounding previously unimpounded marshland are unacceptable;

(2) proposals to repair or replace water control structures will be assessed on a case-by-case basis.

B. Watershed Impoundments:

Impoundments of rivers, bayous and tributaries are generally unacceptable because they alter the quality, quantity, and timing of fresh water flows into estuaries as well as block migration of fishery resources.

X. Drainage Canals or Ditches:

Drainage canals can be important elements in upland development plans. However, because of their potential for shunting polluted run-off directly into tidal waters, thereby degrading water quality, their design should take full advantage of the natural filtration process provided by marshlands. Guidelines are as follows:

a. Drainage canals from upland development should not be extended through marshlands (except where land subsidence has severely lowered the developed lands). Rather, they should terminate at the landward edge of the marsh, to allow filtration through the marsh. However, the effluent should not contain materials toxic to marsh vegetation or other aquatic life. A spreader canal along the uplands adjacent to marsh may be necessary to allow sheetflow through the marsh;

b. In areas where no marsh exists, adequate detention ponds should be constructed in uplands;

c. All dredged material should be placed on uplands;

d. Even with the above safeguards, any proposed drainage plan should be part of a comprehensive flood plain management plan and the applicant is encouraged to consult closely with the Environmental Protection Agency and appropriate State agencies to ensure that his proposed drainage will meet water quality standards;

e. Ditches for mosquito control in marshes should be designed not to drain coastal marshes, but only to prevent water stagnation and to provide access for aquatic organisms which feed on mosquito larvae.

XI. Oil and Gas Exploration and Production:

Exploration and production of oil and gas resources in shallow water and marshland can almost always be expected to have adverse impacts, because dredging and filling are usually involved. In open marine waters, where dredging and filling for navigation are not necessary, special stipulations are also required to reduce adverse impacts on fishery resources or their utilization. In addition to the above guidelines and criteria for navigation channels, access canals, and pipeline installation, the following apply:

a. In coastal marshes

These activities should be conducted so that damage to coastal marshes would be minimized to the greatest practicable extent. To accomplish this, activities should be performed in the following manner:

(1) Drilling shall be conducted from existing drilling sites, canals, bayous, deeper bay waters, or non-wetland locations, wherever possible, rather than dredging canals or constructing board roads in coastal marshes;

(2) If (1) is not possible, temporary roadbeds (preferably plank roads) to provide access from land are usually preferable to dredging canals for access to well sites;

(a) proposed road alignments should use upland or already distrubed marsh areas, to the maximum extent possible;

(b) fill from borrow pits, if that source is necessary, should be dredged adjacent to, and on alternate sides of the road;

(c) all streams should be bridged or culverted to prevent alterations to the natural drainage patterns;

(d) culverts or similar structures should be installed under the road at sufficient intervals (never more than 500-feet apart) to prevent blockage of surface drainage or tidal flow, with all culvert openings being subsequently maintained;

(3) No hydrocarbons, hydrocarbon-containing substances, drilling muds, drill cuttings, and toxic substances should be released into coastal marshes;

(4) Upon completion or abandonment of wells in coastal marshes, all unnecessary equipment should be removed and the area restored as much as practicable. Upon abandonment of a well in coastal marsh, the well site, various pits, levees, roads and work areas should be restored to the conditions prior to development by restoring indigenous vegetation whenever practicable. Abandoned canals frequently will need plugging at their origin (mouths) to minimize bank erosion and prevent saltwater intrusion.

b. Estuarine water areas

Activities in estuarine waters should be conducted as flows so that the least environmental damage would result:

(1) Maximum use should be made of existing navigable waters already having sufficient width and depth for access to mineral extraction sites;

(2) Conflicts between mineral extraction and sport and commercial fishing operations should be minimized by marking any structures that could obstruct fishing operations;

(3) No hydrocarbon, hydrocarbon-containing substances and other toxic substances should be released into waters;

(4) Environmentally sensitive areas such as oyster reefs, submerged grass beds and other productive shallow-water areas should be avoided when siting extraction facilities;

(5) All unnecessary equipment and structures usually should be removed upon abandonment of wells or termination of production.

c. Continental shelf

These activities should be conducted so that no hydrocarbor or hydrocarbon-containing substances such as oil-based drilling mud, oil-contaminated drill cuttings, oil residues, or other toxic substances are released into the water or onto the seafloc Also, the shorelines of barrier islands or beaches, small fishing or hard banks, or coral reefs should not be disturbed.

(1) Some of the following measures may be recommended for exploration and production activities in close proximity to fishing or hard banks and banks containing reef building coral:

(a) drill cuttings may be required to be shunted through a conduit to be discharged at or near the bottom, or be transported to shore or to less sensitive offshore locations concurred in by NMFS. Usually shunting is only effective when the point of the shunted discharge can be placed deeper than the area of the bank being protected. However, bulk discharge of drilling muds and mud additives to the marine waters may be prohibited;

(b) normally, all drilling and production structures, including pipelines, should not be placed within a mile c the bases of live reefs.

(2) To maintain the integrity of small fishing banks (generally 1,000 acres or less) and their accessibility to sport and commercial fishermen, structures should not be placed either temporarily or permanently on the top of slope of these banks;

(3) No debris which could impair recreational or commercia fishing should be allowed to remain on the seafloor;

(4) All submerged wellheads should be terminated beneath the seafloor. Whenever this is not feasible, they should be marked by a lighted buoy to prevent fouling of fishing gear;

(5) All pipelines placed in waters less than 300 feet deep should be buried to a minimum of 3 feet beneath the seafloor, where possible. Where not possible, and in deeper waters where user-conflicts are likely, pipelines should be marked by lighted buoys and/or lighted ranges on platforms, to reduce the risk of damage to fishing gear and to provide an added degree of safety

to the pipelines. Pipeline alignment should be located along the least damaging route in order to minimize damage to marine and estuarine habitat.

XII. Other Mineral Mining, Extraction:

a. In general, proposals for mining (extracting) mineral resources (sand, gravel, shell, phosphates, etc.) from or within 1,500 feet of exposed shell reefs, from vegetated wetlands, and within 1,500 feet of shorelines will be recommended for denial, except for obtaining cultch material;

b. All other proposals will be considered on a case-by-case basis.

XIII. Steam-Electric Plants and Other Facilities Requiring Water for Cooling or Heating:

Major adverse impacts are caused by impingement of organisms on intake screens, entrainment of organisms in the heat-exchange system, or the discharge plume, and the discharge of toxic materials in the discharge water. Most, if not all, of these adverse impacts can be avoided with the following guidelines:

a. Once-through cooling systems are unacceptable in areas where fishery organisms are concentrated, specifically in estuaries, inlets, or small coastal embayments. Steam-electric plants located on these areas must employ ocean intake and discharges sited in areas of low organism concentrations on a site-specific basis or cooling towers incorporating sufficient safeguards to ensure that blow-down pollutants do not have an adverse impact;

b. Intakes should be designed to minimize impingement. If offshore intakes are used, velocity caps on intakes to produce horizontal intake currents are recommended, with a maximum velocity of 0.5 f.p.s. at the intake screen;

c. Discharge temperatures should not exceed the thermal tolerance of the majority of the plant and animal species in the receiving body of water (both heated and chilled effluents);

d. The use of construction materials which cause the release of toxic substances into receiving waters (e.g., copper) should be minimized. The use of biocides, such as chlorine, to prevent fouling should be avoided where possible. Every effort should be made to find alternative methods for the prevention of fouling.

XIV. Mitigation:

Adherence to Guidelines I - XIII should minimize various project impacts on fishery resources and their habitats, but some impacts associated with public interest projects are unavoidable. Such impacts could individually or cumulatively reduce the production of fishery resources. Therefore, to avoid a net loss of habitat, NMFS will consider and recommend mitigation only after a project has been demonstrated to be water-dependent with no feasible alternatives and clearly in the public interest.

Mitigation may consist of restoration of impacted habitat, the generation of new habitat, or a combination of both. Regardless of which option is used, a ratio of at least one acre of mitigation for one acre of destroyed habitat is recommended.

a. Restoration - The numerous impacted wetlands that exist in the southeast offer an opportunity to restore acre-for-acre almost any wetland that is lost in future projects. This may be relatively simple, such as restoring tidal flows to a wetland area impounded by an old highway, or more complex such as restoring a dredged cut or disposal area that is no longer being used. Restoration of destroyed emergent and submerged vegetation is now a feasible and recognized option. The services of an experienced restoration team is essential to ensure success.

b. Generation - The generation of wetland habitat involves the conversion of upland habitat to wetland habitat to replace that which is destroyed in the construction and operation of a water-dependent public interest project. Generation of habitat does not mean converting one type of wetland habitat to another. For example, the building of marshes out of existing shallow-water habitat is not acceptable ~~mitig~~ation.
generation

Four basic considerations involved in the planning for habitat generation are type of habitat, location, size and configuration. Each of these considerations must be applied to the ecological setting of the project site, but the following guidelines apply:

(1) Habitat type - The habitat generated should be as nearly identical as possible to that destroyed. For example, a *Spartina alterniflora* marsh should be generated if a *Spartina alterniflora* marsh is destroyed. The same would apply to mangrove species, submerged grasses, and tidal flats. Each should be replaced in kind.

(2) Location - The new site should be located as near the destroyed site as possible, preferably adjacent to the project site. In any event, the new site should be in the same estuarine system as that of the destroyed habitat and should not interrupt existing circulation or drainage patterns.

(3) Size - The size of the habitat generated should be at least equal to the size of the one destroyed, preferably larger.

(4) Configuration - There are many possibilities regarding configuration, depending on the ecological setting. Regardless of the configuration chosen, it should not interfere with existing drainage and circulation patterns in adjacent wetlands.

ENVIRONMENTAL POLICIES AND
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U.S. SOIL CONSERVATION SERVICE

marsh should clearly be outlined.

5.) Monitoring Plan

A monitoring plan should be included to evaluate whether the goals have been accomplishes and to what degree. Monitoring may be done by gathering information from: water quality sampling, vegetational change analysis, aerial photography, hunting or trapping records or other similar methods.

6.) Non-Marsh Management Activities

A statement of policy should be included concerning activities other than those involved with marsh management which may occur within the management area (i.e. the dredging of oil and gas canals and the placement of spoil). In addition, a statement of policy should be included concerning restoration of areas impacted by non-marsh management activities (i.e the plugging or backfilling of abandoned canals).

7.) In addition, the following specific information should be provided where applicable.

a. The length and cross section (with scale) of any levee(s) to be constructed or reconstructed.
b. The amount of fill material or dredging necessary for levee or water control structure construction.
c. Present elevation of existing levees.
d. The location of any tidal creeks which may be closed by this activity.
e. Allowances for the ingress and egress of estuarine organisms.

SCS Environmental Policy and Technical Assistance Guidelines

The SCS mission is to provide assistance that will allow use and management of ecological, cultural, natural, physical, social and economic resources by striving for a balance between use, management, conservation, and preservation of the Nation's natural resource base. The SCS will conduct and coordinate its plans, functions, programs, and recommendations on resource use so that stewards of the environment for succeeding generation:

(1) Can maintain safe, healthful, productive, and aesthetically and culturally pleasing surroundings that support diversity of individual choices; and

(2) Are encouraged to attain the widest range of beneficial uses of soil, water, and related resources without degradation of the environment, risk to health or safety, or other undesirable and unintended consequences.

SCS Environmental Policy

SCS is to administer federal assistance within the following overall environmental policies:

(1) Provide assistance to landowners and users that will motivate them to

maintain equilibrium among their ecological, cultural, natural, physical, social, and economic resources by striving for a balance between conserving and preserving the Nation's natural resource base.

(2) Provide technical and financial assistance through a systematic interdisciplinary approach to planning and decision making to insure a balance between the natural, physical and social sciences.

(3) Consider environmental quality equal to economic, social, and other factors in decision-making.

(4) Insure that plans satisfy identified needs and at the same time minimize adverse effects of planned actions on the human environment through interdisciplinary planning before providing technical and financial assistance.

(5) Counsel with highly qualified and experienced specialists from within and outside SCS in many technical fields as needed.

(6) Encourage broad public participation in defining environmental quality objectives and needs.

(7) Identify and make provisions for detailed survey, recovery, protection, or preservation of unique cultural resources that otherwise may be irrevocably lost or destroyed by SCS-assisted project actions, as required by Historic Preservation legislation and/or Executive Order.

(8) Encourage local sponsors to review with interested publics the operation and maintenance programs of completed projects to insure that environmental quality is not degraded.

(9) Advocate the retention of important farmlands and forestlands, prime farmlands, rangeland, wetlands, or other lands designated by state or local governments. Whenever proposed conversions are caused or encouraged by actions or programs of a federal agency, licensed by or require approval by a federal agency, or are inconsistent with local or state government plants, provisions are to be sought to insure that such lands are not irreversibly converted to other uses unless other national interests override the importance of preservation or otherwise outweigh the environmental benefits derived from their protection. In addition, the preservation of farmland in general provides the benefits of open space, protection of scenery, wildlife habitat, and in some cases, recreation opportunities and controls on urban sprawl.

(10) Advocate actions that reduce the risk of flood loss, minimize effects of floods on human safety, health and welfare, and restore and preserve the natural and beneficial functions and values of flood plains.

(11) Advocate and assist in the reclamation of abandoned surface-mined lands and in planning for the extraction of coal and other non-renewable resources to facilitate restoration of the land to its prior productivity as mining is completed.

(12) Advocate the protection of valuable wetlands, threatened and endangered animal and plant species and their habitats, and designated ecosystems.

(13) Advocate the conservation of natural and man-made scenic resources to insure that SCS-assisted programs or activities protect and enhance the visual quality of the landscape.

(14) Advocate and assist in actions to preserve and enhance the quality of the Nation's waters.

Threatened and Endangered Species of Plants and Animals

Background

(1) A variety of plant and animal species of the United States are so reduced in numbers that they are threatened with extinction. The disappearance of any of these would be a biological, cultural, and in some instances an economic loss. Their existence contributes to scientific knowledge and understanding, and their presence adds interest and variety to life.

(2) The principal hazard to threatened and endangered species is the destruction or deterioration of their habitats by human activities such as industrialization, urbanization, agriculture, lumbering, recreation, exploration and extraction, and transportation. These activities of man will continue, but the necessity of recognizing their impacts and selecting practices or actions that minimize or eliminate such impacts on threatened and endangered species is imperative.

(3) The Endangered Species Act of 1973, as amended, (PL 93-205, 87 Stat. 884 (16 U.S.C. 1531 et seq.)) provides a means whereby the ecosystems upon which threatened and endangered species depend, may be maintained, as well as a program for the conservation of such species. The Act also provides that, in addition to the Department of the Interior all other federal departments and agencies shall, in consultation with and with the assistance of the Secretary of the Department of the Interior, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of threatened and endangered species listed pursuant to Section 4 of this Act. Each federal agency is to insure that its actions do not jeopardize the continued existence of threatened and endangered species or result in the destruction or adverse modification of their habitat. Critical habitats will be determined in consultation, as appropriate, with the affected states.

Policy

The SCS will assist in the conservation of threatened and endangered species and consistent with legal requirements, avoid or prevent activities detrimental to such species. SCS's concern for these species will not be limited to those listed by the Secretary of the Interior and published in the Federal Register, but will include species designated by state agencies as rare, threatened, endangered, etc.

Scenic Beauty

Background

Contributions to scenic beauty are a normal product of SCS work. Emphasis is given to those soil and water conservation measures that contribute to a productive and efficient agriculture, enhance wildlife, increase the attractiveness of rural landscapes and are in line with goals and objectives of conservation districts. This can be accomplished by considering the landscape visual resource when providing planning assistance to individual landowners, groups, units of government, and watershed and
resource conservation development project sponsors.

Policy

SCS will:

(1) Provide technical assistance with full consideration of alternative management and development systems that preserve scenic beauty or improve the landscape;

(2) Emphasize the application of conservation practices having scenic beauty or landscape resource values particularly in waste management systems, field borders, field windbreaks, wildlife and wetland habitat management, access road, critical area treatment; design and management of ponds, stream margins, odd areas, and farmstead; siting or positioning of structures and buildings to be in harmony with the landscape while reducing the potential for erosion; using native and other adaptable plants for conservation which enhance scenic beauty and create variety while linking beauty with utility;

(3) Promote personal pride in landowners in the installation, maintenance, and appearance of conservation practices and their properties;

(4) Select suitable areas for waste products.

(5) Encourage conservation districts to include practices which promote scenic beauty in their annual and long-range programs.

Responsibility

SCS will provide technical assistance through conservation districts to landowners, operators, communities, and state and local governments in developing programs relating to scenic beauty.

POLICIES AND PROCEDURES
ON
MARSH MANAGEMENT

U.S. ENVIRONMENTAL PROTECTION AGENCY

EPA POLICY/PROCEDURES ON MARSH MANAGEMENT

EPA INVOLVEMENT WITH MARSH MANAGEMENT IS LARGELY BASED ON RESPONSIBILITIES ASSOCIATED WITH THE CLEAN WATER ACT, SECTION 404.

EPA'S MAJOR ROLE IS RELATED TO THE COMPLIANCE OF ANY PROPOSED PROJECT WITH THE SECTION 404(b)(1) GUIDELINES. THE ACT REQUIRED EPA TO DEVELOP AND INTERPRET THE GUIDELINES, AND REQUIRES THE CORPS OF ENGINEERS TO APPLY THEM IN THEIR EVALUATION BEFORE PROPOSING ANY PERMIT ACTION.

EPA PROVIDES COMMENTS/RECOMMENDATIONS TO THE CORPS REGARDING THE COMPLIANCE OF A PROPOSED PROJECT.

THE REGULATORY EVALUATION MUST CONSIDER IMPACTS TO THE PHYSICAL, CHEMICAL, AND BIOLOGICAL ASPECTS OF THE AQUATIC SYSTEM. DIRECT, SECONDARY, AND CUMULATIVE IMPACT EVALUATIONS ARE INCLUDED IN THE EVALUATION PROCESS.

A MARSH IS A WETLAND, WHICH MEANS IT IS A "SPECIAL AQUATIC SITE" WITHIN THE DEFINITION OF WATERS OF THE UNITED STATES, AND RECEIVES ADDITIONAL CONSIDERATION. FOR EXAMPLE, THE GUIDELINES PROHIBIT A DISCHARGE INTO A SPECIAL AQUATIC SITE, IF THE ACTIVITY IS NOT WATER DEPENDENT, AND DOES NOT REQUIRE SITING WITHIN A SPECIAL AQUATIC SITE TO ACHIEVE THE BASIC PURPOSE OF THE ACTIVITY.

EPA IS CONCERNED WITH PROTECTION FOR THE NATURAL MARSH ITSELF AND THE RELATED WETLAND FUNCTION AND VALUES, INCLUDING WATER SUPPLY, FLOODWATER STORAGE, WATER QUALITY FUNCTIONS, CONTRIBUTIONS TO THE FOOD CHAIN, AS WELL AS IT'S WILDLIFE AND FISHERIES HABITATS. THEREFORE, EPA IS CONCERNED WITH THE ENTIRE NATURAL SYSTEM AND ALL WETLAND FUNCTIONS.

THE LOUISIANA COASTAL LAND LOSS PROBLEM, INVOLVING IT'S MANY MARSHES IS WELL KNOWN. EPA IS CONCERNED THAT MARSH MANAGEMENT PROJECTS THAT MAY RECEIVE CLEAN WATER ACT 404 PERMITS, SHOULD PROTECT NATURAL MARSH SYSTEMS, ALL WETLAND FUNCTIONS, AND NOT CONTRIBUTE TO FURTHER LAND LOSS.

STUDIES ARE CURRENTLY UNDERWAY TO EVALUATE THE IMPACTS OF MARSH MANAGEMENT PRACTICES. WE ARE CONCERNED THAT THE STUDIES BE COMPREHENSIVE AND OBJECTIVE. EPA IS PARTICIPATING IN SOME OF THE ONGOING MARSH MANAGEMENT EFFORTS.

WE ARE ALSO CONCERNED THAT MARSH MANAGEMENT PLANS SHOULD NOT BE CONSIDERED AS MITIGATION FOR LAND LOSS, FOR IN MANY CASES THE MAJOR MANAGEMENT PURPOSE IS FOR IMPOUNDMENT, AND INCREASING OPEN WATER AREAS AND WATER LEVELS FOR THE BENEFIT OF SOME SPECIES. For example, WHAT IS THE LONGTERM IMPACT ON THE MARSH WHEN EVERY YEAR IS A HIGH WATER YEAR?

WE ARE ALSO CONCERNED THAT IN CASES WHERE SALTWATER INTRUSION INTO PREVIOUSLY FRESHER AREAS IS CONTRIBUTING TO LAND LOSS, THAT SPECIFIC PROVISION which IS PROPOSED FOR MARINE WATER INFLOW TO ACCOMMODATE MARINE ORGANISMS contributes to saltwater intrusion. ON THE LONG TERM, CAN MARSHES BE REBUILT UNDER THESE CONDITIONS?

WHAT PART DOES SOIL AND VEGETATION TYPE, AND MINOR SALINITY CHANGES/FLUCTUATIONS PLAY IN THE MAINTENANCE OF A GIVEN MARSH? WHAT impact occurs in areas adjacent to a "managed" area?

WHAT IS THE APPROPRIATE MANAGEMENT PROCEDURE WHEN THE OBJECTIVE IS TO ONLY SAVE OR RESTORE THE MARSH, WITHOUT OTHER OBJECTIVES AT CROSS PURPOSE?

WE FIND NO EASY ANSWERS.

WE ARE ALSO CONCERNED THAT GOOD BASELINE DATA BE ESTABLISHED FROM WHICH TO MONITOR AND MEASURE THE CHANGES WHICH OCCUR WITH DIFFERENT MANAGEMENT SCHEMES, SO THAT BETTER MANAGEMENT DECISIONS ARE MADE IN THE FUTURE.

THE BOTTOM LINE IS THAT WE BELIEVE EACH MARSH MANAGEMENT PLAN CONTINUE TO BE EVALUATED ON A CASE BY CASE BASIS, AND IN CASES WHERE A PERMIT MAY BE ISSUED - MONITORING MUST BE REQUIRED. WE ALSO BELIEVE THAT ALL WETLAND FUNCTIONS MUST BE PROTECTED AND THAT SINGLE FUNCTIONS (SUCH AS WILDLIFE PRODUCTION) NOT BE FAVORED AT THE EXPENSE OF THE NATURAL SYSTEM.

APPENDIX G

MEMORANDUM OF AGREEMENT

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-OR

RECEIVED DEC 6 1989 COASTAL MANAGEMENT DIVISION

15 NOV 1989

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Mitigation Memorandum of Agreement (MOA) between the Department of the Army and the Environmental Protection Agency (EPA)

1. On November 15, 1989, Mr. Robert W. Page, Assistant Secretary of the Army for Civil Works, and Ms. LaJuana S. Wilcher, Assistant Administrator for Water, U. S. Environmental Protection Agency signed an MOA providing guidance on the type and level of mitigation required to determine compliance with the Section 404(b)(1) Guidelines. A copy is enclosed. The effective date of this policy is 15 December 1989.

2. This MOA has been the subject of considerable discussion and negotiation between the two agencies. It is intended to clarify the Corps mitigation practices (33 CFR 320.4(r)) in applying the Guidelines. The MOA clarifies and establishes a consistent Corps wide practice for considering mitigation. Mitigation should occur in a clear sequence of avoidance of wetlands impacts through the evaluation of practicable alternatives, minimization as the second step in the sequence, and lastly, compensation of unavoidable impacts through restoration or creation. Some flexibility in narrowly defined circumstances is allowed in the application of the mitigation sequence.

3. Questions regarding the MOA should be directed to HQUSACE, CECW-OR.

FOR THE COMMANDER:

Encl

PATRICK J. KELLY
Brigadier General (P), USA
Director of Civil Works

DISTRIBUTION
(SEE PG. 2)

MEMORANDUM OF AGREEMENT BETWEEN THE ENVIRONMENTAL PROTECTION AGENCY AND THE DEPARTMENT OF THE ARMY CONCERNING THE DETERMINATION OF MITIGATION UNDER THE CLEAN WATER ACT SECTION 404(b)(1) GUIDELINES

I. Purpose

The United States Environmental Protection Agency (EPA) and the United States Department of the Army (Army) hereby articulate the policy and procedures to be used in the determination of the type and level of mitigation necessary to demonstrate compliance with the Clean Water Act (CWA) Section 404(b)(1) Guidelines ("Guidelines"). This Memorandum of Agreement (MOA) expresses the explicit intent of the Army and EPA to implement the objective of the CWA to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, including wetlands. This MOA is specifically limited to the Section 404 Regulatory Program and is written to provide clarification for agency field personnel on the type and level of mitigation required to demonstrate compliance with requirements in the Guidelines. The policies and procedures discussed herein are consistent with current Section 404 regulatory practices and are provided in response to questions that have been raised about how the Guidelines are implemented.

Although the Guidelines are clearly applicable to all discharges of dredged or fill material, including general permits and Corps of Engineers (Corps) civil works projects, this MOA focuses on standard permits (33 CFR 325.5(b)(1))[1]. This focus is intended solely to reflect the unique procedural aspects associated with the review of standard permits, and does not obviate the need for other regulated activities to comply fully with the Guidelines. EPA and Army will seek to develop supplemental guidance for other regulated activities consistent with the policies and principles established in this document.

This MOA is a directive for Corps and EPA personnel and must be adhered to when considering mitigation requirements for standard permit applications. The Corps will use this MOA when making its determination of compliance with the Guidelines with respect to mitigation for standard permit applications. EPA will use this MOA in developing its positions on compliance with the Guidelines for proposed discharges and will reflect this MOA when commenting on standard permit applications.

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[1]Standard permits are those individual permits which have been processed through application of the Corps public interest review procedures (33 CFR 325) and EPA's Section 404(b)(1) Guidelines, including public notice and receipt of comments. Standard permits do not include letters of permission, regional permits, nationwide permits, or programmatic permits.

II. Policy

A. The Council on Environmental Quality (CEQ) has defined mitigation in its regulations at 40 CFR 1508.20 to include: avoiding impacts, minimizing impacts, rectifying impacts, reducing impacts over time, and compensating for impacts. The Guidelines establish environmental criteria which must be met for activities to be permitted under Section 404.[2] The types of mitigation enumerated by CEQ are compatible with the requirements of the Guidelines; however, as a practical matter, they can be combined to form three general types: avoidance, minimization and compensatory mitigation. The remainder of this MOA will speak in terms of these more general types of mitigation.

B. The Clean Water Act and the Guidelines set forth a goal of restoring and maintaining existing aquatic resources. The Corps will strive to avoid adverse impacts and offset unavoidable adverse impacts to existing aquatic resources, and for wetlands, will strive to achieve a goal of no overall net loss of values and functions. In focusing the goal of no overall net loss to wetlands only, EPA and Army have explicitly recognized the special significance of the nation's wetlands resources. This special recognition of wetlands resources does not in any manner diminish the value of other waters of the United States, which are often of high value. All waters of the United States, such as streams, rivers, lakes, etc., will be accorded the full measure of protection under the Guidelines, including the requirements for appropriate and practicable mitigation. The determination of what level of mitigation constitutes "appropriate" mitigation shall be based on the values and functions of the aquatic resource that will be impacted. This determination shall not be based upon characteristics of the proposed project such as need, societal value, or the nature or investment objectives of the project's sponsor. "Practicable" shall be defined as in Section 230.10(a)(2) of the Guidelines. However, the level of mitigation determined to be appropriate and practicable under Section 230.10(d) may lead to individual permit decisions which do not fully meet this goal because the mitigation measures necessary to meet this goal are not feasible, not practicable, or would accomplish only inconsequential reductions in impacts. Consequently, it is recognized that no net loss of wetlands functions and values may not be achieved in each and every permit action. However, it remains a goal of the Section 404 regulatory program to contribute to the national goal of no overall net loss of the nation's remaining wetlands base. EPA and Army are committed to working with others through the Administration's interagency task force and other avenues to help achieve this national goal.

C. In evaluating standard Section 404 permit applications, as a practical matter, information on all facets of a project, including potential mitigation, is typically gathered and reviewed at the same time. Notwithstanding this procedural approach, the Corps will, except as indicated below, first make a determination that potential impacts have been avoided to the maximum extent practicable; remaining unavoidable impacts will then be

[2](except where Section 404(b)(2) applies).

mitigated to the extent appropriate and practicable by requiring steps to minimize impacts and, only as a last resort, compensate for aquatic resource values. This sequence will be considered satisfied where the proposed mitigation is in accordance with specific provisions of a Corps and EPA approved comprehensive plan that ensures compliance with the compensation requirements of this MOA, as set forth at Section II.B (examples of such comprehensive plans may include Special Area Management Plans, Advance Identification areas (Section 230.80), and State Coastal Zone Management Plans). In some circumstances, it may be appropriate to deviate from the sequence when EPA and the Corps agree the proposed discharge is necessary to avoid environmental harm (e.g., to protect a natural aquatic community from saltwater intrusion, chemical contamination, or other deleterious physical or chemical impacts), or EPA and the Corps agree that the proposed discharge can reasonably be expected to result in environmental gain. This environmental gain must be solely attributable to the project itself, exclusive of benefits which may accrue from proposed compensatory mitigation.

In determining "appropriate and practicable" measures to offset unavoidable impacts, such measures should be appropriate to the scope and degree of those impacts and practicable in terms of cost, existing technology, and logistics in light of overall project purposes. The Corps will give full consideration to the views of the resource agencies when making this determination.

1. **Avoidance.**[3] Section 230.10(a) allows permit issuance for only the least environmentally damaging practicable alternative.[4] The thrust of this section on alternatives is avoidance of impacts. Section 230.10(a)(1) requires that, to be permittable, an alternative must be the least environmentally damaging practicable alternative. In addition, Section 230.10(a)(3) sets forth rebuttable presumptions that 1) alternatives for non-water dependent activities that do not involve special aquatic sites[5] are available and 2) alternatives that do not involve special aquatic sites have less adverse impact on the aquatic environment. Compensatory mitigation may not be used as a method to reduce environmental impacts in the selection of the least environmentally damaging practicable alternatives for the purposes of requirements under Section 230.10(a).

2. **Minimization.** Section 230.10(d) states that appropriate and practicable steps to minimize the adverse impacts will be required through project modifications and permit

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[3]Avoidance as used in this MOA does not include compensatory mitigation.

[4]It is important to recognize that there are circumstances where the impacts of the project are so significant that even if alternatives are not available, the discharge may not be permitted regardless of the compensatory mitigation proposed (40 CFR 230.10(c)).

[5]Special aquatic sites include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs and riffle pool complexes.

conditions. Subpart H of the Guidelines describes several (but not all) means for minimizing impacts of an activity.

3. **Compensatory Mitigation.** Appropriate and practicable compensatory mitigation will be required for unavoidable adverse impacts which remain after all appropriate and practicable minimization has been required. Compensatory actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands) should be undertaken, when practicable, in areas adjacent or contiguous to the discharge site (on-site compensatory mitigation). If on-site compensatory mitigation is not practicable, off-site compensatory mitigation should be undertaken in the same geographic area (i.e., in close physical proximity and, to the extent possible, the same watershed). In determining compensatory mitigation, the functional values lost by the resource to be impacted must be considered. In most cases, in-kind compensatory mitigation is preferable to out-of-kind. There is continued uncertainty regarding the success of wetland creation or other habitat development. Therefore, in determining the nature and extent of habitat development of this type, careful consideration should be given to its likelihood of success. Because the likelihood of success is greater and the impacts to potentially valuable uplands are reduced, restoration should be the first option considered.

In the situation where the Corps is evaluating a project where a permit issued by another agency requires compensatory mitigation, the Corps may consider that mitigation as part of the overall application for purposes of public notice, but avoidance and minimization shall still be sought.

Mitigation banking may be an acceptable form of compensatory mitigation under specific criteria designed to ensure an environmentally successful bank. Where a mitigation bank has been approved by EPA and the Corps for purposes of providing compensatory mitigation for specific identified projects, use of that mitigation bank for those particular projects will be considered as meeting the requirements of Section II.C.3 of this MOA, regardless of the practicability of other forms of compensatory mitigation. Additional guidance on mitigation banking will be provided. Simple purchase or "preservation" of existing wetlands resources may in only exceptional circumstances be accepted as compensatory mitigation. EPA and Army will develop specific guidance for preservation in the context of compensatory mitigation at a later date.

III. Other Procedures

A. Potential applicants for major projects should be encouraged to arrange preapplication meetings with the Corps and appropriate federal, state or Indian tribal, and local authorities to determine requirements and documentation required for proposed permit evaluations. As a result of such meetings, the applicant often revises a proposal to avoid or minimize adverse impacts after developing an understanding of the Guidelines requirements by which a future Section 404 permit decision will be made, in addition to gaining an understanding of other state or tribal, or local requirements.

B. In achieving the goals of the CWA, the Corps will strive to avoid adverse impacts and offset unavoidable adverse impacts to existing aquatic resources. Measures which can accomplish this can be identified only through resource assessments tailored to the site performed by qualified professionals because ecological characteristics of each aquatic site are unique. Functional values should be assessed by applying aquatic site assessment techniques generally recognized by experts in the field and/or the best professional judgment of federal and state agency representatives, provided such assessments fully consider ecological functions included in the Guidelines. The objective of mitigation for unavoidable impacts is to offset environmental losses. Additionally for wetlands, such mitigation will provide, at a minimum, one for one functional replacement (i.e., no net loss of values)[6], with an adequate margin of safety to reflect the expected degree of success associated with the mitigation plan, recognizing that this minimum requirement may not be relevant in some cases, as discussed in Section II.B of this MOA.

C. The Guidelines are established as the environmental standard for Section 404 permit issuance under the CWA. Aspects of a proposed project may be affected through a determination of requirements needed to comply with the Guidelines to achieve these CWA environmental goals. Other reviews, such as NEPA and the Corps public interest review, cannot be used to nullify any Guidelines requirements or to justify less rigorous Guidelines evaluations.

D. Monitoring is an important aspect of mitigation, especially in areas of scientific uncertainty. Monitoring should be directed toward determining whether permit conditions are complied with and whether the purpose intended to be served by the condition is actually achieved. Any time it is determined that a permittee is in non-compliance with mitigation requirements of the permit, the Corps will take action in accordance with 33 CFR Part 326. Monitoring should not be required for purposes other than these, although information for other uses may accrue from the monitoring requirements. For projects to be permitted involving mitigation with higher levels of scientific uncertainty, such as some forms of compensatory mitigation, long term monitoring, reporting and potential remedial action should be required. This can be required of the applicant through permit conditions.

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[6]In most cases a minimum of 1 to 1 acreage replacement of wetlands will be required to achieve no net loss of values. However, this ratio may be greater where the functional values of the area being impacted are demonstrably high. Conversely, the ratio may be less than 1 to 1 for areas where the functional values associated with the area being impacted are demonstrably low and the likelihood of success associated with the mitigation proposal is high.

E. Mitigation requirements shall be conditions of standard Section 404 permits. Army regulations authorize mitigation requirements to be added as special conditions to an Army permit to satisfy legal requirements (e.g., conditions necessary to satisfy the Guidelines) [33 CFR 325.4(a)]. This ensures legal enforceability of the mitigation conditions and enhances the level of compliance. If the mitigation plan necessary to ensure compliance with the Guidelines is not reasonably implementable or enforceable, the permit shall be denied.

F. Nothing in this document is intended to diminish, modify or otherwise affect the statutory or regulatory authorities of the agencies involved. Furthermore, formal policy guidance on or interpretation of this document shall be issued jointly.

G. This MOA shall take effect thirty (30) days after the date of the last signature below, and will apply to those completed standard permit applications which are received on or after the effective date. This MOA may be modified or revoked by agreement of both parties, or revoked by either party alone upon six (6) months written notice.

11/14/89	NOV 15 1989
Robert W. Page (date)	LaJuana S. Wilcher (date)
Assistant Secretary of the Army	Assistant Administrator for Water
(Civil Works)	U.S. Environmental Protection Agency

APPENDIX H

ACT 6 OF THE SECOND EXTRAORDINARY

SESSION OF THE 1989 LOUISIANA LEGISLATURE

WETLANDS CONSERVATION AND RESTORATION

ACT NO. 6

S.B.No. 26

AN ACT to amend and reenact R.S. 36:351(B) and (C)(1), R.S. 39:1482(A), and R.S. 49:213.11(G); to enact Subpart A of Part II of Chapter 2 of Title 49 of the Louisiana Revised Statutes of 1950, to be comprised of R.S. 49:213.1 through 213.7; to enact Subpart B of Part II of Chapter 2 of Title 49 of the Louisiana Revised Statutes of 1950, to be comprised of R.S. 49:214.1 through 214.5; to enact R.S. 56:2011(C), and R.S. 36:4(J) and 358(B); and to repeal Chapter 5-A of Subtitle I of Title 30 of the Louisiana Revised Statutes of 1950, comprised of R.S. 30:311 through 316; to redesignate the heading of Part II of Chapter 2 of Title 49 of the Louisiana Revised Statutes of 1950 and present sections as "Subpart C. Louisiana Coastal Zone Management Program" consisting of R.S. 49:214.21 through 214.41; relative to wetlands conservation, restoration, and management; to create and provide with respect to the office of coastal restoration and management within the Department of Natural Resources; to create and provide with respect to the Wetlands Conservation and Restoration Authority within the office of the governor; to provide for the gubernatorial appointment of the executive assistant of the authority and for his powers, duties, and responsibilities; to create and provide with respect to the Wetlands Conservation and Restoration Task Force; to create and provide with respect to the wetlands conservation and restoration program and plan; to create and provide with respect to the Wetlands Conservation and Restoration Fund; and to provide for related matters.

Be it enacted by the Legislature of Louisiana:

Section 1. R.S. 36:351(B) and (C)(1) are hereby amended and reenacted and R.S. 36:4(J) and 358(B) are hereby enacted, all to read as follows:

§ 4. Structure of executive branch of state government

* * *

J. The Wetlands Conservation and Restoration Authority (R.S. 49:213.1, et seq.) shall be placed within the office of the governor and shall perform and exercise its powers, duties, functions, and responsibilities as provided by law.

* * *

§ 351. Department of Natural Resources; creation, domicile; composition; purposes and functions

* * *

B. The Department of Natural Resources, through its offices and officers, shall be responsible for the conservation, management, and development of water, minerals, and other such natural resources of the state, including coastal restoration and management, except timber and fish and wildlife and their habitats.

C. (1) The Department of Natural Resources shall be composed of the executive office of the secretary, the office of management and finance, the office of conservation, the office of mineral resources, the office of coastal restoration and management, and such other offices as shall be created by law.

B. (1) The office of coastal restoration and management shall perform the functions of the state relative to conservation, development and, where feasible, restoration and enhancement of the state's coastal wetlands resources, and will serve as the primary state agency responsible for implementation of the state's coastal vegetated wetlands conservation and restoration plan.

(2) The office of coastal restoration and management shall be composed of the coastal restoration division and the coastal management division. The coastal management division shall implement the coastal zone management program. The coastal restoration division shall perform those functions of the state relating to the conservation, restoration, creation, and enhancement of coastal wetlands in Louisiana as provided by law.

* * *

Section 2. R.S. 39:1482(A) is hereby amended and reenacted to read as follows:

§ 1482. Application of the Chapter

A. Except as otherwise provided herein, this Chapter shall apply to every expenditure of public funds by the executive branch of this state, except expenditures by the Department of Transportation and Development and the coastal restoration division within the Department of Natural Resources, under any contract or like business agreement to purchase professional, personal, consulting, or social services. However, this Chapter shall not apply to grants or to contracts or like business agreements between the state and its political subdivisions or other governmental entities or between political subdivisions or other governmental entities, or between higher education boards and institutions under their jurisdiction, except this Chapter shall apply to interagency contracts as defined in R.S. 39:1490(C), and to contracts or grants between the state and its political subdivision to procure social services. A copy of each contract between a higher education board and an institution under its jurisdiction shall be provided to the office of contractual review within fifteen days of its execution.

* * *

Section 3. Subpart A of Part II of Chapter 2 of Title 49 of the Louisiana Revised Statutes of 1950, to be comprised of R.S. 49:213.1 through 213.7, and Subpart B of Part II of Chapter 2 of Title 49 of the Louisiana Revised Statutes of 1950, to be comprised of R.S. 49:214.1 through 214.5, are hereby enacted to read as follows:

SUBPART A. WETLANDS CONSERVATION AND RESTORATION AUTHORITY

§ 213.1. Statement of intent

A. Coastal land loss in Louisiana continues in catastrophic proportions. Wetlands loss threatens valuable fish and wildlife production and the viability of residential, agricultural, and industrial development in coastal Louisiana.

B. In the past, efforts by the state to address the myriad, interrelated problems of coastal land loss have been inadequate, fragmented, uncoordinated, and lacking in focus and strong direction. Meanwhile, coastal deterioration has escalated to a point such that the potential for vegetated wetlands restoration and enhancement in particular is declining rapidly.

C. The state must act immediately to conserve, restore, create, and enhance vegetated wetlands in coastal Louisiana while encouraging use of coastal resources and recognizing that it is in the public interest of the people of Louisiana to establish a responsible balance between development and conservation. Management of renewable coastal resources must proceed in a manner that is consistent with and complementary to the efforts to establish a proper balance between development and conservation.

D. It is the intention of the legislature that wetlands conservation and restoration be elevated in tandem to a position within state government of high visibility and action and that the conservation, restoration, creation, and nourishment of coastal vegetated wetlands be of high priority within that structure. To provide aggressive state leadership, direction, and consonance in the development and implementation of policies, plans, and programs to encourage multiple uses of the coastal zone and to achieve a proper balance between development and conservation, restoration, creation, and nourishment of renewable coastal resources, the legislature places responsibility for the direction and development of the state's coastal vegetated wetlands conservation and restoration plan in the Wetlands Conservation and Restoration Authority within the office of the governor. Primary responsibility for carrying out the elements of the plan is placed in the office of coastal restoration and management within the Department of Natural Resources.

§ 213.2. Definitions

As used in this Part, the following terms shall have the meaning ascribed to them below:

(1) "Authority" means the Wetlands Conservation and Restoration Authority.

(2) "Conservation and restoration" means the conservation and restoration of coastal wetlands resources including but not limited to coastal vegetated wetlands through the construction and management of coastal wetlands enhancement projects, including privately funded marsh management projects or plans, and those activities requiring a coastal use permit which significantly affect such projects or which significantly diminish the benefits of such projects or plans insofar as they are intended to conserve or enhance coastal wetlands consistent with the legislative intent as expressed in R.S. 49:213.1.

(3) "Executive assistant" means the special assistant to the governor for coordination of coastal activities.

(4) "Fund" means the Wetlands Conservation and Restoration Fund.

(5) "Plan" means the state coastal vegetated wetlands conservation and restoration plan.

(6) "Project" means a physical structure or structures designed and constructed according to the plan.

(7) "Task Force" means the Wetlands Conservation and Restoration Task Force.

§ 213.3. Creation; personnel

A. The Wetlands Conservation and Restoration Authority is hereby created within the office of the governor. The authority is hereby established, and shall exercise the powers and duties hereinafter set forth or otherwise provided by law.

B. The authority shall be composed of the executive assistant to the governor for coastal activities and the Task Force. The executive assistant shall be appointed by the governor, subject to Senate confirmation, to serve at his pleasure. He shall report directly to the governor.

C. The governor, through the executive assistant, consistent with the legislative intent as expressed in R.S. 49:213.1, shall coordinate the powers, duties, functions, and responsibilities of any state agency relative to coastal wetlands conservation and restoration and shall administer the programs of the authority. The executive assistant shall employ necessary staff to carry out the duties and functions of the authority as provided in this Part or as otherwise provided by law.

§ 213.4. Powers and duties

A. The authority shall:

(1) Develop a comprehensive policy addressing the conservation and restoration of coastal wetlands resources through the construction and management of coastal vegetated wetlands enhancement projects, including privately funded marsh management projects or plans, and addressing those activities requiring a coastal use permit which significantly affect such projects, all consistent with the legislative intent as expressed in R.S. 49:213.1.

(2) Develop and submit to the legislative committees on natural resources for their approval a plan developed pursuant to R.S. 49:213.6 for conserving and restoring the state's coastal vegetated wetlands, consistent with legislative intent and with the policy developed by the authority. Upon approval of the plan by the legislative committees on natural resources and prior to implementation of the plan, in whole or in part, the plan shall be approved by the legislature as provided in R.S. 49:213.6(D).

(3) Approve all state departmental budget requests for programs and projects pertaining to coastal wetlands conservation and restoration insofar as such requests are for funds to be appropriated from the Wetlands Conservation and Restoration Fund.

(4) Be authorized to delegate any of its powers, duties, and functions to the executive assistant.

B. The governor, through the executive assistant, shall:

(1) Coordinate all state departmental budget requests for programs and projects pertaining to coastal wetlands conservation and restoration as well as all requests for funds to be appropriated from the Wetlands Conservation and Restoration Fund.

(2) Coordinate and focus the functions of all state agencies as they relate to wetlands conservation and restoration.

(3) Review and reconcile state agency comments on federally sponsored water resource development projects or permitted conservation and restoration activities to establish and present the official state position which shall be consistent with the policies of the authority.

(4) Represent the policy and consensus viewpoint of the state at the federal, regional, state, and local levels with respect to wetlands conservation and restoration.

(5) Appraise the adequacy of statutory and administrative mechanisms for coordinating the state's policies and programs at both the intrastate and interstate levels with respect to wetlands conservation and restoration.

(6) Appraise the adequacy of federal, regional, state, and local programs to achieve the policies and meet the goals of the state with respect to wetlands conservation and restoration.

(7) Oversee and coordinate federal and state-funded research related to coastal land loss and subsidence.

(8) Coordinate and focus federal involvement in Louisiana with respect to coastal wetlands conservation and restoration.

(9) Provide the official state recommendations to the legislature and congress with respect to policies, programs, and coordinating mechanisms relative to wetlands conservation and restoration or wetlands loss research.

(10) Monitor and seek available federal and private funds consistent with the purposes of the Part.

(11) Manage his personnel as provided by law.

(12) Manage his budget, office, and related functions as provided by law.

(13) Report annually to the legislative committees on natural resources as to the progress of the projects and programs enumerated in the plan. For each project or program, estimated construction and maintenance costs, progress reports, and estimated completion timetables shall be provided.

(14) Perform such powers, duties, and functions as may be delegated to him by the authority.

C. The governor, through his executive assistant, may, in an effort to advance the plan or purposes of this Part, within any department, agency, board, or commission:

(1) Review and modify policies, procedures, or programs not established or approved by the legislature or pursuant to the Administrative Procedure Act that may affect the design, construction, operation, management, and monitoring and more particularly to require expeditious permitting of restoration projects, wetlands enhancement or marsh management plans, or expenditures from the Fund.

(2) Review and request modifications of state departmental policies, procedures, programs, rules, and regulations that are established by law or pursuant to the Administrative Procedure Act that may affect the design, construction, operation, management, and monitoring of restoration projects, wetlands enhancement or marsh management plans, or expenditures from the Fund. Such rule changes shall be initiated by the appropriate department.

(3) Appoint advisory panels.

(4) Accept and use, in accordance with law, gifts, grants, bequests, and endowments for purposes consistent with responsibilities and functions of the agency and take such actions as are necessary to comply with any conditions required for such acceptance.

(5) Utilize the services of other executive departments of state government upon mutually agreeable terms and conditions.

(6) Develop guidelines for cost-share agreements with public and private entities undertaking approved coastal restoration projects.

(7) Take such other actions not inconsistent with law as are necessary to perform properly the functions of the authority.

(8) Review and modify proposed coastal use permits prior to issuance to the extent that such permits seek to authorize activities which significantly affect wetlands conservation and restoration projects or which significantly diminish the benefits of such projects insofar as they are intended to conserve or enhance coastal wetlands and to require the issuance of permits for public or private wetlands enhancement projects or plans.

D. Approval by the authority shall be required for any request by a state agency or department for any funds to finance research, programs, or projects involving the conservation and restoration of coastal wetlands resources; however, this Subsection shall not affect self-generated or dedicated funds.

§ 213.5. Wetlands Conservation and Restoration Task Force

A. The Wetlands Conservation and Restoration Task Force is hereby created within the Wetlands Conservation and Restoration Authority.

B. The task force shall be composed of the following members:

(1) Executive Assistant of the governor.

(2) Secretary of the Department of Natural Resources.

(3) Secretary of the Department of Wildlife and Fisheries.

(4) Secretary of the Department of Environmental Quality.

(5) Secretary of the Department of Transportation and Development.

(6) Assistant Chief of Staff for Health, Welfare, and Environment (governor's office).

(7) Commissioner of Administration.

(8) The director of the State Soil and Water Conservation Committee.

C. The executive assistant shall serve as chairman of the task force and shall develop procedures for the operation of the task force.

§ 213.6. Wetlands conservation and restoration plan; development; priorities

A. The authority shall, in accordance with the procedures set forth in R.S. 49:953, develop the plan which shall serve as the state's overall strategy for conserving and restoring coastal wetlands through the construction and management of coastal wetlands enhancement projects, including privately funded marsh management projects or plans, and addressing those activities requiring a coastal use permit which significantly affect such projects, all consistent with the legislative intent as expressed in R.S. 49:213.1, and which plan shall be subject to the approval of the legislature as provided in R.S. 49:213.6(D).

B. The plan shall address coastal land loss problems from both short and long-range perspectives and shall incorporate structural, management, and institutional components. The plan shall include but not limited [1] to the following:

(1) A list of projects and programs required for the conservation and restoration of coastal wetlands and the action required of each state agency to implement said project or program.

(2) A schedule and estimated cost for the implementation of each project or program included in the plan.

C. Where feasible, the plan shall include scientific data and other reasons, including but not limited to the social, geographic, economic, and biological considerations as to why each project or program was selected for inclusion. Specifically, this will include an explanation as to how each project or program advances the plan objectives with respect to the management, conservation, or enhancement of vegetated wetlands areas.

D.(1) The plan shall be submitted to the natural resources committees of the legislature on or before March 15 of each year beginning in 1990; however, the plan shall not be effective or implemented unless approved in accordance with Paragraphs (2), (3), (4), and (5) of this Subsection.

(2) The natural resources committees shall approve or disapprove of the plan on or before April 1 of each calendar year. If either committee disapproves the plan, it shall send the plan back to the authority together with a brief summary of the reasons for disapproval and may make recommendations concerning changes it deems necessary or appropriate to remedy any deficiencies in the plan. If the plan is approved, the committee shall submit the plan to the legislature for approval as provided for in Paragraphs (3), (4), and (5) of this Subsection. Should the natural resources committee in either house fail to report the plan and proposed recommendations if any to its respective house, then a majority of the elected members of the respective house may, by motion or by simple resolution direct the committee to report the plan to the house, in which case the committee so directed shall report the instrument as directed.

(3) The legislature may approve or disapprove of the plan by resolution adopted by a majority vote of the members of each house of the legislature provided that such resolution is adopted on or before June first of each calendar year. If the legislature disapproves of the plan, it shall include in the resolution a brief summary of the reasons for disapproval and may make recommendations concerning any changes it deems necessary or appropriate to remedy any deficiencies in the plan.

(4) If the legislature approves the plan, or if the legislature fails to disapprove the plan by June first, the authority shall implement the plan. The projects and programs provided for in the plan shall be undertaken in conformity with the order of priority as contained in the plan.

(5) At any time subsequent to the adoption and/or implementation of the plan in accordance with the procedure set forth herein, the authority may amend or supplement the plan to add or delete projects and programs. No project shall be added or deleted unless and until the amendment to the plan is approved as provided herein. Any amendment to the plan submitted to the legislature shall conform to the requirements specified in R.S. 49:213.6(B) and (C).

§ 213.7. Funding

A. (1) To provide a dedicated, recurring source of revenue for the development and implementation of a program to conserve and restore Louisiana's coastal vegetated wetlands, there shall be established in the state treasury on the effective date of this Subpart the Wetlands Conservation and Restoration Fund.

(2) Of all mineral revenues received in each fiscal year by the state including those received as a result of the production of or exploration for minerals, hereinafter referred to as mineral revenues from severance taxes, royalty payments, bonus payments, or

[1] In the introductory paragraph of subsec. B of R.S. 49:213.6 as set forth in Act 6, the phrase "shall include but not limited" is as it appears in the enrolled bill.

rentals, and excluding such revenues received by the state as a result of grants or donations when the terms or conditions thereof require otherwise, the treasurer shall make the following allocations:

(a) To the Bond Security and Redemption Fund as provided in Article VII, Section 9(B) of the Constitution of Louisiana.

(b) To the political subdivisions of the state as provided in Article VII, Sections 4(D) and (E) of the Constitution of Louisiana.

(c) As provided by the requirements of Article VII, Sections 10-A and 10.1 of the Constitution of Louisiana.

B. (1) After making the allocations provided for in Subsection A of this Section, the treasurer shall then deposit in and credit to the Wetlands Conservation and Restoration Fund any amount of mineral revenues that may be necessary to insure that a total of five million dollars is deposited into such fund for the fiscal year from this source; provided that the balance of the fund which consists of mineral revenues from severance taxes, royalty payments, bonus payments, or rentals shall not exceed forty million dollars.

(2) After making the allocations and deposits as provided for in Subsections A and B(1) of this Section, the treasurer shall deposit in and credit to the Wetlands Conservation and Restoration Fund as follows:

(a) Ten million dollars of the mineral revenues in excess of six hundred million dollars which remain after the allocations provided for in Subsection A are made by the treasurer.

(b) Ten million dollars of the mineral revenues in excess of six hundred fifty million dollars which remain after the allocations provided in Subsection A are made by the treasurer.

(3) The balance of the fund which consists of mineral revenues shall not exceed forty million dollars.

C. The treasurer shall deposit in and credit to the fund the amount of mineral revenues as provided for herein.

D. The money in the fund shall be invested as provided by law and any earnings realized on investment of money in the fund shall be deposited in and credited to the fund. Money from other sources, such as donations, appropriations, or dedications, may be deposited in and credited to the fund; however, the balance of the fund which consists of mineral revenues from severance taxes, royalty payments, bonus payments, or rentals shall not exceed forty million dollars. Any unexpended money remaining in the fund at the end of the fiscal year shall be retained in the fund.

E. (1) The money in the Wetlands Conservation and Restoration Fund is subject to appropriations by the legislature to the office of coastal restoration or to other agencies. The money in the fund may be used only for those projects and programs which are consistent with the statement of intent, R.S. 49:213.1, and the plan as it pertains to the conservation and restoration of coastal wetlands and the following purposes:

(a) Projects and structures engineered for the enhancement, creation, or restoration of coastal vegetated wetlands.

(b) Match for federal or local project planning, design, construction, and monitoring.

(c) Administration and project management, planning, design, construction, and monitoring.

(d) Operation and maintenance of structural projects consistent with the purpose of this fund.

(e) Vegetation planting, seeding, or other revegetation methods.

(f) Planning and implementation of modifications to federal, state, or local flood control, navigation, irrigation, or enhancement projects.

SUBPART B.

LOUISIANA COASTAL WETLANDS CONSERVATION AND RESTORATION PROGRAM

§ 214.1. Short title

This Subpart shall be known and may be cited as the Louisiana Coastal Wetlands Conservation and Restoration Act.

§ 214.2. Policy

The legislature declares that it is the public policy of the state to develop and implement, on a comprehensive and coordinated basis, a program for coastal vegetated wetlands conservation and restoration in order to reduce if not eliminate the catastrophic rate of coastal land loss in Louisiana. Consistent with this goal, it is the policy of this state to achieve a proper balance between development and conservation and encourage the use of coastal resources.

§ 214.3. Definitions

As used in this Subpart, the following terms shall have the meaning ascribed to them below:

(1) "Plan" means the coastal vegetated wetlands conservation and restoration plan provided for in R.S. 49:213.6.

(2) "Program" means the coastal vegetated wetlands conservation and restoration program provided for in this Subpart.

(3) "Wetlands" means an open water area or an area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, but specifically excluding fastlands and lands more than five feet above mean sea level which occur within the designated coastal zone of the state. Wetlands generally include swamps, marshes, bogs, and similar areas.

§ 214.4. Wetlands conservation and restoration program; administration; powers and duties

A. A coastal vegetated wetlands conservation and restoration program is hereby established within the division of coastal restoration of the Department of Natural Resources. The secretary shall administer and implement the program in accordance with the plan developed by the authority and shall employ staff necessary for that purpose.

B. The secretary shall:

(1) Implement the coastal vegetated wetlands conservation and restoration plan, as approved by the legislature.

(2) Negotiate and execute contracts, upon such terms as he may agree upon, for legal, financial, engineering, construction, and other professional services necessary in the conduct of the affairs of the office.

(3) Promulgate the necessary rules and regulations to establish and assure uniform criteria for the negotiation and execution of such contracts.

C. The secretary may:

(1) Enter into cost sharing agreements with the federal government, with local governments, or with private entities to implement coastal vegetated wetlands conservation and restoration projects.

(2) Acquire by purchase, donation, or otherwise any land needed for wetlands and coastal restoration or conservation projects and other property required for the operation of the projects that are to be owned and operated by the office or political subdivision of

the state; provided, that any property acquired for any project shall reserve the minerals to the landowners, whether private or public, in accordance with the provisions of R.S. 31:149.

(3) Develop procedures to evaluate new and improved coastal restoration and preservation technologies.

(4) Perform pre-construction and post-construction monitoring of projects that will be implemented or have been implemented by the office.

(5) Coordinate coastal restoration efforts with local governments, interest groups, and the public.

(6) Develop, implement, operate, maintain, and monitor coastal restoration plans and projects.

(7) Take any other action necessary to administer the program.

§ 214.5. Legislative oversight

Any rule, regulation, or guideline developed pursuant to this Subpart shall be proposed or adopted pursuant to the rulemaking procedures set forth in the Administrative Procedure Act.

Section 4. R.S. 49:213.11(G) is hereby amended and reenacted to read as follows:

§ 213.11. Coastal use permits

* * *

G. The secretary is authorized to establish a reasonable schedule for fees to be charged to the applicant for the processing and evaluation of coastal use permit applications. The fees authorized by this Subsection shall not apply to any state agency or political subdivision engaged in a coastal restoration activity consistent with the plan as provided in R.S. 49:213.6 nor to local public bodies for constructing drainage improvements. Funds generated from these fees shall be deposited in the Coastal Resources Trust Fund as provided in R.S. 49:214.41.

Section 5. R.S. 56:2011(C) is hereby enacted to read as follows:

§ 2011. Permit to dredge, royalties

* * *

C. Any state agency, political subdivision, or associated consultant or contractor engaged in a coastal conservation or restoration activity consistent with the plan established pursuant to R.S. 49:213.6 shall be exempt from payment or provision of the fees, royalties, or bond requirements of this Section.

* * *

Section 6. Chapter 5-A of Subtitle I of Title 30 of the Louisiana Revised Statutes of 1950, comprised of R.S. 30:311 through 316 is hereby repealed.

Section 7. The heading of Part II of Chapter 2 of Title 49 of the Louisiana Revised Statutes of 1950 is hereby redesignated as "Louisiana Coastal Wetlands Conservation, Restoration, and Management" and the Louisiana State Law Institute is hereby authorized and requested to redesignate the present sections in Part II as "Subpart (C) Louisiana Coastal Zone Management Program" consisting of R.S. 49:214.21 through 214.41 and make appropriate statutory cross references.

Section 8. This Act shall become effective upon signature by the governor or, if not signed by the governor, upon expiration of the time for bills to become law without signature by the governor, as provided in Article III, Section 18 of the Constitution of Louisiana.

Approved July 14, 1989.

APPENDIX I

HABITAT CHARACTERIZATION DATABASE DEVELOPMENT

Development of the Digital Level One Data Bases Used in the MMS Project

The present 1956 and 1978 digital habitat data bases used for the MMS project are based on a classifying system developed by the Coastal Management Division of the Louisiana Department of Natural Resources to simplify the Ecological Characterization (habitat) maps of coastal Louisiana developed for the U.S. Fish and Wildlife Service by Coastal Environments, Inc. The habitat maps consists of approximately 540 1:24,000 maps which are referenced to the existing 7.5' U.S. Geological Survey topographic quadrangle base of coastal Louisiana. The coding system used to develop the habitat maps was adapted from the Classification of Wetlands and Deep-Water Habitats of the United States (Cowardin et al. 1979) (see table 1) and consists of a hierarchical structure used to identify wetland and nonwetland vegetative types, non-vegetated habitat such as spoil or beach, developed areas, oil/natural gas related habitats, and water habitat types (Wicker 1980). These maps were developed by photointerpretation of 1978 false color infrared and 1951-58 black and white aerial photographic coverage (scale 1:20,000-1:24,000) of coastal Louisiana. The photointerpreted habitat maps were then digitized by the Fish and Wildlife Service to serve as a digital data base for the environmental geographic information systems which were being developed by the Coastal Management Division and the Fish and Wildlife Service in the early 1980s.

Coastal Management Division incorporated the habitat data into its vector based geographic information system, the Map Overlay and Statistical System, to aid in analyzing permit impacts, produce a variety of special projects, and for land change analysis. The Cowardin coding scheme used in the original habitat maps was aggregated to a less complex level one landcover classification system because most of these analyses did not require the level of detail inherent in the Cowardin system. In addition to Map Overlay Statistical System, Coastal Management Division also operates a satellite image processing system that uses the Earth Resources Data Analysis System for the purpose of obtaining recent thematic coverage of coastal Louisiana. In 1986 Coastal Management Division contracted the development of a Landsat Thematic Mapper level-one landcover data base for Louisiana's coastal zone. December 1984 and January 1985 thematic mapper imagery of coastal Louisiana was used to develop a classified data base that was completed in early 1987. The thematic mapper classification scheme was designed to adhere as closely as possible to the aggregated classification scheme developed for the 1956 and 1978 habitat data so that comparisons were possible between the two data sets. The comparison of the habitat data to the classified thematic mapper data required that the habitat data be converted from a maps overlay statistical system vector format to an Earth Resources Data Analysis System cell format. Once the habitat data was in a cellular format, comparisons could be made between the two data sets for selected areas. Generally, these comparisons are limited to areas ranging in size from several thousand to tens of thousands of acres.

The Technical Services Section of Coastal Management Division discovered through trial and error that the habitat comparisons were easier to produce using Earth Resources Data Analysis System rather than map overlay statistical

Table 1. U.S. Fish and Wildlife Service codes used in habitat characterizations (Cowardin et al. 1979, Wicker 1980).

Habitat Codes	
WATER (Natural)	
E1OW	Estuarine Subtidal Open Water
E1OWt	Estuarine Subtidal Open Water Tidal
L1OW	Lacustrine Limnetic Open Water
L2OW	Lacustrine Littoral Open Water
M1OW	Marine Subtidal Open Water
POW	Palustrine Open Water
POWh	Palustrine Open Water Diked/Impounded
R1OW	Riverine Subtidal Open Water
R2OW	Riverine Lower Perennial Open Water
R4OW	Riverine Intermittent Open Water
WATER (Artificial)	
E1OWh	Estuarine Subtidal Open Water Impounded/Diked
E1OWo	Estuarine Subtidal Open Water Oil/Gas/Mineral
E1OWx	Estuarine Subtidal Open Water Excavated
L2OWh	Lacustrine Littoral Open Water Diked/Impounded
L2OWo	Lacustrine Littoral Open Water Oil/Gas/Mineral
L2OWx	Lacustrine Littoral Open Water Excavated
POW1o	Palustrine Open Water Oil/Gas/Minerals
POWx	Palustrine Open Water Excavated
R1OWo	Riverine Subtidal Open Water Oil/Gas/Mineral
R1OWx	Riverine Subtidal Open Water Excavated
R2OWo	Riverine Lower Perennial Open Water Oil/Gas/Mineral
R2OWx	Riverine Lower Perennial Open Water Excavated
FRESH MARSH	
PEM	Palustrine Emergent Vegetation
PEMd	Palustrine Emergent Vegetation Partially Drained/ Ditched
PEMm	Palustrine Emergent Vegetation Leveed; Managed Water Levels
INTERMEDIATE MARSH	
E2EM5P6	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Oligohaline
E2EM5P6d	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Oligohaline Partially Drained/Ditched

E2EM5P6m	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Oligohaline Leveed; Managed Water Levels
E2EM5P6w	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Oligohaline Leveed; Standing Water

BRACKISH MARSH

E2EM5P5	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Mesohaline
E2EM5P5d	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Mesohaline Partially Drained/Ditched
E2EM5P5m	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Mesohaline Leveed; Managed Water Levels
E2EM5P5w	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Irregular Tidal Regime Mesohaline Leveed; Standing Water

SALINE MARSH

E2EM5N4	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Regular Tidal Regime Polyhaline
E2EM5N4d	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Regular Tidal Regime Polyhaline Partially Drained/Ditched
E2EM5N4s	Estuarine Intertidal Emergent Vegetation Narrow-Leaved Persistent Regular Tidal Regime Polyhaline Spoil

NON-FRESH MARSH (1956)

E2EM	Estuarine Intertidal Emergent Vegetation
E2EMd	Estuarine Intertidal Emergent Vegetation Partially Drained/Ditched
E2EMm	Estuarine Intertidal Emergent Vegetation Leveed; Managed Water Levels

FOREST (Upland/Bottomland Hardwoods)

Upland Codes

UFO1/3	Upland Forested Broad-Leaved Deciduous/Broad-Leaved Evergreen
UFO1/3/4	Upland Forested Broad-Leaved Deciduous/Broad-Leaved Evergreen/Needle-Leaved Evergreen

UF013s	Upland Forested Broad-Leaved Deciduous/Broad-Leaved Evergreen Spoil
UF01s	
UF03	Upland Forested Broad-Leaved Evergreen
UF03/4	Upland Forested Broad-Leaved Evergreen/Needle-Leaved Evergreen
UF03/4s	Upland Forested Broad-Leaved Evergreen/Needle-Leaved Evergreen Spoil
UF04	Upland Forested Needle-Leaved Evergreen
	Bottomland/Hardwoods Codes
PF01/2/3	Palustrine Forested Broad-Leaved Deciduous/Needle-Leaved Deciduous/Broad-Leaved Evergreen
PF01/3	Palustrine Forested Broad-Leaved Deciduous/Broad-Leaved Evergreen
PF01/3/4	Palustrine Forested Broad-Leaved Deciduous/Broad-Leaved Evergreen/Needle-Leaved Evergreen
PF03/4	Palustrine Forested Broad-Leaved Evergreen/Needle-Leaved Evergreen

SWAMP

PF01	Palustrine Forested Broad-Leaved Deciduous
PF01/2	Palustrine Forested Broad-Leaved Deciduous/Needle-Deciduous
PF02/4	Palustrine Forested Needle-Leaved Deciduous/Needle-Leaved Evergreen

SHRUB/SCRUB

E2SS3	Estuarine Intertidal Scrub/Shrub Broad-Leaved Evergreen
PSS1	Palustrine Scrub/Shrub Broad-Leaved Deciduous
PSS1/2	Palustrine Scrub/Shrub Broad-Leaved Deciduous/Needle-Leaved Deciduous
PSS1/3	Palustrine Scrub/Shrub Needle-Leaved Deciduous/Broad-Leaved Evergreen
PSS2	Palustrine Scrub/Shrub Needle-Leaved Deciduous
USS1/3	Upland Scrub/Shrub Broad-Leaved Deciduous/Broad-Leaved Evergreen
USS1/3/4	Upland Scrub/Shrub Broad-Leaved Deciduous/Broad-Leaved Evergreen/Needle-Leaved Evergreen

SHRUB/SCRUB (Spoil)

PSS1s	Palustrine Scrub/Shrub Broad-Leaved Deciduous Spoil
USS1/3s	Upland Scrub/Shrub Broad-Leaved Deciduous/Broad-Leaved Evergreen Spoil
USS1s	Upland Scrub/Shrub Broad-Leaved Deciduous Spoil
USS1S3S	

AGRICULTURE/PASTURE

UDV2	Upland Developed Agriculture/Pasture/Modified Grasslands
UDV2e	Upland Developed Agriculture/Pasture/Modified Grasslands Reclaimed Wetland
UDV2o	Upland Developed Agriculture/Pasture/Modified Grasslads Oil/Gas/Mineral
UGRp	Upland Grasslands Beach Dunes

DEVELOPED

PDV	Palustrine Developed
UDV	Upland Developed
UDV1	Upland Developed Urban/Residental Commerical/ Commercial/Industrial
UDV1o	Upland Developed Commercial/Industrial Oil/Gas/Mineral

AQUATIC VEGETATION (floating/submerged/undefined)

Aquatic Vegetation - floating

E1AB5	Estuarine Subtidal Aquatic Bed Floating
E1AB5H	Estuarine Subtidal Aquatic Bed Floating Diked/Impounded
E1AB5o	Estuarine Subtidal Aquatic Bed Floating Oil/Gas/Mineral
E1AB5x	Estuarine Subtidal Aquatic Bed Floating Excavated
L2AB5	Lacustrine Littoral Aquatic Bed Floating
L2AB5h	Lacustrine LIttoral Aquatic Bed Floating Diked/Impounded
L2AB5x	Lacustrine Littoral Aquatic Bed Floating Excavated
PAB5	Palustrine Aquatic Bed Floating
PAB5h	Palustrine Aquatic Bed Floating Diked/Impounded
PAB5x	Palustrine Aquatic Bed Floating Excavated
R1AB5	Riverine Tidal Aquatic Bed Floating
R1AB5o	Riverine Tidal Aquatic Bed Floating Oil/Gas/Mineral
R1AB5x	Riverine Tidal Aquatic Bed Floating Excavated
R2AB5	Riverine Lower Perennial Aquatic Bed Floating
R2AB5o	Riverine Lower Perennial Aquatic Bed Floating Oil/Gas/Mineral
R2AB5x	Riverine Lower Perennial Aquatic Bed Floating Excavated

Aquatic Vegetation - submerged

E1AB	Estuarine Subtidal Aquatic Bed
E1AB1/2	Estuarine Subtidal Aquatic Bed Submergent Algal/SubmergentVascular Vegetation

E1AB2	Estuarine Subtidal Aquatic Bed Submergent Vascular Vegetation
E1AB2o	Estuarine Subtidal Aquatic Bed Submergent Vascular Vegetation Oil/Gas/Mineral
L2AB2	Lacustrine Littoral Aquatic Bed Submergent Vascular
L2AB2h	Lacustrine Littoral Aquatic Bed Submergent Vascular Diked/Impounded
PAB2	Palustrine Aquatic Bed Submerged Vascular
PAB2x	Palustrine Aquatic Bed Submerged Vascular Excavated
R1AB2	Riverine Tidal Aquatic Bed Submerged Vascular
R1AB2o	Riverine Tidal Aquatic Bed Submerged Vascular Oil/Gas/Mineral

Aquatic Vegetation - undefined

L2AB	Lacustrine Littoral Aquatic Bed
R1AB	Riverine Tidal Aquatic Bed
R1ABo	Riverine Tidal Aquatic Bed Oil/Gas/Mineral

<u>INERT</u>

E1UB2	Estuarine Subtidal Unconsolidated Bottom Sand
E2RF2	Estuarine Intertidal Reef Mollusc
E2RS2r	Estuarine Intertidal Rocky Shore Boulder Artificial
E2UB3/4	Estuarine Intertidal Unconsolidated Bottom Mud/Organic
M1UB2	Marine Subtidal Unconsolidated Bottom Sand
R1BB2	Riverine Tidal Beach/Bar Sand/Shell
UDV3	Upland Developed Unvegetated Land/Spoil/Disposal Sites

Inert -flats

E2FL	Estuarine Intertidal Flat
E2FL2	Estuarine Intertidal Flat Sand/Shell
E2FL3	Estuarine Intertidal Flat Mud
E2FL3/4	Estuarine Intertidal Flat Mud/Organic
E2FL3/4h	Estuarine Intertidal Flat Mud/Organic Diked/Impounded
E2FL3h	Estuarine Intertidal Flat Mud Diked/Impounded
E2FL5	Estuarine INtertidal Flat Vegetated Pioneer
L2FL3	Lacustrine Littoral Flat Mud
L2FL3/4	Lacustrine Littoral Flat Mud/Organic
L2FL3/4h	Lacustrine Littoral Flat Mud/Organic Diked/Impounded
L2FL5	Lacustrine Littoral Flat Vegetated Pioneer
PFL3	Palustrine Flat Mud
PFL3/4	Palustrine Flat Mud/Organic
PFL5	Palustrine Flat Vegetated Pioneer
R1FL	Riverine Tidal Flat
R1FL3	Riverine Tidal Flat Mud
R1FL5	Riverine Tidal Flat Vegetated Pioneer

BEACH

E2BB2	Estuarine Intertidal Beach Sand/Shell
M2BB2	Marine Intertidal Beach/Bar Sand/Shell
M2BB2s	Marine Intertidal Beach/Bar Sand/Shell Spoil
R2BB2	Riverine Lower Perennial Beach/Bar Sand/Shell

UNASSIGNED (1983)

E1USN
UBS
UU
UUO

system, especially if fairly large areas were involved. The topological complexity of the habitat data and the map overlay statistical system vector based data structure made time change analysis for areas larger than a few thousand acres prohibitive because of the cpu time involved and the inability of map overlay statistical system to complete the complex overlays created during the change analysis. This problem was solved by converting the habitat data for the study area in question from the map overlay statistical system vector format to the map overlay statistical system cell format and then converting the map overlay statistical system cell format to an Earth Resources Data Analysis System cell format. Once in Earth Resources Data Analysis System the habitat change analysis could be completed quickly and efficiently. The map overlay statistical system vector habitat data was gridded at a 25-meter cell size in order to allow comparisons between the habitat data and the classified thematic mapper data and as a disk space saving measure. This procedure gave the Coastal Management Division the ability to produce change projects quickly but had several drawbacks, the main one being that each change analysis required the cellurization of whatever 1956 and 1978 vector habitat quads covered the study area. In other words, the number of steps required for the conversion of the data to an Earth Resources Data Analysis System format was warranted only if a fairly large area (7.5' quad size or greater) was required for the project. The time required to grid the vector habitat maps needed for a particular habitat change analysis became prohibitive as the number and the areal extent of habitat change analyses requests increased. The solution was to develop Earth Resources Data Analysis System files that covered the entire coastal zone for 1956 and 1978 in order to increase the production efficiency for habitat change project analyses.

The creation of these coastal zone habitat files required that each MOSS vector 1956 and 1978 habitat map be gridded at a 25-meter cell size and converted into an Earth Resources Data Analysis System format, after which Coastal Management Division's aggregated level-one habitat coding scheme and a standard color table would be applied to each map. The maps would then be mosaicked to form the coastal zone habitat maps. The result of this would be that habitat change projects could then be produced with a much quicker turnaround time than was previously available. The Minerals Management Service project was proposed after the initial phases of the Earth Resources Data Analysis System reformatting of the habitat data had begun. The types of analyses proposed for the Minerals Management Service project required that the Earth Resources Data Analysis System coastal zone habitat be produced so it was decided to incorporate. The regional land change analyses portion of the Minerals Management Service project required that the coastal zone Earth Resources Data Analysis System maps be completed before the analyses could be performed. The 1978 habitat data had been completely gridded, converted to an Earth Resources Data Analysis System format, and was in the process of being mosaiced when the Minerals Management Service project began. The 1956 data had been partially gridded and was incorporated into the Minerals Management Service project. The 1984 TMC coastal zone file had been completed before the Minerals Management Service project began.

The regional hydrologic unit analysis for the Minerals Management Service project began once the coastal zone habitat files were completed. This analysis required that the 1978 level-one aggregated habitat data and the 1984 TMC data be compared on a hydrologic unit basis in order to evaluate recent habitat change trends within the units. The comparison between the 1978 level-one aggregated habitat data and the 1984 TMC data has several inherent problems. They are 1) misregistration between the data sets, 2) differences in the classification methodologies used to develop the data sets, and 3) differences in weather/tidal conditions between the data sets. The cause of the misregistration between the habitat and the TMC data sets is due to the photorectification process used to develop the habitat maps. The habitat maps are registered to each other but do not register well with other digital maps. The 1984 TMC data is registered to control points taken from 7.5 minute U.S. Geological Survey maps and does not register exactly with the habitat data. The comparison between the 1956 and 1978 level-one habitat data is more logical than the 1978 to 1984 comparison since the habitat data sets were developed using the same methodology (photointerpretation) verses the methodology used to classify the 1984 data (satellite image classification). Variations in weather/tidal conditions at the time imagery is taken (either film or satellite) can cause variation in water levels which in turn, can influence habitat/TMC change comparisons based on the data sets derived from the imagery. Other problems also exist in comparing these data sets in addition to problems mentioned above. One problem is that the boundaries for the habitat data follow the 1978 coastal zone boundary while the TM data follows the present coastal zone boundary. The present boundary encompasses a larger area than the 1978 boundary which causes area mismatches between the two data sets when comparing some hydrologic units. The hydrologic units with the most missing 1956 and 1978 habitat data are the Barataria, Pontchartrain, and Pearl units. 1956/78 habitat areas are also missing in the Atchafalaya, Sabine, Mississippi, Terrebonne, and Vermilion-Teche units. In addition to the boundary problem, some hydrologic units for which 1956 coverage exists are missing 1978 coverage. For example, the Mermentau unit has complete 1956 habitat coverage for the Intracoastal City area but only has partial 1978 coverage for the same location. For some unknown reason the 1956 aerial photography for the Intracoastal City 7.5 minute quadrangle was photointerpreted and digitized, but the 1978 photography was photointerpreted for only the eastern half of the quadrangle map, causing a discrepancy of some 20,000 acres between the 1956 and 1978 data for that area.

Methodology Outline for the Development of the Various Habitat Data Bases (Digital and Hardcopy)

The previous discussion is a general description of Coastal Management Division's adaption of the habitat data for its own uses and of how the geographic information system requirements for the Minerals Management Service project were incorporated into Coastal Management Division's geographic information system. The information listed below will provide a general outline of the methodology used to originally develop the habitat maps and the methodology used to develop the hydrologic unit maps for the Minerals Management Service grant.

Coastal Environments, Inc. and U.S. Fish and Wildlife Service Habitat Maps

1. These maps were developed by photointerpretation of 1951-57 and 1978 aerial photography and required the following basic steps:

    A. Acquiring the aerial imagery
    B. Interpreting the various Cowardin habitat types and mapping their occurrences on the aerial photography by drawing and labeling polygons on mylar overlays of the aerial photos. This process also involved removing distortion inherent in the aerial photography by rectifying or correcting this distortion by using ground control points to reference the habitat overlays to USGS 7.5' topographic quadrangle maps.
    C. The mylar habitat overlays were cleaned up for cartographic reproduction and were then digitized using the Analytical Mapping System for input into the Maps Overlay Statistical System, a vector-based geographic information system used by the Fish and Wildlife Service at that time. Coastal Management Division purchased these digital habitat maps to serve as the primary data base for its geographic information system.

Coastal Management Division Modifications of the Habitat Maps to an Earth Resources Data Analysis System format

2. The conversion of the habitat maps from their original map overlay statistical system vector format to an Earth Resources Data Analysis System format required the following steps:

    A. Conversion of the habitat maps from a MOSS vector format to a MOSS cell format at a 25 meter (.154459 acre) cell size.
    B. Conversion of the habitat maps from the MOSS cell format to an Earth Resources Data Analysis System cell format.
    C. Recoding the Cowardin coded Earth Resources Analysis System cell maps to Coastal Management Division's level-one classification scheme.
    D. Mosaicking the 500+ level-one Earth Resources Data Analysis System cell maps to form the digital 1956 and 1978 coastal zone habitat maps.
    E. Extraction of the 1956/1978 level-one habitat and the 1984 TMC data rom the digital coastal zone maps for each hydrologic unit to produce the 1956, 1978, and 1984 maps and statistics for each hydrologic unit.
    F. Comparison of the 1956 to the 1978 level-one habitat data and the 1978 level-one habitat data to the 1984 TMC data to produce the 56/78 and 78/84 change maps and change statistics for the hydrologic units.
    G. Development of color schemes for the printing of the hydrologic unit maps.
    H. Printing of the habitat maps.

Usefulness of the Earth Resources Data Analysis System Coastal Management Division Level-One Habitat Data

A valid question concerning the development of the level one 1956 and 1978 coastal zone data sets for the purpose of obtaining acreage figures and change statistics is why do it all? Several studies have already been done to calculate land loss using the 1956 and 1978 habitat data so why repeat them? The answer is that the Minerals Management Service study compares the habitat data using different techniques than those used in previous studies. The major land loss studies of the early 1980s compared the 1956 to the 1978 habitat data on a 7.5' quadrangle map basis (Gagliano et al. 1981) that was used to calculate land loss rates for the deltaic plain, used the quadrangle comparison methodology. Basically, this methodology required that the habitat polygons for each 1956 and 1978 7.5' quadrangle map be traced using an electronic planimeter/digitizer in order to obtain the habitat acreage figures for each map. Land loss statistics were then determined for each 7.5' quadrangle by comparing the 1956 acreage values for each habitat class to the 1978 acreage values. While this method will quantify the acres of land loss per 7.5 minute quad, it will not show the spatial distribution of land loss within that quad.

The advantage of using a geographic information system to analyze land loss is that it will not only calculate how much wetland loss, it will show where the loss is occurring and with a much greater level of resolution than 7.5' cell. The reasoning for this statement is that the quadrangle comparison method of calculating land loss will allow the analyst to determine the amount of land loss occurring within a particular 7.5' habitat map, but does not shown where the land loss is located within the habitat map. The best estimate that can be given of where the land loss is occurring is limited to stating that the loss is occurring somewhere within the 400,000 acres that comprise the habitat map. The spatial resolution the data is degraded to a 7.5' cell. The analyst loses insight into the specific physical processes causing land loss because the analyst cannot determine with any reasonable degree of accuracy where the land loss is occurring. Using a geographic information system to analyze the spatial distribution of land loss allows the analyst to answer the following questions:

1) How much land loss/habitat change has occurred?
2) Where have the changes occurred?
    a. Is there more interior breakup or shoreline erosion or a combination of both occurring within the area?
3) How is the land loss distributed?
    a. Does the land loss occur as large continuous areas of loss or does it take the from of many small ponds.
4) How has man directly impacted marsh loss?
    a. Is some of the loss in the form of excavated navigational/oilfield access/pipeline canals? Have some wetland areas been drained for agricultural purposed or for urbanization?

Some recent geographic information system analyses have been performed using the habitat data for the purpose of assessing land loss (Liebowitz,

1987) but these analyses used only selected areas within the coastal zone. The Minerals Management Service analysis is the first geographic information system habitat change study to assess land loss on a coast wide basis. The compilation of the level-one habitat data sets into 1956 and 1978 coverage files offered the following specific advantages for temporal analysis of the habitat data

1) The capability to perform regional or site specific change analyses.
   a. The analyst is no longer limited to examining habitat change on a quad by quad basis. The coastal zone can be examined as a whole or a subset of the whole can be extracted to examine specific areas of interest such as state/federal wildlife refuges, marsh management plans, hydrologic basins, parishes, environmental management units, etc.
2) The ability to perform various spatial analytical functions on a regional scale.
   a. An example of this would be the compilation of the 1956 to 1978 coastal zone land loss density map or any of the land loss maps developed for his project.
3) The ability to output maps for any of the areas under study. Examples include the hydrologic unit maps or the land loss density map.
4) The speed with which projects can now be completed. Projects can now be completed in much less time than was required previous to the development of the coastal zone level-one habitat fields.
5) The ability to display the entire coastal zone for either 1956, 1978, or 1984. The analyst can quickly view any portion of the coastal zone that he/she wishes to view. The analyst can see the "big picture". The 1956 to 1978 coastal zone land loss map can be viewed in the same manner. The amount of land loss that occurred between these dates ius a regional phenomenon. That is the effects of land loss visible even when the image of the coastal zone is reduced 42 times in order to display the entire image on the monitor (the computer is sampling only every 42nd pixel of the 1956 to 1978 land loss file in order to display the image of the land loss map on the monitor). Land loss between these two dates is severe enough that actual geographic locations throughout the coastal zone can be identified using a map depicting only land loss.

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APPENDIX J

FEDERAL AND STATE REFUGES, U.S. SOIL CONSERVATION SERVICE MANAGEMENT PLANS, AND PRIVATE MANAGEMENT PLANS IN THE LOUISIANA COASTAL ZONE

Table 1. Wildlife management areas and refuges in the Louisiana coastal zone.[*]

State-Managed Areas	Acres	Hectares	%
1. Atchafalaya Delta Wildlife Management Area	133,410	54,012	15
2. Biloxi Wildlife Management Area	41,658	16,865	5
3. Manchac Wildlife Management Area	7,768	3,145	1
4. Russell Sage (Marsh Island) Wildlife Refuge and Game Preserve	72,696	29,431	8
5. Pass A Loutre Game and Fish Preserve	110,702	44,818	13
6. Point Au Chien Wildlife Management Area	31,319	12,680	4
7. Rockefeller Wildlife Refuge and Game Preserve	76,568	30,999	9
8. Salvador Wildlife Management Area	30,639	12,404	3
9. Louisiana State Wildlife Refuge and Game Preserve	14,957	6,055	2
10. Bohemia Wildlife Management Area[**]	33,000	13,360	4
11. Wisner Wildlife Management Area	15,463	6,260	2
12. Pearl River Wildlife Management Area[**]	11,755[+]	4,759	1[*]
Total	579,935	234,788	67
Federally Managed Areas			
1. Delta National Wildlife Refuge	49,017	19,845	6
2. Lacassine National Wildlife Refuge	32,910	13,334	4
3. Sabine National Wildlife Refuge	171,011	69,235	20
4. Jean Lafitte National Wildlife Refuge	9,000	3,643	1
Total	262,028	106,047	31
Privately Managed Refuge			
1. Paul J. Rainey Wildlife Refuge and Game Preserve (owned and operated by the National Audubon Society)	23,041	9,328	2
Total	23,041	9,328	2
Grand Total	864,914	350,163	100

[*]All areas are shown on plate 7 unless otherwise indicated.
[**]Not shown on plate 7.
[+]Only lower portion is located in coastal zone, approximately 1/4 of total acreage; total area is 40,302 acres.

Table 2. U.S. Soil Conservation Service management plans in the Louisiana coastal zone, shown on plate 7.

ATLAS	SCS NO.	PARISH (S)	QUAD NO(S).	ACRES	HECTARES	%
S500AA	095/22	ST. JOHN	160CD,189AB	7788.32	3153.17	2.23
S501AA	087/17	ST. BERNARD	198A,199B	6104.01	2471.26	1.75
S502AA	087/16	ST. BERNARD	198C	4718.09	1910.16	1.35
S503AA	087/18	ST. BERNARD	198C	7426.84	3006.82	2.13
S504AA	087/19	ST. BERNARD	199A,200B	1982.23	802.52	.57
S505AA	087/14	ST. BERNARD	199D	2733.18	1106.55	.78
S506AA	089/11	ST. CHARLES	201C	3501.83	1417.74	1.00
S507AA	051/01	JEFFERSON	201CD,233A	11085.25	4487.96	3.17
S508AA	045/01	IBERIA	208A	653.47	264.56	.19
S509AA	045/02	IBERIA, VERMILION	208AC	1634.56	661.77	.47
S510AA	113/08	VERMILION	208C,209D	306.22	123.98	.09
S511AA	023/02	CAMERON	215D	7095.68	2872.74	2.03
S512AA	113/05	VERMILION	224D,225C	5761.93	2332.77	1.65
S513AA	113/06	VERMILION	225A	4696.94	1901.60	1.34
S514AA	113/07	VERMILION	225AC	3761.47	1522.86	1.08
S515AA	101/01	ST. MARY	228D,229AC	10180.35	4121.60	2.91
S516AA	109/03	TERREBONNE	229CD,247AB	27647.36	11193.26	7.91
S517AA	103/01	ST. TAMMANY	158CD	4599.64	1862.20	1.32
S518AA	023/07	CAMERON	175D,176C,216B	1393.05	563.99	.40
S519AA	089/24	ST. CHARLES	201C,202BD,232B	34156.82	13828.67	9.77
S520AA	023/08	CAMERON	211ABCD	8102.57	3280.39	2.32
S521AA	109/07	TERREBONNE	247AC	10272.45	4158.89	2.94
S522AA	109/12	TERREBONNE	247ABCD	24916.68	10087.72	7.13
S523AA	109/21	TERREBONNE	247B,246A	13191.50	5340.69	3.77
S524AA	109/05	TERREBONNE	230CD	7773.36	3147.11	2.22
S525AA	109/20	TERREBONNE	231CD,245AB	4348.43	1760.50	1.24
S526AA	057/08	TERREBONNE, LAFAYETTE	231D,232CD	13427.80	5436.36	3.84
S527AA	109/22	TERREBONNE	245A	2309.49	935.02	.66
S528AA	109/11	TERREBONNE, JEFFERSON	245A,233AC	3218.80	1303.16	.92
S529AA	051/04	JEFFERSON, PLAQUEMINES	233B,234A	10556.62	4273.94	3.02
S530AA	051/05	JEFFERSON	233BD	2520.03	1020.26	.72
S531AA	051/09	JEFFERSON	233D,243AB	5004.91	2026.28	1.43
S532AA	051/23	JEFFERSON	233D,243B	3696.26	1496.46	1.06
S533AA	051/08	JEFFERSON	243B	1293.28	523.60	.37
S534AA	057/11	LAFAYETTE	243CD	8010.72	3243.21	2.29
S535AA	057/10	LAFAYETTE	243C,244BD	12487.85	5055.81	3.57
S536AA	057/12	LAFAYETTE	244AB	5225.99	2115.79	1.50
S537AA	057/09	LAFAYETTE	244ABCD	16778.62	6792.96	4.80
S538AA	109/18	TERREBONNE	246A	6728.14	2723.94	1.93
S539AA	10915	TERREBONNE	246AC	6007.59	2432.22	1.72
S540AA	109/06	TERREBONNE	246CD	12990.15	5259.17	3.72
S541AA	057/04	LAFAYETTE	254B	10483.47	4244.32	3.00
S542AA	057/05	LAFAYETTE	255A	6690.57	2708.73	1.91
S543AA	057/07	LAFAYETTE	255A	6195.09	2508.13	1.77

Table 3. Coastal Management Division permits included in the marsh management profile database, the applicant name, and corresponding Corps of Engineers and Soil Conservation Service numbers, as of May 15, 1989 (see plate 7).

	CMD Permit Number	Applicant Name	SCS Number	Size (ac)	Hydro. Basin
1	P810035	McDermott		849	Terrebonne
2	P810134	Hebert, Murray J.	109/13	1,243	Terrebonne
3	P810233	Avery	045/09	516	Verm-Teche
4	P810252	Ledet, Dane		53	Terrebonne
5	P811112	Chabert, Leonard		456	Terrebonne
6	P811129	Isadore Delcambre	113/08	897	Verm-Teche
7	P811151	Webb Estate, James	051/03	2,108	Barataria
8	P811540	Blanchard, Genny	109/03	845	Terrebonne
9	P812007	Slidell		3	N. Pontch.
10	P820051	Brian, Eugene		18	Terrebonne
11	P820203	Sooner		149	Verm-Teche
12	P820204	Duet, Louis	057/02	704	Barataria
13	P820348	Rathborne		4,226	Barataria
14	P820488	Patout-Roane, Inc.		263	Verm-Teche
15	P820504	Derouen, Jarrett	023/03	873	Calcasieu
16	P820539	Delacroix		3,571	S. Pontch.
17	P820880	Le Maire, Carroll		21	Calcasieu
18	P821020	Crain, John Paul		344	Sabine
19	P821066	Peret, Alvin		31	Barataria
20	P821083	St. Bernard Par. P. J.		3,425	S. Pontch.
21	P821245	Superior		174	Mermentau
22	P821320	Cameron Par. P. J.		3,537	Mermentau
23	P821333	Domangue, Richard		180	Terrebonne
24	P821514	McIlhenny	045/04	1,977	Verm-Teche
25	P821533	Little Pecan		642	Mermentau
26	P830226	Stone	101/03	174	Verm-Teche
27	P830279	Orgeron, Herman		581	Terrebonne
28	P830300	St. Bern. Par. P. J	087/21	4,482	S. Pontch.
29	P830301	St. Bernard Par. P. J.		2,055	S. Pontch
30	P830302	St. Bernard Par. P. J.		2,999	S. Pontch.
31	P830303	St. Bernard Par. P. J.		228	S. Pontch.
32	P830304	St. Bernard Par. P. J.		5,496	S. Pontch.
33	P830321	Cheramie, Louis J.	057/06	1,548	Barataria
34	P830367	DBA Simoneaux		2,809	Barataria
35	P830368	DBA Simoneaux		6,776	Barataria
36	P830438	Continental Land	109/01	3,251	Terrebonne
37	P830450	Cam. Grav. Drn. Dist. 4		1,477	Mermentau
38	P830563	Continental Land	109/02	6,267	Terrebonne
39	P830674	Hawthorne		4,248	Barataria

Table 3. Coastal Management Division permits included in the marsh management profile database, the applicant name, and corresponding Corps of Engineers and Soil Conservation Service numbers, as of May 15, 1989 (see plate 7) (continued).

40	P830785	Simmons, Edward	045/09	150	Verm-Teche
41	P830895	Cheramie, Louis J.	057/06	24	Barataria
42	P830896	Cheramie, Louis J.	057/06	2,892	Barataria
43	P830897	Cheramie, Louis J.	057/06	4,100	Barataria
44	P830943	Lafourche Realty	057/01	9,726	Barataria
45	P831020	Superior	109/12	477	Terrebonne
46	P831153	Lafourche Realty	057/01	9,272	Barataria
47	P831284	Chevron	109/12	742	Terrebonne
48	P831289	James		70	Sabine
49	P831307	Cam. Grav. Drn. Dist. 4		798	Calcasieu
50	P831323	Exxon	045/09	150	Verm-Teche
51	P831340	LL&E	089/12	2,912	Barataria
52	P831371	Little Pecan		849	Mermentau
53	P831442	Miami Corp.		44,979	Mermentau
54	P831446	Texas Crude, Inc.	045/49	160	Verm-Teche
55	P831466	Vaughan, Alfred		10	Mermentau
56	P831618	Sea Farms		2,268	Barataria
57	P831622	Exxon		1,600	Verm-Teche
58	P831695	Moran	109/12	334	Terrebonne
59	P831710	LL&E	057/03	6,612	Barataria
60	P831731	Carlson	109/13	1,253	Terrebonne
61	P840078	BHP Petroleum		1,278	Verm-Teche
62	P840151	Plaq. Par. Comm.		219	S. Pontch.
63	P840240	Lindsey, Clyde		45	Terrebonne
64	P840269	La. Delta Farms	057/02	46,222	Barataria
65	P840349	Tenneco	109/10	6,987	Terrebonne
66	P840376	Davis Oil		347	Barataria
67	P840490	Vermillion Corp.	113/13	3,883	Mermentau
68	P840538	LL&E	089/12	5,994	Barataria
69	P840637	Vermillion Corp.	113/04	4,168	Mermentau
70	P840643	Buruieres, J. M.	101/04	344	Verm-Teche
71	P840796	Simoneaux, Gibson		4	N. Pontch.
72	P840836	Huffco Petroleum	109/13	119	Terrebonne
73	P841031	Byler, L. P.		10	Calcasieu
74	P841047	LL&E	057/01	3,573	Barataria
75	P841252	Huber, Bruce M.		885	N. Pontch.
76	P841371	Moran Explor.	109/12	502	Terrebonne
77	P841371	Iberia Invest.		87	Verm-Teche
78	P841532	LL&E	051/07	2,450	Barataria
79	P841571	Cashco			Verm-Teche
80	P841604	Shell Western			Calcasieu
81	P841605	Ryan, Lydia		25,969	Barataria
82	P850029	Tenneco		1,144	Terrebonne
83	P850030	Tenneco		1,891	Terrebonne
84	P850031	Tenneco	109/14	7,236	Terrebonne

Table 3. Coastal Management Division permits included in the marsh management profile database, the applicant name, and corresponding Corps of Engineers and Soil Conservation Service numbers, as of May 15, 1989 (see plate 7) (continued).

85	P850038	Sanderfer		272	Barataria
86	P850048	Pettit, Mike	113/01	81	Verm-Teche
87	P850076	Welch, Benny		279	Mermentau
88	P850365	Whitney National		1,971	Barataria
89	P850376	Tenneco	109/12	266	Terrebonne
90	P850463	Vermillion Corp.	113/11	2,989	Mermentau
91	P850484	Avoca	101/02	613	Terrebonne
92	P850490	Vermilion Par. P. J.		7,129	Mermentau
93	P850558	Caldwell, Donald	113/02	669	Verm-Teche
94	P850631	Chachere, Mike	023/01	1,753	Mermentau
95	P850639	Terr. Par. Cons.		643	Terrebonne
96	P850732	Terr. Par. Cons.	109/04	6,834	Terrebonne
97	P850991	Levis, Robert J.		4	Pearl
98	P851028	Amoco		6,847	Calcasieu
99	P851064	Vermillion Corp.	113/10	3,936	Verm-Teche
100	P851123	Vincent, Amos		5	Mermentau
101	P851501	Continental Land	109/17	21,980	Terrebonne
102	P851514	Dominque, Bryant		356	Mermentau
103	P851615	Shaughnessy, Terry		1,439	Calcasieu
104	P851617	Terr. Parish		1,928	Terrebonne
105	P851633	Hebert, Avery	109/04	76	Terrebonne
106	P860046	Miami Corp.		3,053	Verm-Teche
107	P860053	Theriot, Dale A.	109/04	34	Terrebonne
108	P860078	Harry Bourg Corp.		211	Terrebonne
109	P860129	Vermillion Bay Land	113/09	1,035	Verm-Teche
110	P860237	Amoco	113/12	22,678	Mermentau
111	P860301	Cam. Grav. Drn. Dist.		1,992	Mermentau
112	P860415	St. Charles Land	089/10	12,905	N. Pontch.
113	P860477	Biloxi Marsh	087/15	5,454	N. Pontch.
114	P860499	Sturlese, Enos J.		883	Mermentau
115	P860594	Patout, M. A.		108	Verm-Teche
116	P860626	Pettit, Mike	113/01	1,250	Verm-Teche
117	P860741	Cenac, Christopher	109/07	899	Terrebonne
118	P860788	St. Char. Par. Co.	089/10	1,976	N. Pontch.
119	P860847	Scott, Henry E.		490	Calcasieu
120	P860931	Harry Bourg Corp.		3,275	Terrebonne
121	P860951	Benoit, George		1	Mermentau
122	P860985	St. Charles Par.		205	N. Pontch.
123	P861084	Cam. Grav. Drn .Dist 3		68,319	Calcasieu
124	P870145	Terr. Par.	109/22	450	Terrebonne
125	P870168	Jack Nicklaus Dev.		549	Barataria
126	P870219	Landry, Ashby		320	Verm-Teche
127	P870293	Little Lake Hunting	051/06	3,572	Barataria
128	P870294	LL&E	051/06	4,894	Barataria
129	P870414	James, N. C.		1	Pearl

Table 3. Coastal Management Division permits included in the marsh management profile database, the applicant name, and corresponding Corps of Engineers and Soil Conservation Service numbers, as of May 15, 1989 (see plate 7) (continued).

130	P870422	Bonsall, Thomas		168	Mermentau
131	P870435	Ledet, Louis		792	Mermentau
132	P870486	Little Lake Hunting	051/06		Barataria
133	P870548	Boudreaux, Larry		5	Mermentau
134	P870551	Cam. Grav. Drn. Dist		567	Mermentau
135	P870594	Rutherford, John		1	Mermentau
136	P870666	Martin, Andrew	057/08	1,186	Terrebonne
137	P870670	Ace Transport.		913	Mermentau
138	P870688	Amoco	023/06	832	Calcasieu
139	P870689	Amoco	023/05	1,521	Calcasieu
140	P870691	Vallette, James		57	Mermentau
141	P870835	Cameron Par.		769	Mermentau
142	P870976	Three G Enter.		705	Barataria
143	P870977	Tenneco		90	Terrebonne
144	P871099	Cashco	045/04	838	Verm-Teche
145	P871109	Hulin, Jewitt		20	Verm-Teche
146	P871131	Vermillion Corp.	113/09		Verm-Teche
147	P880023	Terr. Par. Cons.	109/16	2,418	Terrebonne
148	P880094	Cavalier, Franklin		121	Terrebonne
149	P880129	H Bar H Inc.	109/05	8,025	Terrebonne
150	P880250	Vermillion Corp.	113/03	10,841	Mermentau
151	P880281	Artra		370	N. Pontch.
152	P880333	Cheramie, Louis	057/06		Barataria
153	P880335	LL&E			Barataria
154	P880336	LL&E			Barataria
155	P880337	LL&E			Terrebonne
156	P880338	LL&E			Terrebonne
157	P880444	Cenac, Christopher	109/08	253	Terrebonne
158	P880535	Robinson Canal Land		271	Terrebonne
159	P880600	Fanguy, Hugh	109/01		Terrebonne
160	P880732	Continental Land	109/02		Terrebonne
161	P880756	Cameron Par.		180	Sabine
162	P880786	Continental Land	109/01		Terrebonne
163	P880862	Semmes Lynch		364	Mermentau
164	P880902	Intracoastal Oilfl	057/08	644	Terrebonne
165	Prior	Tenneco	109/11	4,420	Terrebonne

APPENDIX K

SUMMARY OF
HABITAT VALUES FOR SIX AGGREGATED CLASSIFICATIONS
COVERING ALL TIME INTERVALS INCLUDING NET CHANGE
SINCE IMPLEMENTATION

AREAS OF MARSH MANAGEMENT AREAS AND NET CHANGE SINCE IMPLEMENTATION

MM AREA	MGMT	HABITAT AGGREGATE	NO.	NET	55/6	78/	81/2/3	85/	88/
Amoco West Black Lake	PLAN	NATURAL & ARTIFICIAL WATER	HA	-206.888	4.120	1574.201	2620.015	2612.395	2408.507
Amoco West Black Lake	PLAN	NATURAL & ARTIFICIAL WATER	%	-7.630	0.150	57.370	95.610	95.370	87.740
Amoco West Black Lake	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	659.281	0.000	0.000	0.000
Amoco West Black Lake	PLAN	AQUATIC VEGETATION	%	0.000	0.000	24.030	0.000	0.000	0.000
Amoco West Black Lake	PLAN	WATER & AQUATIC VEGETATION	HA	-206.888	4.120	2233.482	2620.015	2612.395	2408.507
Amoco West Black Lake	PLAN	WATER & AQUATIC VEGETATION	%	-7.630	0.150	81.400	95.610	95.370	87.740
Amoco West Black Lake	PLAN	MARSH	HA	25.302	2702.897	507.867	117.763	123.823	149.125
Amoco West Black Lake	PLAN	MARSH	%	0.920	98.640	18.500	4.300	4.520	5.440
Amoco West Black Lake	PLAN	SHRUB/SCRUB (not spoil)	HA	0.140	0.000	0.460	0.720	0.970	1.110
Amoco West Black Lake	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.020	0.030	0.040	0.040
Amoco West Black Lake	PLAN	OTHER	HA	183.526	33.341	2.310	1.870	2.060	185.586
Amoco West Black Lake	PLAN	OTHER	%	6.690	1.220	0.080	0.070	0.080	6.770
Amoco West Black Lake	CONTROL	NATURAL & ARTIFICIAL WATER	HA	-25.351	1.580	1027.043	1043.184	1046.804	1021.453
Amoco West Black Lake	CONTROL	NATURAL & ARTIFICIAL WATER	%	-1.790	0.120	78.470	79.730	80.040	78.250
Amoco West Black Lake	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Amoco West Black Lake	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Amoco West Black Lake	CONTROL	WATER & AQUATIC VEGETATION	HA	-25.351	1.580	1027.043	1043.184	1046.804	1021.453
Amoco West Black Lake	CONTROL	WATER & AQUATIC VEGETATION	%	-1.790	0.120	78.470	79.730	80.040	78.250
Amoco West Black Lake	CONTROL	MARSH	HA	4.130	1304.932	273.519	259.169	253.958	258.088
Amoco West Black Lake	CONTROL	MARSH	%	0.350	99.880	20.900	19.800	19.420	19.770
Amoco West Black Lake	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.010	0.000	0.000	0.000	0.140	0.150
Amoco West Black Lake	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.010	0.010
Amoco West Black Lake	CONTROL	OTHER	HA	18.641	0.000	8.280	6.050	6.980	25.621
Amoco West Black Lake	CONTROL	OTHER	%	1.430	0.000	0.630	0.460	0.530	1.960
Creole Canal	PLAN	NATURAL & ARTIFICIAL WATER	HA	-81.453	99.663	234.978	237.638	263.689	182.236
Creole Canal	PLAN	NATURAL & ARTIFICIAL WATER	%	-7.180	8.780	20.740	21.000	23.290	16.110
Creole Canal	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	PLAN	WATER & AQUATIC VEGETATION	HA	-81.453	99.663	234.978	237.638	263.689	182.236
Creole Canal	PLAN	WATER & AQUATIC VEGETATION	%	-7.180	8.780	20.740	21.000	23.290	16.110
Creole Canal	PLAN	MARSH	HA	64.523	1017.193	886.239	868.928	852.007	916.530
Creole Canal	PLAN	MARSH	%	5.720	89.620	78.220	76.780	75.270	80.990
Creole Canal	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	PLAN	OTHER	HA	16.590	18.130	11.840	25.171	16.280	32.870
Creole Canal	PLAN	OTHER	%	1.470	1.600	1.040	2.230	1.440	2.910
Creole Canal	CONTROL	NATURAL & ARTIFICIAL WATER	HA	-6.201	11.370	116.403	79.243	28.841	22.640
Creole Canal	CONTROL	NATURAL & ARTIFICIAL WATER	%	-0.850	1.550	16.040	10.780	3.930	3.080
Creole Canal	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	CONTROL	WATER & AQUATIC VEGETATION	HA	-6.201	11.370	116.403	79.243	28.841	22.640
Creole Canal	CONTROL	WATER & AQUATIC VEGETATION	%	-0.850	1.550	16.040	10.780	3.930	3.080
Creole Canal	CONTROL	MARSH	HA	-5.640	705.863	580.688	627.400	597.810	592.170
Creole Canal	CONTROL	MARSH	%	-0.750	96.340	79.030	85.290	81.460	80.710
Creole Canal	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Creole Canal	CONTROL	OTHER	HA	11.790	15.440	37.671	29.001	107.153	118.943
Creole Canal	CONTROL	OTHER	%	1.600	2.100	5.120	3.950	14.600	16.200
Little Pecan Island, Unit 6	PLAN	NATURAL & ARTIFICIAL WATER	HA	16.410	20.551	31.821	35.621	47.881	48.231
Little Pecan Island, Unit 6	PLAN	NATURAL & ARTIFICIAL WATER	%	9.090	12.050	18.750	20.820	27.940	27.840
Little Pecan Island, Unit 6	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	PLAN	WATER & AQUATIC VEGETATION	HA	16.410	20.551	31.821	35.621	47.881	48.231
Little Pecan Island, Unit 6	PLAN	WATER & AQUATIC VEGETATION	%	9.090	12.050	18.750	20.820	27.940	27.840
Little Pecan Island, Unit 6	PLAN	MARSH	HA	-17.480	147.675	129.384	125.474	118.524	111.904
Little Pecan Island, Unit 6	PLAN	MARSH	%	-11.660	86.570	76.250	73.330	69.150	64.590
Little Pecan Island, Unit 6	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	PLAN	OTHER	HA	4.650	2.350	8.470	10.000	5.000	13.120
Little Pecan Island, Unit 6	PLAN	OTHER	%	2.580	1.380	5.000	5.850	2.910	7.580
Little Pecan Island, Unit 6	CONTROL	NATURAL & ARTIFICIAL WATER	HA	4.700	12.780	53.892	52.131	59.532	58.592
Little Pecan Island, Unit 6	CONTROL	NATURAL & ARTIFICIAL WATER	%	1.890	7.980	34.080	32.870	37.430	35.970
Little Pecan Island, Unit 6	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	CONTROL	WATER & AQUATIC VEGETATION	HA	4.700	12.780	53.892	52.131	59.532	58.592
Little Pecan Island, Unit 6	CONTROL	WATER & AQUATIC VEGETATION	%	1.890	7.980	34.080	32.870	37.430	35.970
Little Pecan Island, Unit 6	CONTROL	MARSH	HA	-7.000	145.474	97.143	98.053	91.363	98.143
Little Pecan Island, Unit 6	CONTROL	MARSH	%	-6.100	90.830	61.440	61.810	57.440	55.340
Little Pecan Island, Unit 6	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 6	CONTROL	OTHER	HA	7.060	1.900	7.090	8.440	8.170	14.150
Little Pecan Island, Unit 6	CONTROL	OTHER	%	4.200	1.190	4.490	5.320	5.140	8.690
Little Pecan Island, Unit 9	PLAN	NATURAL & ARTIFICIAL WATER	HA	1.460	0.000	30.981	38.151	38.301	32.441
Little Pecan Island, Unit 9	PLAN	NATURAL & ARTIFICIAL WATER	%	0.340	0.000	6.870	8.470	8.500	7.210
Little Pecan Island, Unit 9	PLAN	AQUATIC VEGETATION	HA	0.050	0.000	0.000	0.000	0.000	0.050
Little Pecan Island, Unit 9	PLAN	AQUATIC VEGETATION	%	0.010	0.000	0.000	0.000	0.000	0.010
Little Pecan Island, Unit 9	PLAN	WATER & AQUATIC VEGETATION	HA	1.510	0.000	30.981	38.151	38.301	32.491
Little Pecan Island, Unit 9	PLAN	WATER & AQUATIC VEGETATION	%	0.350	0.000	6.870	8.470	8.500	7.220
Little Pecan Island, Unit 9	PLAN	MARSH	HA	-5.911	443.104	410.023	412.093	412.382	404.112
Little Pecan Island, Unit 9	PLAN	MARSH	%	-0.980	100.000	90.860	91.520	91.510	89.880

AREAS OF MARSH MANAGEMENT AREAS AND NET CHANGE SINCE IMPLEMENTATION

Little Pecan Island, Unit 9	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 9	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 9	PLAN	OTHER	HA	2.791	0.000	10.260	0.000	0.000	13.051
Little Pecan Island, Unit 9	PLAN	OTHER	%	0.640	0.000	2.270	0.000	0.000	2.910
Little Pecan Island, Unit 9	CONTROL	NATURAL & ARTIFICIAL WATER	HA	-0.790	0.000	45.872	45.751	43.341	45.082
Little Pecan Island, Unit 9	CONTROL	NATURAL & ARTIFICIAL WATER	%	-0.140	0.000	11.440	11.440	10.840	11.300
Little Pecan Island, Unit 9	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 9	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 9	CONTROL	WATER & AQUATIC VEGETATION	HA	-0.790	0.000	45.872	45.751	43.341	45.082
Little Pecan Island, Unit 9	CONTROL	WATER & AQUATIC VEGETATION	%	-0.140	0.000	11.440	11.440	10.840	11.300
Little Pecan Island, Unit 9	CONTROL	MARSH	HA	-6.091	400.632	354.971	354.331	356.592	348.880
Little Pecan Island, Unit 9	CONTROL	MARSH	%	-1.140	100.000	88.560	88.560	89.160	87.420
Little Pecan Island, Unit 9	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 9	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Little Pecan Island, Unit 9	CONTROL	OTHER	HA	5.120	0.000	0.000	0.000	0.000	5.120
Little Pecan Island, Unit 9	CONTROL	OTHER	%	1.280	0.000	0.000	0.000	0.000	1.280
Rockefeller Refuge	PLAN	NATURAL & ARTIFICIAL WATER	HA	376.832	349.651	1138.507	1028.653	974.042	726.483
Rockefeller Refuge	PLAN	NATURAL & ARTIFICIAL WATER	%	18.120	16.740	54.560	49.310	46.690	34.860
Rockefeller Refuge	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	8.530	28.231	5.400	0.000
Rockefeller Refuge	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.410	1.350	0.260	0.000
Rockefeller Refuge	PLAN	WATER & AQUATIC VEGETATION	HA	376.832	349.651	1147.037	1056.884	979.442	726.483
Rockefeller Refuge	PLAN	WATER & AQUATIC VEGETATION	%	18.120	16.740	54.970	50.660	46.950	34.860
Rockefeller Refuge	PLAN	MARSH	HA	-427.564	1737.706	929.020	1021.403	1070.265	1310.142
Rockefeller Refuge	PLAN	MARSH	%	-20.350	83.210	44.520	48.970	51.290	62.860
Rockefeller Refuge	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Rockefeller Refuge	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Rockefeller Refuge	PLAN	OTHER	HA	46.382	1.060	10.860	7.630	36.702	47.442
Rockefeller Refuge	PLAN	OTHER	%	2.230	0.050	0.520	0.360	1.760	2.280
Rockefeller Refuge	CONTROL	NATURAL & ARTIFICIAL WATER	HA	155.875	165.386	307.620	246.748	283.500	321.261
Rockefeller Refuge	CONTROL	NATURAL & ARTIFICIAL WATER	%	9.730	10.300	19.180	15.330	17.570	20.030
Rockefeller Refuge	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	47.592	0.000	0.000
Rockefeller Refuge	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	2.960	0.000	0.000
Rockefeller Refuge	CONTROL	WATER & AQUATIC VEGETATION	HA	155.875	165.386	307.620	294.340	283.500	321.261
Rockefeller Refuge	CONTROL	WATER & AQUATIC VEGETATION	%	9.730	10.300	19.180	18.290	17.570	20.030
Rockefeller Refuge	CONTROL	MARSH	HA	-162.976	1440.927	1295.452	1315.032	1322.812	1277.951
Rockefeller Refuge	CONTROL	MARSH	%	-10.030	89.700	80.790	81.680	81.960	79.670
Rockefeller Refuge	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Rockefeller Refuge	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Rockefeller Refuge	CONTROL	OTHER	HA	4.810	0.000	0.420	0.680	7.603	4.810
Rockefeller Refuge	CONTROL	OTHER	%	0.300	0.000	0.030	0.040	0.470	0.300
Vermilion Corp., Unit 42	PLAN	NATURAL & ARTIFICIAL WATER	HA	15.091	39.061	44.452	47.722	61.002	54.152
Vermilion Corp., Unit 42	PLAN	NATURAL & ARTIFICIAL WATER	%	3.930	10.340	11.710	12.550	16.070	14.270
Vermilion Corp., Unit 42	PLAN	AQUATIC VEGETATION	HA	1.000	0.000	1.270	1.310	1.190	1.000
Vermilion Corp., Unit 42	PLAN	AQUATIC VEGETATION	%	0.260	0.000	0.330	0.340	0.310	0.260
Vermilion Corp., Unit 42	PLAN	WATER & AQUATIC VEGETATION	HA	16.091	39.061	45.722	49.032	62.192	55.152
Vermilion Corp., Unit 42	PLAN	WATER & AQUATIC VEGETATION	%	4.190	10.340	12.040	12.890	16.380	14.530
Vermilion Corp., Unit 42	PLAN	MARSH	HA	-20.321	338.811	333.900	331.411	316.960	318.490
Vermilion Corp., Unit 42	PLAN	MARSH	%	-5.720	89.660	87.960	87.110	83.520	83.940
Vermilion Corp., Unit 42	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Corp., Unit 42	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Corp., Unit 42	PLAN	OTHER	HA	5.780	0.000	0.000	0.000	0.350	5.780
Vermilion Corp., Unit 42	PLAN	OTHER	%	1.520	0.000	0.000	0.000	0.090	1.520
Vermilion Corp., Unit 42	CONTROL	NATURAL & ARTIFICIAL WATER	HA	-7.790	7.790	51.331	53.001	50.902	0.000
Vermilion Corp., Unit 42	CONTROL	NATURAL & ARTIFICIAL WATER	%	-5.070	5.070	33.370	34.680	33.250	0.000
Vermilion Corp., Unit 42	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Corp., Unit 42	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Corp., Unit 42	CONTROL	WATER & AQUATIC VEGETATION	HA	-7.790	7.790	51.331	53.001	50.902	0.000
Vermilion Corp., Unit 42	CONTROL	WATER & AQUATIC VEGETATION	%	-5.070	5.070	33.370	34.680	33.250	0.000
Vermilion Corp., Unit 42	CONTROL	MARSH	HA	-51.132	140.745	96.713	98.533	91.793	89.613
Vermilion Corp., Unit 42	CONTROL	MARSH	%	-34.250	91.620	62.860	64.480	59.960	57.370
Vermilion Corp., Unit 42	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Corp., Unit 42	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Corp., Unit 42	CONTROL	OTHER	HA	61.502	5.080	5.800	1.280	10.390	66.582
Vermilion Corp., Unit 42	CONTROL	OTHER	%	39.310	3.310	3.770	0.840	6.780	42.620
Vermilion Bay Land, Unit 50	PLAN	NATURAL & ARTIFICIAL WATER	HA	-49.472	12.080	137.165	134.215	141.725	92.253
Vermilion Bay Land, Unit 50	PLAN	NATURAL & ARTIFICIAL WATER	%	-11.210	2.750	31.460	30.510	31.970	20.760
Vermilion Bay Land, Unit 50	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	PLAN	WATER & AQUATIC VEGETATION	HA	-49.472	12.080	137.165	134.215	141.725	92.253
Vermilion Bay Land, Unit 50	PLAN	WATER & AQUATIC VEGETATION	%	-11.210	2.750	31.460	30.510	31.970	20.760
Vermilion Bay Land, Unit 50	PLAN	MARSH	HA	-13.110	387.643	282.999	290.409	285.319	272.209
Vermilion Bay Land, Unit 50	PLAN	MARSH	%	-3.080	88.360	64.910	66.020	64.350	61.270
Vermilion Bay Land, Unit 50	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	PLAN	OTHER	HA	63.523	38.971	15.771	15.281	16.310	79.833
Vermilion Bay Land, Unit 50	PLAN	OTHER	%	14.290	8.890	3.620	3.470	3.680	17.970
Vermilion Bay Land, Unit 50	CONTROL	NATURAL & ARTIFICIAL WATER	HA	-5.650	6.550	72.523	95.003	28.191	22.541
Vermilion Bay Land, Unit 50	CONTROL	NATURAL & ARTIFICIAL WATER	%	-2.010	2.370	26.020	34.120	10.000	7.990
Vermilion Bay Land, Unit 50	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	CONTROL	WATER & AQUATIC VEGETATION	HA	-5.650	6.550	72.523	95.003	28.191	22.541
Vermilion Bay Land, Unit 50	CONTROL	WATER & AQUATIC VEGETATION	%	-2.010	2.370	26.020	34.120	10.000	7.990

AREAS OF MARSH MANAGEMENT AREAS AND NET CHANGE SINCE IMPLEMENTATION

Vermilion Bay Land, Unit 50	CONTROL	MARSH	HA	-5.170	253.458	181.806	150.745	155.215	158.045
Vermilion Bay Land, Unit 50	CONTROL	MARSH	%	-1.870	91.700	65.240	54.140	55.060	53.190
Vermilion Bay Land, Unit 50	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Vermilion Bay Land, Unit 50	CONTROL	OTHER	HA	11.030	16.381	24.341	32.701	98.493	109.523
Vermilion Bay Land, Unit 50	CONTROL	OTHER	%	3.880	5.930	8.730	11.740	34.940	38.820
State Wildlife Refuge	PLAN	NATURAL & ARTIFICIAL WATER	HA	202.946	74.623	252.908	260.338	275.489	277.569
State Wildlife Refuge	PLAN	NATURAL & ARTIFICIAL WATER	%	13.790	5.080	17.200	17.720	18.770	18.870
State Wildlife Refuge	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	3.770	0.000	0.000	0.000
State Wildlife Refuge	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.260	0.000	0.000	0.000
State Wildlife Refuge	PLAN	WATER & AQUATIC VEGETATION	HA	202.946	74.623	256.678	260.338	275.489	277.569
State Wildlife Refuge	PLAN	WATER & AQUATIC VEGETATION	%	13.790	5.080	17.460	17.720	18.770	18.870
State Wildlife Refuge	PLAN	MARSH	HA	-221.047	1394.155	1210.889	1208.589	1192.028	1173.108
State Wildlife Refuge	PLAN	MARSH	%	-15.150	94.920	82.380	82.280	81.230	79.770
State Wildlife Refuge	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
State Wildlife Refuge	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
State Wildlife Refuge	PLAN	OTHER	HA	19.971	0.000	2.250	0.000	0.000	19.971
State Wildlife Refuge	PLAN	OTHER	%	1.360	0.000	0.150	0.000	0.000	1.360
State Wildlife Refuge	CONTROL	NATURAL & ARTIFICIAL WATER	HA	109.394	58.102	173.606	170.546	172.035	167.496
State Wildlife Refuge	CONTROL	NATURAL & ARTIFICIAL WATER	%	7.100	3.770	11.270	11.080	11.150	10.870
State Wildlife Refuge	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	1.140	0.000	0.000	0.000
State Wildlife Refuge	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.070	0.000	0.000	0.000
State Wildlife Refuge	CONTROL	WATER & AQUATIC VEGETATION	HA	109.394	58.102	174.746	170.546	172.035	167.496
State Wildlife Refuge	CONTROL	WATER & AQUATIC VEGETATION	%	7.100	3.770	11.340	11.080	11.150	10.870
State Wildlife Refuge	CONTROL	MARSH	HA	-119.964	1481.408	1365.694	1368.474	1370.984	1361.444
State Wildlife Refuge	CONTROL	MARSH	%	-7.840	96.230	88.630	88.920	88.850	88.390
State Wildlife Refuge	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
State Wildlife Refuge	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
State Wildlife Refuge	CONTROL	OTHER	HA	11.341	0.000	0.510	0.000	0.000	11.341
State Wildlife Refuge	CONTROL	OTHER	%	0.740	0.000	0.030	0.000	0.000	0.740
McIlhenny Co., Unit 56	PLAN	NATURAL & ARTIFICIAL WATER	HA	-1.020	23.701	29.541	26.701	12.280	25.681
McIlhenny Co., Unit 56	PLAN	NATURAL & ARTIFICIAL WATER	%	-0.120	2.980	3.720	3.360	1.550	3.240
McIlhenny Co., Unit 56	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
McIlhenny Co., Unit 56	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
McIlhenny Co., Unit 56	PLAN	WATER & AQUATIC VEGETATION	HA	-1.020	23.701	29.541	26.701	12.280	25.681
McIlhenny Co., Unit 56	PLAN	WATER & AQUATIC VEGETATION	%	-0.120	2.980	3.720	3.360	1.550	3.240
McIlhenny Co., Unit 56	PLAN	MARSH	HA	-14.641	752.504	722.014	759.535	758.205	744.894
McIlhenny Co., Unit 56	PLAN	MARSH	%	-1.630	94.640	90.870	95.610	95.260	93.980
McIlhenny Co., Unit 56	PLAN	SHRUB/SCRUB (not spoil)	HA	9.061	18.941	39.841	4.980	4.480	14.041
McIlhenny Co., Unit 56	PLAN	SHRUB/SCRUB (not spoil)	%	1.140	2.380	5.010	0.630	0.560	1.770
McIlhenny Co., Unit 56	PLAN	OTHER	HA	4.740	0.000	3.120	3.230	21.001	7.970
McIlhenny Co., Unit 56	PLAN	OTHER	%	0.610	0.000	0.390	0.400	2.640	1.010
McIlhenny Co., Unit 56	CONTROL	NATURAL & ARTIFICIAL WATER	HA	15.292	22.231	36.691	20.050	24.631	35.342
McIlhenny Co., Unit 56	CONTROL	NATURAL & ARTIFICIAL WATER	%	1.750	2.570	4.230	2.320	2.850	4.070
McIlhenny Co., Unit 56	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
McIlhenny Co., Unit 56	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
McIlhenny Co., Unit 56	CONTROL	WATER & AQUATIC VEGETATION	HA	15.292	22.231	36.691	20.050	24.631	35.342
McIlhenny Co., Unit 56	CONTROL	WATER & AQUATIC VEGETATION	%	1.750	2.570	4.230	2.320	2.850	4.070
McIlhenny Co., Unit 56	CONTROL	MARSH	HA	-9.190	718.353	736.263	803.936	796.896	794.746
McIlhenny Co., Unit 56	CONTROL	MARSH	%	-1.100	82.910	84.760	92.740	92.050	91.640
McIlhenny Co., Unit 56	CONTROL	SHRUB/SCRUB (not spoil)	HA	6.610	123.354	85.663	15.431	15.090	22.041
McIlhenny Co., Unit 56	CONTROL	SHRUB/SCRUB (not spoil)	%	0.760	14.240	9.860	1.780	1.740	2.540
McIlhenny Co., Unit 56	CONTROL	OTHER	HA	-12.290	2.430	10.030	27.471	29.081	15.181
McIlhenny Co., Unit 56	CONTROL	OTHER	%	-1.420	0.280	1.150	3.170	3.360	1.750
Marsh Island Refuge	PLAN	NATURAL & ARTIFICIAL WATER	HA	120.044	131.684	201.616	237.717	232.087	251.728
Marsh Island Refuge	PLAN	NATURAL & ARTIFICIAL WATER	%	17.610	19.390	29.720	35.040	34.210	37.000
Marsh Island Refuge	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Island Refuge	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Island Refuge	PLAN	WATER & AQUATIC VEGETATION	HA	120.044	131.684	201.616	237.717	232.087	251.728
Marsh Island Refuge	PLAN	WATER & AQUATIC VEGETATION	%	17.610	19.390	29.720	35.040	34.210	37.000
Marsh Island Refuge	PLAN	MARSH	HA	-135.235	547.568	430.654	425.074	432.604	412.333
Marsh Island Refuge	PLAN	MARSH	%	-20.000	80.610	63.470	62.650	63.760	60.610
Marsh Island Refuge	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Island Refuge	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Island Refuge	PLAN	OTHER	HA	16.200	0.000	46.222	15.661	13.820	16.200
Marsh Island Refuge	PLAN	OTHER	%	2.380	0.000	6.820	2.310	2.040	2.380
Marsh Island Refuge	CONTROL	NATURAL & ARTIFICIAL WATER	HA	94.513	133.844	199.687	199.986	203.126	228.357
Marsh Island Refuge	CONTROL	NATURAL & ARTIFICIAL WATER	%	12.490	17.990	26.830	26.820	27.190	30.480
Marsh Island Refuge	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	2.200	4.670	0.000
Marsh Island Refuge	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.300	0.630	0.000
Marsh Island Refuge	CONTROL	WATER & AQUATIC VEGETATION	HA	94.513	133.844	199.687	202.186	207.796	228.357
Marsh Island Refuge	CONTROL	WATER & AQUATIC VEGETATION	%	12.490	17.990	26.830	27.120	27.820	30.480
Marsh Island Refuge	CONTROL	MARSH	HA	-124.784	610.320	517.427	520.737	513.387	485.536
Marsh Island Refuge	CONTROL	MARSH	%	-17.200	82.010	69.500	69.840	68.710	64.810
Marsh Island Refuge	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Island Refuge	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
Marsh Island Refuge	CONTROL	OTHER	HA	35.251	0.000	27.340	22.731	25.951	35.251
Marsh Island Refuge	CONTROL	OTHER	%	4.710	0.000	3.670	3.040	3.480	4.710
Avoca - Bayou Lawrence	PLAN	NATURAL & ARTIFICIAL WATER	HA	-71.592	6.970	75.912	87.113	121.854	50.262
Avoca - Bayou Lawrence	PLAN	NATURAL & ARTIFICIAL WATER	%	-28.850	2.830	30.770	35.090	49.110	28.260
Avoca - Bayou Lawrence	PLAN	AQUATIC VEGETATION	HA	-1.371	0.000	17.380	1.460	18.821	17.450
Avoca - Bayou Lawrence	PLAN	AQUATIC VEGETATION	%	-0.550	0.000	7.040	0.590	7.500	7.030

AREAS OF MARSH MANAGEMENT AREAS AND NET CHANGE SINCE IMPLEMENTATION

Avoca - Bayou Lawrence	PLAN	WATER & AQUATIC VEGETATION	HA	-72.963	6.970	93.292	68.573	140.675	67.712
Avoca - Bayou Lawrence	PLAN	WATER & AQUATIC VEGETATION	%	-29.400	2.030	37.010	35.680	56.690	27.290
Avoca - Bayou Lawrence	PLAN	MARSH	HA	6.011	174.596	68.602	79.972	45.131	51.142
Avoca - Bayou Lawrence	PLAN	MARSH	%	2.420	70.800	27.800	32.210	18.190	20.610
Avoca - Bayou Lawrence	PLAN	SHRUB/SCRUB (not spoil)	HA	2.160	33.541	37.791	29.441	27.791	29.981
Avoca - Bayou Lawrence	PLAN	SHRUB/SCRUB (not spoil)	%	0.870	13.600	15.320	11.860	11.200	12.070
Avoca - Bayou Lawrence	PLAN	OTHER	HA	64.762	31.491	47.041	50.262	34.561	99.323
Avoca - Bayou Lawrence	PLAN	OTHER	%	26.100	12.700	19.070	20.250	13.920	40.020
Avoca - Bayou Lawrence	CONTROL	NATURAL & ARTIFICIAL WATER	HA	-112.643	11.330	139.015	184.716	208.916	96.273
Avoca - Bayou Lawrence	CONTROL	NATURAL & ARTIFICIAL WATER	%	-42.870	4.290	53.100	71.090	79.650	36.700
Avoca - Bayou Lawrence	CONTROL	AQUATIC VEGETATION	HA	103.663	0.000	20.841	0.000	9.830	113.493
Avoca - Bayou Lawrence	CONTROL	AQUATIC VEGETATION	%	39.610	0.000	7.960	0.000	3.750	43.360
Avoca - Bayou Lawrence	CONTROL	WATER & AQUATIC VEGETATION	HA	-8.980	11.330	159.856	184.716	218.746	209.766
Avoca - Bayou Lawrence	CONTROL	WATER & AQUATIC VEGETATION	%	-3.260	4.290	61.060	71.090	83.400	80.140
Avoca - Bayou Lawrence	CONTROL	MARSH	HA	-10.710	191.246	84.913	62.352	33.401	22.691
Avoca - Bayou Lawrence	CONTROL	MARSH	%	-4.060	72.510	32.430	24.000	12.730	8.670
Avoca - Bayou Lawrence	CONTROL	SHRUB/SCRUB (not spoil)	HA	-1.090	0.000	0.390	1.740	1.090	0.000
Avoca - Bayou Lawrence	CONTROL	SHRUB/SCRUB (not spoil)	%	-0.420	0.000	0.150	0.670	0.420	0.000
Avoca - Bayou Lawrence	CONTROL	OTHER	HA	20.231	61.162	16.650	11.030	9.060	29.291
Avoca - Bayou Lawrence	CONTROL	OTHER	%	7.750	23.190	6.350	4.250	3.450	11.200
Fina / Falgout Canal	PLAN	NATURAL & ARTIFICIAL WATER	HA	-79.581	14.031	554.620	769.335	945.420	865.039
Fina / Falgout Canal	PLAN	NATURAL & ARTIFICIAL WATER	%	-2.860	0.540	20.050	27.820	34.140	31.280
Fina / Falgout Canal	PLAN	AQUATIC VEGETATION	HA	40.772	0.000	361.632	70.042	13.710	54.482
Fina / Falgout Canal	PLAN	AQUATIC VEGETATION	%	1.480	0.000	13.080	2.530	0.490	1.970
Fina / Falgout Canal	PLAN	WATER & AQUATIC VEGETATION	HA	-38.809	14.031	916.260	839.377	959.130	920.321
Fina / Falgout Canal	PLAN	WATER & AQUATIC VEGETATION	%	-1.380	0.540	33.130	30.350	34.630	33.250
Fina / Falgout Canal	PLAN	MARSH	HA	-79.712	2727.399	1570.571	1588.021	1555.230	1478.518
Fina / Falgout Canal	PLAN	MARSH	%	-2.840	98.740	56.800	57.460	56.150	53.310
Fina / Falgout Canal	PLAN	SHRUB/SCRUB (not spoil)	HA	92.513	0.000	240.138	239.398	211.247	303.760
Fina / Falgout Canal	PLAN	SHRUB/SCRUB (not spoil)	%	3.350	0.000	8.680	8.660	7.630	10.980
Fina / Falgout Canal	PLAN	OTHER	HA	23.561	19.850	38.141	97.753	44.351	67.912
Fina / Falgout Canal	PLAN	OTHER	%	0.850	0.720	1.380	3.530	1.600	2.450
Fina / Falgout Canal	CONTROL	NATURAL & ARTIFICIAL WATER	HA	10.262	0.060	141.614	190.266	253.397	263.659
Fina / Falgout Canal	CONTROL	NATURAL & ARTIFICIAL WATER	%	1.400	0.010	20.590	27.580	36.710	38.110
Fina / Falgout Canal	CONTROL	AQUATIC VEGETATION	HA	7.760	0.000	124.824	30.201	0.000	7.760
Fina / Falgout Canal	CONTROL	AQUATIC VEGETATION	%	1.120	0.000	18.150	4.380	0.000	1.120
Fina / Falgout Canal	CONTROL	WATER & AQUATIC VEGETATION	HA	18.022	0.060	266.438	220.467	253.397	271.419
Fina / Falgout Canal	CONTROL	WATER & AQUATIC VEGETATION	%	2.520	0.010	38.740	31.960	36.710	39.230
Fina / Falgout Canal	CONTROL	MARSH	HA	-28.933	669.722	407.703	427.944	423.015	394.082
Fina / Falgout Canal	CONTROL	MARSH	%	-4.320	96.330	59.270	62.030	61.290	56.970
Fina / Falgout Canal	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.420	0.000	0.000	9.100	2.970	3.390
Fina / Falgout Canal	CONTROL	SHRUB/SCRUB (not spoil)	%	0.060	0.000	0.000	1.320	0.430	0.490
Fina / Falgout Canal	CONTROL	OTHER	HA	12.091	25.481	13.680	32.451	10.000	22.091
Fina / Falgout Canal	CONTROL	OTHER	%	1.750	3.660	1.990	4.700	1.560	3.310
L. L. & E. / Lake Mechant	PLAN	NATURAL & ARTIFICIAL WATER	HA	418.913	387.693	763.865	834.247	826.307	806.606
L. L. & E. / Lake Mechant	PLAN	NATURAL & ARTIFICIAL WATER	%	13.960	12.920	28.470	27.830	27.570	26.880
L. L. & E. / Lake Mechant	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	PLAN	WATER & AQUATIC VEGETATION	HA	418.913	387.693	763.865	834.247	826.307	806.606
L. L. & E. / Lake Mechant	PLAN	WATER & AQUATIC VEGETATION	%	13.960	12.920	25.470	27.830	27.570	26.880
L. L. & E. / Lake Mechant	PLAN	MARSH	HA	-481.685	2613.594	2195.721	2127.139	2140.059	2131.909
L. L. & E. / Lake Mechant	PLAN	MARSH	%	-16.050	87.080	73.200	70.950	71.660	71.030
L. L. & E. / Lake Mechant	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	PLAN	OTHER	HA	62.512	0.000	40.071	36.681	23.201	62.812
L. L. & E. / Lake Mechant	PLAN	OTHER	%	2.080	0.000	1.330	1.230	0.780	2.080
L. L. & E. / Lake Mechant	CONTROL	NATURAL & ARTIFICIAL WATER	HA	202.017	602.439	746.544	786.065	794.316	804.456
L. L. & E. / Lake Mechant	CONTROL	NATURAL & ARTIFICIAL WATER	%	8.840	26.540	32.970	34.720	35.060	35.380
L. L. & E. / Lake Mechant	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	CONTROL	WATER & AQUATIC VEGETATION	HA	202.017	602.439	746.544	786.065	794.316	804.456
L. L. & E. / Lake Mechant	CONTROL	WATER & AQUATIC VEGETATION	%	8.840	26.540	32.970	34.720	35.060	35.380
L. L. & E. / Lake Mechant	CONTROL	MARSH	HA	-199.736	1654.153	1510.659	1471.948	1466.760	1454.417
L. L. & E. / Lake Mechant	CONTROL	MARSH	%	-8.900	72.870	66.730	65.010	64.740	63.970
L. L. & E. / Lake Mechant	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
L. L. & E. / Lake Mechant	CONTROL	OTHER	HA	1.229	13.561	6.690	5.890	4.600	14.790
L. L. & E. / Lake Mechant	CONTROL	OTHER	%	0.050	0.600	0.290	0.260	0.210	0.650
Fina / Bayou Chauvin	PLAN	NATURAL & ARTIFICIAL WATER	HA	77.572	0.010	31.721	25.021	41.031	102.593
Fina / Bayou Chauvin	PLAN	NATURAL & ARTIFICIAL WATER	%	32.100	0.000	13.400	10.490	17.140	42.590
Fina / Bayou Chauvin	PLAN	AQUATIC VEGETATION	HA	-18.281	0.000	11.101	19.791	0.280	1.510
Fina / Bayou Chauvin	PLAN	AQUATIC VEGETATION	%	-7.670	0.000	4.690	8.300	0.120	0.630
Fina / Bayou Chauvin	PLAN	WATER & AQUATIC VEGETATION	HA	59.291	0.010	42.822	44.812	41.311	104.103
Fina / Bayou Chauvin	PLAN	WATER & AQUATIC VEGETATION	%	24.430	0.000	18.090	18.790	17.260	43.220
Fina / Bayou Chauvin	PLAN	MARSH	HA	-48.501	234.527	147.065	160.405	167.366	111.904
Fina / Bayou Chauvin	PLAN	MARSH	%	-20.810	97.630	62.110	67.270	69.900	46.460
Fina / Bayou Chauvin	PLAN	SHRUB/SCRUB (not spoil)	HA	-15.191	0.000	34.631	21.011	15.221	5.820
Fina / Bayou Chauvin	PLAN	SHRUB/SCRUB (not spoil)	%	-6.390	0.000	14.630	8.810	6.360	2.420
Fina / Bayou Chauvin	PLAN	OTHER	HA	6.829	5.680	12.270	12.211	15.528	19.840
Fina / Bayou Chauvin	PLAN	OTHER	%	2.780	2.360	5.100	5.120	6.484	7.900
Fina / Bayou Chauvin	CONTROL	NATURAL & ARTIFICIAL WATER	HA	121.714	0.710	24.630	30.261	59.703	159.875
Fina / Bayou Chauvin	CONTROL	NATURAL & ARTIFICIAL WATER	%	44.600	0.260	9.010	13.960	22.070	58.560

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Fina / Bayou Chauvin	CONTROL	AQUATIC VEGETATION	HA	3.141	0.000	12.700	9.580	2.400	12.721
Fina / Bayou Chauvin	CONTROL	AQUATIC VEGETATION	%	1.170	0.000	4.600	3.490	0.920	4.660
Fina / Bayou Chauvin	CONTROL	WATER & AQUATIC VEGETATION	HA	124.855	0.710	37.410	47.841	62.103	172.696
Fina / Bayou Chauvin	CONTROL	WATER & AQUATIC VEGETATION	%	45.770	0.260	13.690	17.450	22.990	63.220
Fina / Bayou Chauvin	CONTROL	MARSH	HA	-104.424	260.499	160.825	180.476	186.936	76.082
Fina / Bayou Chauvin	CONTROL	MARSH	%	-37.970	95.150	61.760	65.810	69.110	27.040
Fina / Bayou Chauvin	CONTROL	SHRUB/SCRUB (not spoil)	HA	-31.461	0.000	50.542	33.641	10.220	2.100
Fina / Bayou Chauvin	CONTROL	SHRUB/SCRUB (not spoil)	%	-11.470	0.000	18.490	12.270	3.780	0.800
Fina / Bayou Chauvin	CONTROL	OTHER	HA	9.981	12.560	16.560	12.270	11.140	22.251
Fina / Bayou Chauvin	CONTROL	OTHER	%	3.660	4.590	6.060	4.400	4.120	8.140
L. H. Ryan	PLAN	NATURAL & ARTIFICIAL WATER	HA	-5.018	17.402	32.820	29.825	39.821	34.803
L. H. Ryan	PLAN	NATURAL & ARTIFICIAL WATER	%	-4.800	25.000	39.750	36.750	46.300	41.500
L. H. Ryan	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	PLAN	WATER & AQUATIC VEGETATION	HA	5.018	17.402	32.820	29.825	39.821	34.803
L. H. Ryan	PLAN	WATER & AQUATIC VEGETATION	%	-4.800	25.000	39.750	36.750	46.300	41.500
L. H. Ryan	PLAN	MARSH	HA	4.451	70.820	53.014	55.038	45.325	49.776
L. H. Ryan	PLAN	MARSH	%	4.000	72.500	55.000	57.500	47.500	51.500
L. H. Ryan	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	PLAN	OTHER	HA	1.376	2.792	5.342	5.028	5.666	7.042
L. H. Ryan	PLAN	OTHER	%	0.800	2.450	5.100	6.200	6.350	7.150
L. H. Ryan	CONTROL	NATURAL & ARTIFICIAL WATER	HA	5.018	30.850	101.698	99.350	00.404	105.502
L. H. Ryan	CONTROL	NATURAL & ARTIFICIAL WATER	%	2.400	15.330	47.400	46.460	47.070	49.470
L. H. Ryan	CONTROL	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	CONTROL	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	CONTROL	WATER & AQUATIC VEGETATION	HA	5.018	30.850	101.698	99.350	100.404	105.502
L. H. Ryan	CONTROL	WATER & AQUATIC VEGETATION	%	2.400	15.330	47.400	46.460	47.070	49.470
L. H. Ryan	CONTROL	MARSH	HA	-2.428	168.754	103.195	105.623	95.911	93.483
L. H. Ryan	CONTROL	MARSH	%	1.330	82.670	49.340	51.340	46.000	44.670
L. H. Ryan	CONTROL	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	CONTROL	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.000	0.000	0.000
L. H. Ryan	CONTROL	OTHER	HA	-2.631	3.359	6.070	4.452	13.760	11.129
L. H. Ryan	CONTROL	OTHER	%	-0.560	2.100	3.330	2.370	6.660	6.104
LaFourche Realty Co.	PLAN	NATURAL & ARTIFICIAL WATER	HA	51.572	33.521	322.401	333.560	388.50	440.07
LaFourche Realty Co.	PLAN	NATURAL & ARTIFICIAL WATER	%	3.780	2.470	23.680	24.570	28.59	32.370
LaFourche Realty Co.	PLAN	AQUATIC VEGETATION	HA	0.000	0.000	0.000	0.000	0.00	0.000
LaFourche Realty Co.	PLAN	AQUATIC VEGETATION	%	0.000	0.000	0.000	0.000	0.00	0.000
LaFourche Realty Co.	PLAN	WATER & AQUATIC VEGETATION	HA	51.572	33.521	322.401	333.560	388.50	440.074
LaFourche Realty Co.	PLAN	WATER & AQUATIC VEGETATION	%	3.780	2.470	23.680	24.570	28.59	32.370
LaFourche Realty Co.	PLAN	MARSH	HA	-62.392	1320.703	1018.083	1009.713	938.380	875.908
LaFourche Realty Co.	PLAN	MARSH	%	-4.620	97.100	74.740	74.390	69.070	64.450
LaFourche Realty Co.	PLAN	SHRUB/SCRUB (not spoil)	HA	0.000	0.000	0.000	0.00	0.000	0.000
LaFourche Realty Co.	PLAN	SHRUB/SCRUB (not spoil)	%	0.000	0.000	0.000	0.00	0.000	0.000
LaFourche Realty Co.	PLAN	OTHER	HA	11.350	5.960	21.571	14.13	31.761	43.111
LaFourche Realty Co.	PLAN	OTHER	%	0.830	0.440	1.580	1.04	2.340	3.170
LaFourche Realty Co.	CONTROL	NATURAL & ARTIFICIAL WATER	HA	134.575	75.942	1036.573	1019.333	1150.997	293.572
LaFourche Realty Co.	CONTROL	NATURAL & ARTIFICIAL WATER	%	4.850	2.820	38.410	37.710	42.990	47.840
LaFourche Realty Co.	CONTROL	AQUATIC VEGETATION	HA	0.000	6.930	0.000	0.000	0.000	0.000
LaFourche Realty Co.	CONTROL	AQUATIC VEGETATION	%	0.000	0.260	0.000	0.000	0.000	0.000
LaFourche Realty Co.	CONTROL	WATER & AQUATIC VEGETATION	HA	134.575	82.872	1036.573	1019.333	150.997	1293.572
LaFourche Realty Co.	CONTROL	WATER & AQUATIC VEGETATION	%	4.850	3.080	38.410	37.710	42.990	47.840
LaFourche Realty Co.	CONTROL	MARSH	HA	-121.375	2565.814	1603.702	1620.902	426.577	1305.202
LaFourche Realty Co.	CONTROL	MARSH	%	-4.660	95.030	59.430	59.960	52.920	48.260
LaFourche Realty Co.	CONTROL	SHRUB/SCRUB (not spoil)	HA	-13.640	31.151	15.211	13.971	13.640	0.000
LaFourche Realty Co.	CONTROL	SHRUB/SCRUB (not spoil)	%	-0.510	1.150	0.560	0.520	0.510	0.000
LaFourche Realty Co.	CONTROL	OTHER	HA	8.850	20.230	42.751	49.392	96.463	105.313
LaFourche Realty Co.	CONTROL	OTHER	%	0.330	0.760	1.590	1.830	3.570	3.900

APPENDIX L

DETAILED DESCRIPTION OF THE PHYSICAL AND BIOLOGICAL ENVIROMENT OF LOUISIANA'S COASTAL ZONE

Supplement to Volume II, Part IV

Supplement to
Part IV
of

A STUDY OF MARSH MANAGEMENT PRACTICE
IN COASTAL LOUISIANA

DETAILED DESCRIPTION OF THE PHYSICAL AND BIOLOGICAL ENVIRONMENT OF LOUISIANA'S COASTAL ZONE

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PREFACE

This report describes the physical characteristics of hydrologic basins, coastal habitats on a regional scale, and threatened and endangered species in the Louisiana coastal zone. This information is provided as a supplement to chapter 6, "Environmental Characteristics and Habitat Change for the Louisiana Coastal Zone," by Joann Mossa, Dianne Lindstedt, Donald Cahoon, and John Barras, of the report "A Study of Marsh Management Practice in Coastal Louisiana."

The detailed descriptions of the physical characteristics of the hydrologic basins and regional habitat types presented in this report complement the detailed basin habitat descriptions presented in chapter 6. This report should be used as a reference for specific physical data and general information not available in chapter 6.

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%	-	percent
cm	-	centimeter
g	-	grams
cm^3	-	cubic centimeters
m	-	meters
yr B.P.	-	years before the present
ft	-	feet
MSL	-	mean sea level
ppt	-	parts per thousand
mg/l	-	milligrams per liter
ppm	-	parts per million
'	-	feet
"	-	inches
mm	-	millimeters
RSL	-	relative sea level
mi^2	-	square miles
km^2	-	square kilometers
cfs	-	cubic feet per second
m^3s^{-1}	-	cubic meters per second
NTU	-	Nephelometric turbidity units
"/yr	-	inches per year
cm/yr	-	centimeter per year
NGVD	-	National Geodetic Vertical Datum
mi	-	mile(s)
Pub. L.	-	public law
La. Rev. Stat.	-	Louisiana Revised Statutes

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Chapter 2.

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Chapter 3.

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Chapter 4.

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CHAPTER I

DATA BASE AND APPROACH FOR PHYSICAL BASIN CHARACTERISTICS

Joann Mossa

Introduction

This report follows from the data base and approach and the regional overview in the main report and describes specific conditions in each of 11 hydrologic basins in coastal Louisiana. In the data base and approach section, sources of data for soils, hydrology, water quality, salinity, and relative sea level rise are discussed. Research methods employed in previous studies and in this report are also briefly discussed. In the basin descriptions section, regional soils data, stage and discharge stations, marsh types, water quality data salinities, relative sea level rise assessments, and major structures are presented by hydrologic basin.

Soils and soil associations were mapped and subdivided in coastal, alluvial, swamp, Pleistocene, and drained categories. Locations of water level, water quality, salinity stations, and major structures including levees, control structures, locks, and channel and navigational improvements are mapped by basin. Maximum and minimum stage elevations at individual stations and across each basin are tabulated and described. Discharge data of major coastal rivers are graphed as annual maxima, means, and minima for the period of record with 5-year moving averages. Fresh, intermediate, brackish, and saline marshes, and non-marsh areas are mapped by basin; the line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence. Monthly dissolved oxygen, turbidity, and total suspended solids trends are graphed for the Department of Environmental Quality water quality stations in the Louisiana coastal zone. These parameters and suspended sediment are graphed for U.S. Geological Survey water quality stations in the coastal zone. Tables of salinities and relative sea level rise assessments are shown by basin. Brief descriptions of hydrologic modifications including roads, canals, and navigation and flood control projects are also provided.

Habitat classifications used in the 1956, 1978, and 1984 data are described in detail in this section and include plants and animals common to each habitat. Detailed species lists of plants, mammals, birds, amphibians, and reptiles are presented for each description. Habitats present in each basin and the areal extent are presented for each basin in the main text. Federal and state threatened and endangered species are discussed by basin and include listed plants, birds, mammals, fish, amphibians, and reptiles.

Soils

Organic soils or Histosols are the most common soil order in the Louisiana coastal marsh, and sometimes occur in coastal swamps. Mineral soils of various soil orders with clayey textures are developed in swamps, alluvium, mudflats. Mineral soils of various soil orders with fine-silty, coarse-silty, sandy, or composite texturesare developed on natural levees, barrier shorelines, and cheniers. Mineral soils developed on Pleistocene deposits may have clayey, silty, sandy, or composite textures depending on the environment of deposition.

Properties used to differentiate these soils include mineral content, organic content, consistence as related to water content, and the development, thickness, and sequence of soil horizons. Throughout much of coastal Louisiana soil properties have been altered through artificial drainage and other human activities. Subsidence due to oxidation of organic materials and cracking of montmorillonitic (shrink-swell) clays are two common responses of the soil to drainage.

Soil and soil association descriptions of Louisiana's coastal basins are based on maps and map legends compiled by Louisiana Department of Agriculture and Forestry (Spicer 1981). Unpublished maps at a scale of 1:250,000 are available for the Baton Rouge, Breton Sound, Lake Charles, Mobile, New Orleans, and Port Arthur quadrangles. There are six levels of categorization in the U.S. Department of Agriculture system (Soil Survey Staff 1975): (1) order; (2) suborder: (3) great group; (4) subgroup; (5) family; and (6) series. These maps have some inconsistencies in that two types of designations are used in soil mapping. Soil series and soil taxonomic classifications, at the great group level, are mapped in different areas.

Soil designations were recompiled for purposes of this project. First, the soil series were uniformly reclassified using taxonomic designations with appropriate modifiers at the subgroup level (table 1). Family criteria were also noted if available (table 1). Second, the soil series or taxonomic groups were differentiated by probable age and depositional environment. Pleistocene soils were grouped together as one category because this project focuses on Holocene wetland soils. The following discussion describes how such distinctions were made. Alluvium, which is intermixed with the marsh, was classified into three types by grain size: coarse alluvium, silty alluvium, and fine alluvium (figure 1). Coastal and marsh categories were not regrouped; the distinctions in these classes were examined as closely as possible.

There are 10 orders (an eleventh order of soils developed on volcanic ash has since been incorporated into the system) in the USDA (Soil Survey Staff 1975) system which are differentiated by the presence or absence of diagnostic horizons or features that show the dominant set of soil-forming processes that has occurred. The soil orders follow a sequence by which they are "keyed out"; thus, one must start at the beginning or top of the key to check differentiating characteristics for placement purposes (Buol et al. 1980). Their order is 1) Histosols; 2) Spodosols; 3) Oxisols; 4) Vertisols; 5) Aridisols; 6) Ultisols; 7) Mollisols; 8) Alfisols; 9) Inceptisols; and 10) Entisols. Of the 10 soil orders, seven occur in south Louisiana: Histosols, Vertisols, Ultisols, Mollisols, Alfisols, Inceptisols, and Entisols. The last letter of the soil code (table 1) designates the soil order based on its first letter (H,V,U,M,A,I, and E). The last two capital letters of this soil code indicate the suborder, the last three capital letters, the great group, and the entire code designates the taxonomic classification at the suborder level.

Because soils found in the coastal marsh of Louisiana are principally in the Histosol, Entisol, and Inceptisol orders as defined by Soil Survey Staff (1975), these types are emphasized in this discussion. Properties used to

Table 1. Soil series, family designations, taxonomic subgroups, and taxonomic codes used herein to describe some major soils occurring in south Louisiana (key to family designations at end of table).

SOIL SERIES	FAMILY	TAXONOMIC SUBGROUP	CODE
Acadia	F, Mo, T	Aeric Ochraqualf	AOAA
Acy	F-s, Mi, T	Aeric Ochraqualf	AOAA
Allemands	C, Mo, E, T	Terric Medisaprist	TeMSH
Arat	F-s, S, N, T	Typic Hydraquent	THAE
Baldwin	F, Mo, T	Vertic Ochraqualf	VOAA
Barbary	V-f, Mo, N, T	Typic Hydraquent	THAE
Basile	F-s, Mi, T	Typic Glossaqualf	TGAA
Beauregard	F-s, S, T	Plinthaquic Paleudult	PaPUU
Bellpass	C, Mo, E, T	Terric Medisaprist	TeMSH
Bienville	S, S, T	Psammetic Paleudalf	PsPUA
Bonn	F-s, Mi, T	Glossic Natraqualf	GNAA
Bruin	C-s, Mi, T	Fluvaquentic Eutrochrept	FaEOI
Bude	F-s, Mi, T	Glossaquic Fragiudalf	GaFUA
Buxin	F, Mi, T	Vertic Hapludoll	VHUM
Caddo	F-s, S, T	Typic Glossaqualf	TGAA
Cahaba	F-l, S, T	Typic Hapludult	THUU
Calhoun	F-s, Mi, T	Typic Glossaqualf	TGAA
Carlin	E, T	Hydric Medihemist	HMHH
Cascilla	F-s, Mi, T	Fluvaquentic Dystrochrept	FaDOI
Clovelly	C, Mo, E, T	Terric Medisaprist	TeMSH
Commerce	F-s, Mi, N, T	Aeric Fluvaquent	AFAE
Convent	C-s, Mi, N, T	Aeric Fluvaquent	AFAE
Coteau	F-s, M, T	Glossaquic Hapludalf	GaHUA
Crevasse	Mi, T	Typic Udipsamment	TUPE
Crowley	F, Mo, T	Typic Albaqualf	TAAA
Deerford	F-s, Mi, T	Albic Glossic Natraqualf	AGNAA
Dexter	F-s, Mi, T	Ultic Hapludalf	UHUA
Dossman	F-s, Mi, T	Ultic Hapludalf	UHUA
Dundee	F-s, Mi, T	Aeric Ochraqualf	AOAA
Duralde	F-s, Mi, T	Fragic Glossudalf	FGUA
Essen	F-s, Mi, T	Aeric Ochraqualf	AOAA
Evangeline	F-s, Mi, T	Glossic Paleudalf	GPUA
Falaya	C-s, Mi, A, T	Aeric Fluvaquent	AFAE
Fausse	V-f, Mo, N, T	Typic Fluvaquent	TFAE
Felicity	Mi, T	Aquic Udipsamment	AUPE
Frost	F-s, Mi, T	Typic Glossaqualf	TGAA
Gallion	F-s, Mi, T	Typic Hapludalf	THUA
Galvez	F, Mi, T	Aeric Ochraqualf	AOAA

Table 1. Soil series, family designations, taxonomic subgroups, and taxonomic codes used herein to describe some major soils occurring in south Louisiana (key to family designations at end of table) (continued).

SOIL SERIES	FAMILY	TAXONOMIC SUBGROUP	CODE
Ged	V-f, Mi, T	Typic Ochraqualf	TOAA
Gentilly	V-f, Mo, N, T	Typic Hydraquent	THAE
Glenmora	F-s, S, T	Glossaquic Paleudalf	GaPUA
Gore	F, Mi, T	Vertic Paleudalf	VPUA
Guyton	F-s, Mi, T	Typic Glossaqualf	TGAA
Harahan	V-f, Mo, N, T	Vertic Haplaquept	VHAI
Iberia	F, Mo, T	Vertic Haplaquoll	VHAM
Jeanerette	F-s, Mi, T	Typic Argiaquoll	TAAM
Judice	F, Mo, T	Vertic Haplaquoll	VHAM
Kenner	E, T	Fluvaquentic Medisaprist	FaMSH
Kenney	L, Mi, S, T	Grossarenic Paleudalf	GrPUA
Kinder	F-s, S, T	Typic Glossaqualf	TGAA
Lafitte	E, T	Typic Medisaprist	TMSH
Larose	V-f, Mo, N, T	Typic Hydraquent	THAE
Latanier	CoL, Mi, T	Vertic Hapludoll	VHUM
Lebeau	V-f, Mo, T	Aquentic Chromudert	ACUV
Leton	F-s, Mi, T	Typic Glossaqualf	TGAA
Lexington	F-s, Mi, T	Typic Paleudalf	TPUA
Loreauville	F-s, Mi, T	Udollic Ochraqualf	UOAA
Loring	F-s, Mi, T	Typic Fragiudalf	TFUA
Malbis	F-l, S, T	Plinthic Paleudult	PPUU
Maurepas	E, T	Typic Medisaprist	TMSH
McKamie	F, Mi, T	Vertic Hapludalf	VHUA
Memphis	F-s, Mi, T	Typic Hapludalf	THUA
Messer	C-s, S, T	Haplic Glossudalf	HGUA
Mhoon	F-s, Mi, N, T	Typic Fluvaquent	TFAE
Midland	F, Mo, T	Typic Ochraqualf	TOAA
Moreland	F, Mi, T	Vertic Hapludoll	VHUM
Morey	F-s, Mi, T	Typic Argiaquoll	TAAM
Mowata	F-s, Mo, T	Typic Glossaqualf	TGAA
Myatt	F-l, Si, T	Typic Ochraquult	TOUU
Norwood	F-s, Mi-c, T	Typic Udifluvent	TUFE
Ochlockonee	C-l, Si, A, T	Typic Udifluvent	TUFE
Olivier	F-s, Mi, T	Aquic Fragiudalf	AFUA
Patoutville	F-s, Mi, T	Aeric Ochraqualf	AOAA
Placedo	N, HT	Typic Fluvaquent	TFAE
Portland	V-f, Mi, N, T	Vertic Haplaquept	VHAI

Table 1. Soil series, family designations, taxonomic subgroups, and taxonomic codes used herein to describe some major soils occurring in south Louisiana (key to family designations at end of table) (continued).

SOIL SERIES	FAMILY	TAXONOMIC SUBGROUP	CODE
Providence	F-s, Mi, T	Typic Fragiudalf	TFUA
Rita	V-f, Mo, N, T	cr. Typic Fluvaquent	TFAE
Robinsonville	C-l, Mi, N, T	Typic Udifluvent	TUFE
Ruston	F-l, Si, T	Typic Paleudult	TPUU
Scatlake	V-f, Mo, N, T	Typic Hydraquent	THAE
Sharkey	V-f, Mo, N, T	Vertic Haplaquept	VHAI
Stough	C-l, Si, T	Fragiaquic Paleudult	FaPUU
Tensas	F, Mo, T	Vertic Ochraqualf	VOAA
Timbalier	E, T	Typic Medisaprist	TMSH
Tunica	CoL, Mo, N, T	Vertic Haplaquept	VHAI
Verdun	F-s, Mi, T	Glossic Natraqualf	GNAA
Verrett		proposed but replaced by Leton	
Vidrine	C-soC, Mi, T	Glossaquic Hapludalf	GaHUA
Westwego	V-f, Mo, N, T	cr. Thapto-Histic Fluvaquent	cT-HFAE
Wrightsville	F, Mi, T	Typic Glossaqualf	TGAA

<u>Key to family designation</u>

Textural Classification

E: Euic
V-f: Very fine
F: Fine
F-s: Fine-silty
C-s: Coarse-silty
F-l: Fine-loamy
L: Loamy
C-l: Coarse loamy
S: Sandy
CoL: Clayey over loamy
CsoC: Coarse silty over clayey

Mineralogy

Mo: Montmorillonitic
Mi: Mixed
S: Siliceous

Temperature Regime

T: Thermic
HT: Hyper-thermic

pH (for Entisols)

N: Non-acid
A: Acid

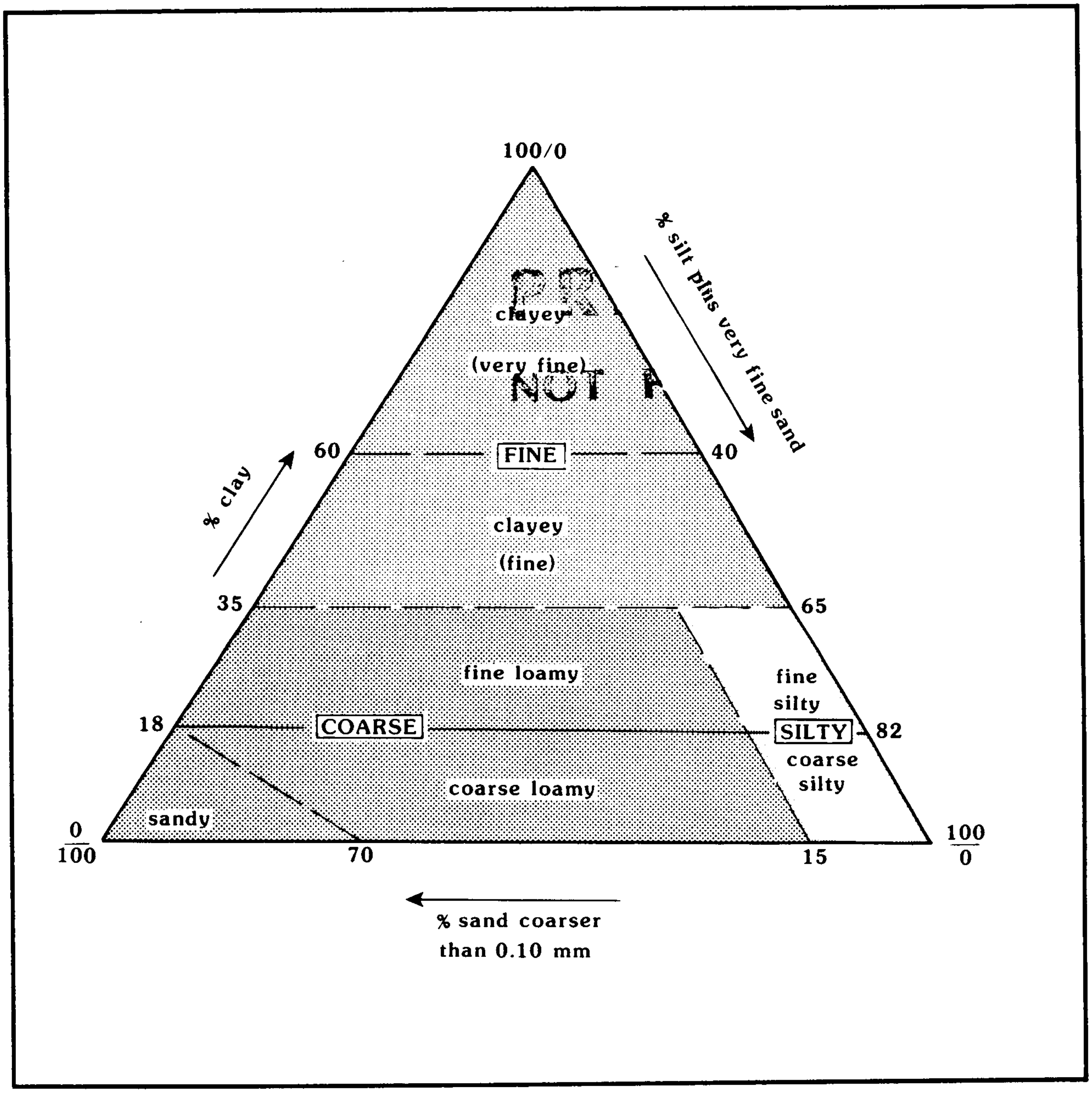


Figure 1. Family criteria for soil textural classification in Louisiana.

differentiate these soils include mineral content, organic content, consistence as related to water content, and the development, thickness, and sequence of soil horizons. Artificial drainage and other human activities have altered the properties of soils throughout much of coastal Louisiana. Subsidence due to oxidation of organic materials and cracking of montmorillonitic (shrink-swell) clays are two common responses of the soil to drainage.

Organic Soils

A soil must contain 12-18% organic carbon (20-30% organic matter) in at least half of the upper 80 cm of the profile or have more than 30% organic matter to a depth of 40 cm (Buol et al. 1980) to be classified as a Histosol. The exact amount of organic carbon required depends upon the soil's clay content (Everett 1983). Furthermore, the organic materials must also meet the following requirements: 1) they may not be overlain by a mineral layer 40 cm or more thick, nor may they contain such a layer whose upper boundary is within 40 cm of the surface; 2) the organic materials may not include mineral layers that have a cumulative thickness of 40 cm or more within the upper 80 cm of the control section.

At the suborder level, organic soils are distinguished by fiber content, or correlatively, state of decomposition. Four suborders are recognized within the Histosols: Fibrists, Hemists, Saprists, and Folists. Only two of the four, Hemists (HH) and Saprists (SH), occur in coastal Louisiana. Hemists contain organic materials that are decomposed such that the biologic origin of two-thirds of the volume cannot easily be determined or that are fibrous and can be largely destroyed by rubbing. Soils of this suborder have extremely high moisture contents and usually have bulk densities between 0.1 and 0.2 g/cm^3. Saprists consist primarily of highly decomposed organic materials. Commonly, few plant remains can be identified botanically and the fiber content is less than 33% (unrubbed) of the organic volume. The bulk density of the organic materials is usually greater than 0.2 g/cm^3 and the moisture content is normally less than that of Hemists.

Great groups include the Medihemists (MHH) and Medisaprists (MSH). Subgroups include the Hydric Medihemists (HMHH), Fluvaquentic Medisaprists (FaMSH), Terric Medisaprists (TeMSH), and Typic Medisaprists (TMSH). Hydric Medihemists have a high moisture content, and are not considered well-suited to marsh management because they generally correspond to the areas of floating or flotant marsh in coastal Louisiana. Typic Medisaprists are the Medisaprists that have 1) less than 12.5 cm of fibric materials and less than 25 cm of the subsurface and bottom tiers consisting of hemic materials, but do not have 2) a mineral layer between 5 and 30 cm thick within organic materials, or two or more continuous mineral layers within the control section; 3) a mineral layer over 30 cm thick with its upper boundary within the control section; 4) a water layer within the control section; or 5) limnic layer(s) that are 5 cm or more thick within the control section (Soil Survey Staff 1975). Fluvaquentic Medisaprists are distinguished from Typic Medisaprists except for 2), with or without 1). Some of the areas classified as Fluvaquentic Medisaprists may also coincide with areas of flotant marsh; the Kenner series, the only Fluvaquentic Medisaprist in Louisiana, has very high subsidence potential and hence is considered unsuitable for extensive drawdown. Terric Medisaprists are distinguished from Typic Medisaprists because they have 3), with or without 2) or 5), or both. Terric

Medisaprists in general are more suited to extensive drawdown than Typic Medisaprists because of their higher mineral content. Histosols in south Louisiana are typically Holocene in age and are the most common soil order in the marsh.

<u>Mineral Soils</u>

In general, the textures of mineral soils in coastal Louisiana are clayey (very fine or fine). They are developed in swamps, alluvium, lakes, and mudflats. Soils developed on natural levees, barrier shorelines, and cheniers have fine-silty, coarse-silty, sandy, and composite textures. Standard SCS designations for family criteria in Louisiana include the following: 1) clayey (very fine), clayey (fine); 2) fine silty and coarse silty; and 3) fine loamy, coarse loamy, and sandy. These three groupings constitute the basis upon which alluvial soils were classified as fine, silty, and coarse, respectively. Soils with finer textures are predominantly montmorillonitic, but the soils with coarser textures have mixed mineral content. The suborders of most of the mineral soils are based on moisture regime, and great groups and subgroups on other diagnostic properties.

Vertisols are soils other than Histosols, Spodosols, and Oxisols that have more than 30% clay in all horizons and have some cracks at 50 cm. Only one soil series mappable on the 1:250,000 scale compilation of south Louisiana is classified as a Vertisol. The suborder, great group, and subgroup of the Lebeau series are Udert (UV), Chromudert (CUV), and Aquentic Chromudert (ACUV). This soil is Holocene in age and occurs on Red River alluvium.

Ultisols are soils other the Histosols, Spodosols, Oxisols, Vertisols, and Aridisols that have an argillic horizon, but a base saturation less than 35% at pH 8.2 at a depth of 1.8 m (Buol et al. 1980). Suborders of the Ultisols in south Louisiana include the Aquults (AU) and Udults (UU). Great groups include the Ochraquults (OAU), Hapludults (HUU), and Paleudults (PUU). Subgroups include the Typic Ochraquults (TOAU), Typic Hapludults (THUU), Fragiaquic Paleudults (FaPUU), Plinthaquic Paleudults (PaPUU), Plinthic Paleudults (PPUU), and Typic Paleudults (TPUU). In south Louisiana, these soils are principally Pleistocene or older in age.

Mollisols with a mollic epipedon are soils other than those keyed out up to Ultisols. They generally have more organic material than do the other mineral soil orders. Mollisols in south Louisiana include Aquolls (AM) and Udolls (UM) at the suborder level. Great groups include Argiaquolls (AAM), Haplaquolls (HAM) and Hapludolls (HUM). Subgroups include Typic Argiaquolls (TAAM), Vertic Haplaquolls (VHAM) and Vertic Hapludolls (VHUM). The Argiaquolls, which have an argillic horizon, are generally Pleistocene in age. Other Mollisols can be younger and their approximate age can be determined from other criteria. They occur in association with Histosols, Entisols, and Inceptisols in the coastal marshes, and with Alfisols on Pleistocene or early Holocene landscapes, with some exceptions.

Alfisols are soils other than those keyed out up to Mollisols and that have an argillic horizon and have greater than 35% base saturation at a depth of 1.8 m. In south Louisiana, these soils are principally Pleistocene in age. Four exceptions of the soils and soil groups listed on the tables include the Calhoun, 0-1%, the Baldwin-Iberia-Galvez association, 0-1%, the Gallion-Galvez-Baldwin association, 0-1%, and the Iberia-Loreauville-Baldwin association, 0-1%. The Calhoun is mapped on both Pleistocene landscapes and in Holocene alluvial bottoms; it occurs in alluvial bottoms in the Pontchartrain basin. The Baldwin-Iberia-Galvez association, the Gallion-Galvez-Baldwin association, and the Iberia-Loreauville-Baldwin association are Alfisols and Mollisols, and are mapped along the alluvium of Bayou Teche and Bayou Cypremort. Radiocarbon dates document these as the oldest surficial Holocene distributaries, ranging from 5,700 to 3,900 yr B.P.

Suborders of Alfisols in south Louisiana include the Aqualf (AA) and Udalf (UA). Great groups include the Albaqualfs (AAA), Glossaqualfs (GAA), Natraqualfs (NAA), Ochraqualfs (OAA), Fragiudalfs (FUA), Glossudalfs (GUA), Hapludalfs (HUA), and Paleudalfs (PUA). Subgroups include Typic Albaqualfs (TAAA), Typic Glossaqualfs (TGAA), Albic Glossic Natraqualfs (AGNAA), Glossic Natraqualfs (GNAA), Aeric Ochraqualfs (AOAA), Typic Ochraqualfs (TOAA), Udollic Ochraqualfs (UOAA), Vertic Ochraqualfs (VOAA), Glossaquic Fragiudalfs (GaFUA), Aquic Fragiudalfs (AFUA), Typic Fragiudalfs (TFUA), Glossaquic Hapludalfs (GaHUA), Typic Hapludalfs (THUA), Ultic Hapludalfs (UHUA), Vertic Hapludalfs (VHUA), Glossaquic Paleudalfs (GaPUA), Glossic Paleudalfs (GPUA), Grossarenic Paleudalfs (GrPUA), Psammentic Paleudalfs (PsPUA), Typic Paleudalfs (TPUA), and Vertic Paleudalfs (VPUA).

Inceptisols are soils other than those keyed out up to Alfisols (that have an umbric, mollic, or plaggen epipedon or a cambic horizon). They have undergone moderate modifications of the parent material by soil-forming processes. Suborders of the Inceptisols in south Louisiana include the Aquepts (AI) and Ochrepts (OI). Great groups include the Haplaquepts (HAI), Dystrochrepts (DOI), and Eutrochrepts (EOI). Subgroups include the Vertic Haplaquepts (VHAI), Fluvaquentic Dystrochrepts (FaDOI), and Fluvaquentic Eutrochrepts (FaEOI). In south Louisiana, these are principally Holocene in age and are most commonly developed on alluvial sediments.

Entisols are the soils that remain after all other orders have been excluded. In general, an Entisol is a slightly developed soil in which the properties are determined largely by the parent material (Grossman 1983). Suborders of Entisols in south Louisiana include the Aquents (AE), Fluvents (FE), and Psamments (PE). Great groups include the Fluvaquents (FAE), Hydraquents (HAE), Udifluvents (UFE), and Udipsamments (UPE). Subgroups include Aeric Fluvaquents (AFAE), Thapto-Histic Fluvaquents (T-HFAE), Typic Fluvaquents (TFAE), Typic Hydraquents (THAE), Typic Udifluvents (TUFE), Aquic Udipsamments (AUPE), and Typic Udipsamments (TUPE). In south Louisiana, these are principally Holocene in age and are developed on alluvial and coastal sediments.

Table 1 shows the soil series listed on the soil association maps, along with family criteria, taxonomic subgroup, and the code designation developed for this report. Map units and associated taxonomic codes, modifiers, and designated classes for the soil association maps are shown in table 2. Maps corresponding to this classification are included with the basin descriptions, below.

Hydrology

Maximum and minimum stages for the period of record for coastal basins were obtained from "Stages and Discharges of the Mississippi River and its Tributaries" (USACE 1988) and from U.S. Geological Survey Water Resources Data Reports (U.S. Geological Survey 1962-1989). Records of the U.S. Army Corps of

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage.

Number	Taxonomic code	Modifiers	Class
BATON ROUGE SOIL ASSOCIATION MAP			
0003	AOAA-GaHUA	0-3%	Pleistocene
0004	AOAA-AOAA-TAAM	0-1%	Pleistocene
0005	TeMSH-HMHH	fresh	Fresh 1
0008	VOAA-VHAI-VHAM	0-1%	Pl.-Al.
0009	THAE	freq. fl.	F. alluvium
0010	THAE-TFAE	freq. fl.	F. alluvium
0028	THAU	0-8%	Pleistocene
0029	THUU-FaPUU	0-5%	Pleistocene
0030	TGAA	0-1%	S. alluv. or Pleistocene
0031	TGAA-FaDOI	freq. fl.	Pl.-Al.
0034	TGAA-AFUA	0-3%	Pleistocene
0036*	FaDOI-TUFE	freq. fl.	S. alluvium
0038*	AFAE	0-1%	S. alluvium
0043	AFAE-VHAI	0-1%	S. alluvium
0045	AFAE	occas. fl.	S. alluvium
0046	AFAE	freq. fl.	S. alluvium
0047	AFAE-THAE	freq. fl.	S. alluvium
0048	AFAE-AFAE-VHAI	0-1%	S. alluvium
0049	AFAE-TFAE	freq. fl.	S. alluvium
0050	GaHUA-AOAA	0-3%	Pleistocene
0055	AGNAA-GNAA-TGAA	0-3%	Pleistocene
0056	UHUA-TGAA	0-5%	Pleistocene
0059	AOAA-UOAA	0-1%	Pleistocene
0060	AOAA	0-1%	Pleistocene
0062	DOI	freq. fl.	S. alluvium
0067	TFAE	freq. fl.	F. alluvium
0068	TFAE-AFAE	freq. fl.	F. alluvium
0069	TFAE-VHAI	freq. fl.	F. alluvium
0072	THUA	0-1%	Pleistocene
0073	THUA-AOAA-VOAA	0-1%	S. alluvium
0074	AOAA-AFAE	0-1%	Pleistocene
0085	HAI-DOI	freq. fl.	F. alluvium
0095	HAE-HAI	freq. fl.	F. alluvium
0097	VHAM-VOAA-VOAA	0-1%	F. alluvium
0099	TAAM-AOAA	0-3%	Pleistocene
0101	FMSH-TeMSH	drained	Drained
0114	TFUA-GaFUA	1-15%	Pleistocene
0116	TMSH	freq. fl.	Swamp 1
0117	TMSH-HAE	freq. fl.	Swamp 2
0123	MSH-HAE	fresh	Fresh 2

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage (continued).

Number	Taxonomic code	Modifiers	Class
BATON ROUGE SOIL ASSOCIATION MAP (continued)			
0124	MSH-HAE	mod. saline	M. Sal. 1
0126	THUA	1-25%	Pleistocene
0127	THUA-EOI	>15%	Pleistocene
0128	THUA-TGAA	0-8%	Pleistocene
0129	THUA-TGAA-GaHUA	0-8%	Pleistocene
0130	THUA-TFUA	1-25%	Pleistocene
0132	TFAE-AFAE	0-1%	S. alluvium
0138	VHUM-VHUM	0-1%	Pleistocene
0141	TOUU-FaPUU-THUU	0-5%	Pleistocene
0142	TOUU-FaPUU-THUU	0-5%	Pleistocene
0144	TUFE	0-1%	S. alluvium
0146	AFrUA-TGAA	0-3%	Pleistocene
0147	AFrUA-TFUA-TGAA	0-8%	Pleistocene
0158	TFUA-GaFUA	0-8%	Pleistocene
0159	TFUA-TGAA-UHUA	0-8%	Pleistocene
0160	TFUA-TPUA	1-15%	Pleistocene
0161	TFUA-AFrUA	0-8%	Pleistocene
0162	TFUA-TPUU	1-8%	Pleistocene
0169	TPUU-PPUU	1-8%	Pleistocene
0170	TPUU-TFUA	1-8%	Pleistocene
0177	VHAI	0-1%	F. alluvium
0178	VHAI	freq. fl.	F. alluvium
0179	VHAI	occas. fl.	F. alluvium
0180	VHAI-VOAA	occas. fl.	F. alluvium
0182	VHAI-AFAE	freq. fl.	F. alluvium
0183	VHAI-AFAE	occas. fl.	F. alluvium
0184	VHAI-TFAE	freq. fl.	F. alluvium
0186	VHAI-TFAE-TUPE	freq. fl.	F. alluvium
0189	VHAI-VHAI	0-1%	F. alluvium
0190	VHAI-VHAI	undulating	F. alluvium
0208	Water		Water
0334	TGAA-FaPUU	0-3%	Pleistocene
0340	AFAE-FaEOI-AFAE	0-1%	S. alluvium
0350	GaHUA-TGAA	0-3%	Pleistocene
0355	AGNAA-GNAA-TAAM	0-3%	Pleistocene
0360	AOAA-VHAI	0-1%	Pl.-Al.
0361	AOAA-VOAA	0-1%	Pleistocene
0406	ACUV	0-1%	Pleistocene
0414	PPUU-TPUU	1-8%	Pleistocene
0448	AFrUA-TFUA	0-5%	Pleistocene
0466	TUFE-AFAE	occas. fl.	C. alluvium
0497	T-HFAE-VHAE	drained	Drained

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage (continued).

Number	Taxonomic code	Modifiers	Class
BATON ROUGE SOIL ASSOCIATION MAP (continued)			
0012	THAE-VHAI	freq. fl.	F. alluvium
BRETON SOUND SOIL ASSOCIATION MAP			
0043	AFAE-VHAI	0-1%	S. alluvium
0096	HAE-MSH	fresh	Fresh 3
0117	TMSH-HAE	freq. fl.	Swamp 2
0119	MSH	fresh	Fresh 4
0120	FAE	drained	Drained
0124	MSH-HAE	mod. saline	M. Sal. 1
0125	MSH-HAE	saline	Saline 1
0174	THAE	freq. fl.(s.)**	Saline 2
0182	VHAI-AFAE	freq. fl.	F. alluvium
0201	UPE-MSH	saline	Saline 3
0208	Water		Water
0364	AUPE	mod. saline	M. Sal. 2
0405	TMSH-TeMSH	freq. fl. (m.s.)**	M. Sal. 3
0492	TMSH-AUPE	freq. fl. (s.)**	Saline 4
0497	T-HFAE-VHAE	drained	Drained
LAKE CHARLES SOIL ASSOCIATION MAP			
0002	AOAA-TGAA	0-3%	Pleistocene
0003	AOAA-GaHUA	0-3%	Pleistocene
0014	TGAA-TGAA-TGAA	freq. fl.	S. alluvium
0017	PaPUU-TGAA	0-5%	Pleistocene
0019	PsPUA-THUU-TGAA	0-5%	Pleistocene
0023	TGAA-PaPUU	0-5%	Pleistocene
0024	TGAA-HGUA	0-3%	Pleistocene
0033	TGAA-TFUA-GaHUA	0-8%	Pleistocene
0035	FaDOI	freq. fl.	S. alluvium
0052	TAAA-TOAA	0-1%	Pleistocene
0053	TAAA-TGAA	0-1%	Pleistocene
0054	TAAA-AOAA	0-3%	Pleistocene
0060	AOAA	0-1%	Pleistocene
0061	FGUA-TGAA	0-3%	Pleistocene
0065	GPUA-UHUA	1-15%	Pleistocene
0072	THUA	0-1%	Pleistocene

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage (continued).

Number	Taxonomic code	Modifiers	Class
LAKE CHARLES SOIL ASSOCIATION MAP (continued)			
0076	GaPUA-TPUU	1-8%	Pleistocene
0077	VPUA	1-15%	Pleistocene
0081	TGAA	freq. fl.	Pleistocene
0083	TGAA-TGAA	0-1%	Pleistocene
0088	HAM-HAE	mod. saline	M. Sal. 4
0095	HAE-HAI	freq. fl.	F. alluvium
0099	TAAM-AOAA	0-3%	Pleistocene
0100	VHAM-TAAM-TOAA	0-1%	Pleistocene
0118	VHUA-UHUA-GRPUA	1-25%	Pleistocene
0121	MSH-HAM	fresh	Fresh 5
0126	THUA	1-25%	Pleistocene
0128	THUA-TGAA	0-8%	Pleistocene
0130	THUA-TFUA	1-25%	Pleistocene
0133	TOAA-TAAA	0-1%	Pleistocene
0134	TOAA-TGAA-VHAM	0-1%	Pleistocene
0135	TOAA-TGAA-TAAA	0-1%	Pleistocene
0136	VHUM	freq. fl.	F. alluvium
0138	VHUM-VHUM	0-1%	Pleistocene
0140	TGAA-TAAM-TAAA	0-1%	Pleistocene
0144	TUFE	0-1%	S. alluvium
0145	AFrUA	0-3%	Pleistocene
0151	AOAA-TAAA-TAAM	0-3%	Pleistocene
0152	AOAA-TGAA	0-1%	Pleistocene
0153	AOAA-TAAM	0-3%	Pleistocene
0169	TPUU-PPUU	1-8%	Pleistocene
0177	VHAI	0-1%	F. alluvium
0180	VHAI-VOAA	occas. fl.	F. alluvium
0208	Water		Water
0211	TGAA-AOAA	0-3%	Pleistocene
0214	TGAA-GaHUA	0-1%	Pleistocene
0309	THAE-THAE	freq. fl.	S. alluvium
0317	PaPUU-PPUU	0-5%	Pleistocene
0324	TGAA-GaPUA	0-3%	Pleistocene
0328	THUU-PsPUA	0-5%	Pleistocene
0350	GaHUA-TGAA	0-3%	Pleistocene
0351	TAAA-TGAA	0-1%	Pleistocene
0361	AOAA-VOAA	0-1%	Pleistocene
0362	AFAE-TGAA	freq. fl.	S. alluvium
0376	THAETeMSH	mod. saline	M. Sal. 5
0377	TOAA-THAE-TeMSH	fresh	Fresh 6
0393	TGAA-AOAA	0-2%	Pleistocene
0394	TGAA-GNAA	0-1%	Pleistocene

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage (continued).

Number	Taxonomic code	Modifiers	Class
LAKE CHARLES SOIL ASSOCIATION MAP (continued)			
0395	TGAA-TGAA	0-1%	Pleistocene
0401	TGAA-GaPUA	0-3%	Pleistocene
0406	ACUV	0-1%	Pleistocene
0414	PPUU-TPUU	1-8%	Pleistocene
0439	TAAM-TGAA-TGAA	0-1%	Pleistocene
MOBILE SOIL ASSOICATION MAP			
0028	THAU	0-8%	Pleistocene
0043	AFAE-VHAI	0-1%	S. alluvium
0085	HAI-DOI	freq. fl.	F. alluvium
0101	FMSH-TeMSH	drained	Drained
0117	TMSH-HAE	freq. fl.	Swamp 2
0124	MSH-HAE	mod. saline	M. Sal. 1
0125	MSH-HAE	saline	Saline 1
0141	TOUU-FaPUU-THUU	0-5%	Pleistocene
0142	TOUU-FaPUU-THUU	0-5%	Pleistocene
0169	TPUU-PPUU	1-8%	Pleistocene
0201	UPE-MSH	saline	Saline 3
0208	Water		Water
0414	PPUU-TPUU	1-8%	Pleistocene
NEW ORLEANS SOIL ASSOCIATION MAP			
0005	TeMSH-HMHH	fresh	Fresh 1
0007	VOAA-VHAM-AOAA	0-1%	Pleistocene
0009	THAE	freq. fl.	F. alluvium
0010	THAE-TFAE	freq. fl.	F. alluvium
0038	AFAE	0-1%	S. alluvium
0043	AFAE-VHAI	0-1%	S. alluvium
0048	AFAE-AFAE-VHAI	0-1%	S. alluvium
0050	GaHUA-AOAA	0-3%	Pleistocene
0067	TFAE	freq. fl.	F. alluvium
0068	TFAE-AFAE	freq. fl.	F. alluvium
0069	TFAE-VHAI	freq. fl.	F. alluvium
0073	THUA-AOAA-VOAA	0-1%	Pleistocene
0088	HAM-HAE	mod. saline	M. Sal. 4
0094	HAE-VHUM-VHAI	freq. fl.	F. alluvium

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage (continued).

Number	Taxonomic code	Modifiers	Class
NEW ORLEANS SOIL ASSOCIATION MAP (continued)			
0096	HAE-MSH	fresh	Fresh 3
0097	VHAM-VOAA-VOAA	0-1%	Pleistocene
0099	TAAM-AOAA	0-3%	Pleistocene
0101	FMSH-TeMSH	drained	Drained
0111	TMSH	mod. saline	M. Sal. 6
0116	TMSH	freq. fl.	Swamp 1
0117	TMSH-HAE	freq. fl.	Swamp 2
0119	MSH	fresh	Fresh 4
0120	FAE	drained	Drained
0123	MSH-HAE	fresh	Fresh 2
0124	MSH-HAE	mod. saline	M. Sal. 1
0125	MSH-HAE	saline	Saline 1
0128	THUA-TGAA	0-8%	Pleistocene
0130	THUA-TFUA	1-25%	Pleistocene
0132	TFAE-AFAE	0-1%	S. alluvium
0157	TFAE	saline	Saline 5
0174	THAE	fr. f (s.)**	Saline 2
0177	VHAI	0-1%	F. alluvium
0182	VHAI-AFAE	freq. fl.	F. alluvium
0184	VHAI-TFAE	freq. fl.	F. alluvium
0189	VHAI-VHAI	0-1%	F. alluvium
0201	UPE-MSH	saline	Saline 3
0208	Water		Water
0310	TeMSH-FaMSH-THAE	fresh	Fresh 7
0364	AUPE	mod. saline	M. Sal. 2
0385	FaMSH-TeMSH	fresh	Fresh 8
0405	TMSH-TeMSH	freq. fl. (m.s.)**	M. Sal. 3
0458	cTFAE-TeMSH	drained	Drained
0492	TMSH-AUPE	freq. fl. (s.)**	Saline 4
0497	T-HFAE-VHAE	drained	Drained
0500	TMSH-TeMSH	saline	Saline 6
PORT ARTHUR SOIL ASSOCIATION MAP			
0054	TAAA-AOAA	0-3%	Pleistocene
0088	HAM-HAE	mod. saline	M. Sal. 4
0089	HAM-HAE	saline	Saline 7
0091	HAM-TAAM-TGAA	drained	Drained
0092	HAM-UPE	mod. saline	M. Sal. 7
0095	HAE-HAI	freq. fl.	F. alluvium
0099	TAAM-AOAA	0-3%	Pleistocene

Table 2. Soil association taxonomic codes at the subgroup or great group level with modifiers and interpreted classes occurring on 1:250,000 scale maps, as compiled by the SCS. Modifiers indicate slope, marsh type, flooding regime, or drainage (continued).

Number	Taxonomic code	Modifiers	Class
NEW ORLEANS SOIL ASSOCIATION MAP (continued)			
0100	VHAM-TAAM-TOAA	0-1%	Pleistocene
0121	MSH-HAM	fresh	Fresh 5
0135	TOAA-TGAA-TAAA	0-1%	Pleistocene
0140	TGAA-TAAM-TAAA	0-1%	Pleistocene
0157	TFAE	saline	Saline 5
0174	THAE	freq. fl. (s)	Saline 2
0208	Water		Water
0350	GaHUA-TGAA	0-3%	Pleistocene
0439	TAAM-TGAA-TGAA	0-1%	Pleistocene

*On Louisiana Department of Agriculture map legend but not on the Department of Natural Resources legend.

**Presence of additional modifier in parentheses indicates modifier was changed because modifier given was considered less appropriate or specific than that within parentheses.

Engineers are listed in table 3 of this report. The U.S. Geological Survey has only a few stations in coastal Louisiana; observations were acquired over shorter periods and are not presented in detail in this report. The U.S. Army Corps of Engineers publishes data on the basis of calendar year, whereas the U.S. Geological Survey publishes data on the basis of water year (October 1 to September 30).

Maximum, mean, and minimum daily discharges for hydrologic basins across coastal Louisiana were obtained from a combination of sources including U.S. Geological Survey Water Supply Papers (U.S. Geological Survey various dates from 1940 to 1964), U.S. Geological Survey Water Resources Data Reports (U.S. Geological Survey 1962-1989), and the U.S. Geological Survey Water Storage and Retrieval (WATSTORE) computer file. Discharges were tabulated for the period of record according to water year. These were displayed on a logarithmic axis when extreme variations of maximum, mean, and minimum discharges existed, and on a linear axis otherwise.

Water Quality

Water quality variables examined include dissolved oxygen, turbidity, total suspended solids, and suspended sediment, where available. Dissolved oxygen measurements are used extensively for determining the degree of pollution in a water supply. The dissolved oxygen content of streamflow primarily reflects its interaction with the overlying air, and is a function of the water temperature, which influences its solubility, which decreases with increasing temperature, and of the atmospheric pressure, which reflects the partial pressure of the gas (Walling 1985). Oxygen is produced within the water body through photosynthesis by macrophytes and algae during daylight hours. Oxygen is consumed by the respiration of aquatic organisms and by the biochemical oxidation of organic material and pollutants. Dissolved oxygen concentration will decrease if this consumption exceeds the rate of atmospheric reaeration and oxygen produced by photosynthesis. Turbidity is an optical property of water. Penetration of light is inhibited by the presence of insoluble material and is a function of both the concentration and particle size of the suspended organic and inorganic particles. Turbidity is reported by the Louisiana Department of Environmental Quality and U.S. Geological Survey in NTU.

Water quality data were obtained from the Department of Environmental Quality computer files and recent reports (Office of Water Resources 1987; Cormier et al. 1988). Trends were shown for monthly measurements for the period of record, or for a maximum of twenty years, for dissolved oxygen (ppm or mg/l), turbidity, and total suspended solids (ppm or mg/l) for several stations in coastal Louisiana. Most trends were shown on a linear axis, with selected plots with large variability shown on a logarithmic axis. Data were graphed by calendar year.

Water quality data collected by the U.S. Geological Survey and described in this report include dissolved oxygen, turbidity, total suspended solids, and (for a few stations) suspended sediment concentrations. For most stations, data have been collected only since water year 1973, and samples were taken monthly, bimonthly, or quarterly. All trends were plotted on a linear axis, by calendar year. Missing data for several months caused discontinuities in the graphs.

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Sabine Basin			
None in coastal Louisiana			
Calcasieu Basin			
Calcasieu River and Pass at Hackberry (#7360021)			
7.25 (1957)	-1.52 (1984)	----	----
Calcasieu River and Pass near Cameron (#7365022)			
12.90 (1957)	-3.12 (1965)	----	----
Intracoastal Waterway at Calcasieu Lock, East (#7688021)			
6.60 (1957)	-0.4 (1951)	----	----
Intracoastal Waterway at Calcasieu Lock, West Staff (#7692021)			
9.00 (1957)	-0.7 (1954)	----	----
Intracoastal Waterway at Calcasieu Lock, West Automatic (#7696021)			
8.80 (1957)	-1.32 (1984)	----	----
Mermentau Basin			
Mermentau River at Catfish Point Control Structure, North (#7067517)			
8.30 (1957)	-0.80 (1975)	----	----
Mermentau River at Catfish Point Control Structure, South Automatic (#7075017)			
8.30 (1957)	-1.56 (1971)	----	----
Mermentau River at Catfish Point Control Structure, South Staff (#7082517)			
8.30 (1957)	-1.50 (1954)	----	----
Mermentau River at Grand Cheniere (#7090017)			
13.0 (1957)	-2.39 (1984)	----	----
Schooner Bayou (Inland Waterway) at Control Structure, East Automatic (#7660017)			
6.63 (1961)	-2.9 (1962)	----	----
Schooner Bayou (Inland Waterway) at Control Structure, East Staff (#7664017)			
6.10 (1973)	-1.95 (1966)	----	----

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985) (continued).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Schooner Bayou (Inland Waterway) at Control Structure, West (#7668017)			
>6.0 (1957)	-1.7 (1924)	----	----
Intracoastal Waterway at Vermilion Lock, East Automatic (#7672013)			
8.9 (1957)	-2.87 (1962)	----	----
Vermilion Basin			
Charenton Drainage Canal at Baldwin (#6445013)			
5.36 (1957)	-1.51 (1948)	----	----
Vermilion River near Bancker (#6787513)			
6.46 (1973)	-2.20 (1966)	----	----
Freshwater Canal above Beef Ridge (#7659017)			
7.45 (1971)	-2.9 (1970 and 1972)	----	----
Freshwater Canal at Freshwater Bayou Lock, North (#7659217)			
4.80 (1973)	-2.9 (1970 and 1972)	----	----
Freshwater Canal at Freshwater Bayou Lock, South (#7659317)			
5.80 (1979)	-3.8 (1970)	----	----
Intracoastal Waterway at Vermilion Lock, East Staff (#7676013)			
8.90 (1957)	-2.90 (1962)	----	----
Intracoastal Waterway at Vermilion Lock, West (#7680013)			
8.9 (1957)	-1.00 (1966)	----	----
Delcambre Bayou at Delcambre (#7950013)			
7.00 (1957)	-3.2 (1951)	----	----
East Cote Blanche Bay at Luke's Landing (#8880013)			
8.91 (1971)	-3.66 (1957)	----	----
Atchafalaya River Basin			
Lower Atchafalaya River at Morgan City (#0378010)			
10.53 (1973)	-5.44 (1976)	4	-0.8
Lower Atchafalaya River below Sweet Lake (#0382010)			
8.05 (1957)	-1.55 (1959)	----	----

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985) (continued).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Wax Lake Outlet vicinity at Belle Isle (#0383010)			
4.56 (1973)	-1.65 (1981)	----	----
Round Bayou at Deer Island (#0385010)			
4.56 (1979)	-1.00 (1976)	----	----
Belle River near Pierre Pass (#5264010)			
4.90 (1973)	-0.30 (1956)	----	----
Intracoastal Waterway at Wax Lake East Control Structure (#7644010)			
8.52 (1957)	-2.08 (1956)	----	----
Wax Lake East Drainage Area at Control Structure (#7648010)			
2.15 (1957)	-3.03 (1978)	----	----
Intracoastal Waterway at Wax Lake West Control Structure (#7656010)			
7.35 (1957)	-2.38 (1964)	----	----
Atchafalaya Bay near Eugene Island (#8855010)			
4.64 (1982)	-1.81 (1981)	----	----
Atchafalaya Bay at Eugene Island (#8860010)			
6.81 (1957)	-3.86 (1976)	----	----
Terrebonne Basin			
Intracoastal Waterway at Houma (#7632007)			
4.75 (1978)	-0.53 (1956)	----	----
Bayou Boeuf (IWW) at Bayou Boeuf Lock, East (#7636010)			
4.68 (1973)	-0.78 (1956)	----	----
Bayou Boeuf (IWW) at Bayou Boeuf Lock, West (#7640010)			
10.56 (1973)	-1.98 (1959)	----	----
Bayou Blue near Catfish Lake (#8230007)			
3.75 (1977)	-0.59 (1983)	----	----
Barataria Basin			
Intracoastal Waterway at Harvey Lock (#7620007)			
4.21 (1973)	-1.28 (1940)	----	----

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985) (continued).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Intracoastal Waterway at Algiers Lock (#7624004)			
4.31 (1973)	-1.64 (1965)	----	----
Bayou Lafourche at Leeville (#8235007)			
5.66 (1974)	-1.44 (1965)	----	----
Bayou Chevreuil near Chegby (#8252507)			
4.35 (1980)	-1.00 (1956)	----	----
Bayou Des Allemands at Des Allemands (#8270007)			
3.74 (1973)	-0.3 (1956)	----	----
Bayou Barataria at Barataria (#8275007)			
3.87 (1977)	-0.29 (1981)	----	----
Bayou Barataria at Lafitte (#8287507)			
4.04 (1964)	-0.68 (1983)	----	----
Grand Isle at East Point (#8840004)			
10.60 (1965)	-1.4 (1951 and 1964)	----	----
Mississippi River Basin			
Mississippi River at College Point (#0124010)			
32.32 (1927)	-0.60 (1916)	17	1.1
Mississippi River at Reserve (#0126006)			
26.00 (1929)	-0.10 (1940)	15	0.7
Mississippi River at New Orleans-Carrollton (#0130007)			
21.27 (1922)	-1.60 (1872)	11	0.5
Mississippi River (IWW) at Harvey Lock (#0132007)			
19.42 (1927)	-0.68 (1953)	9.5	0.35
Mississippi River (IWW) at Inner Harbor Navigation Canal Lock (#0134007)			
17.52 (1945)	-0.48 (1953 and 1954)	8.5	0.15
Mississippi River at Chalmette (#0136007)			
17.58 (1927)	-0.52 (1940)	8	0.1
Mississippi River (IWW) at Algiers Lock (#0138004)			
16.11 (1973)	-0.15 (1981)	7.5	0.08

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985) (continued).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Mississippi River near Braithwaite (#0138604)			
12.32 (1984)	0.43 (1977)	7.0	----
Mississippi River at Alliance (#0139004)			
10.33 (1979)	0.49 (1977)	7.0	----
Mississippi River at West Pointe a la Hache (#0140004)			
15.25 (1965)	-1.06 (1940)	3.0	0.1
Mississippi River at Port Sulphur (#0142004)			
9.50 (1950)	-0.60 (1977)	3.0	----
Mississippi River at Empire (#0144004)			
10.92 (1969)	-0.74 (1977)	1	-0.2
Mississippi River at Venice (#0148004)			
9.11 (1969)	-0.73 (1977)	1.0	-0.36
Mississippi River at Head of Passes (#0154504)			
12.03 (1969)	-0.85 (1940)	1	-0.4
Southwest Pass at Mile 9.2 (#0157504)			
4.94 (1973)	-1.03 (1977)	1.0	----
Southwest Pass at East Jetty (#0167004)			
5.50 (1972)	-1.60 (1940)	1.0	----
South Pass at Port Eads (#0185002)			
5.50 (1965)	-1.87 (1939)	---	----
West Bay near Burrwood (#8835004)			
4.43 (1983)	-1.04 (1977)	---	----
Breton Sound Basin			
Bayou Dupre at Floodgate, West (#7600504)			
3.49 (1980)	-1.94 (1979)	----	----
Bayou Dupre at Floodgate, East (#7601004)			
4.51 (1979)	-1.89 (1978)	----	----
Bayou Bienvenue at Paris Road (#7602004)			
4.82 (1978)	-2.00 (1984)	----	----

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985) (continued).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Bayou Bienvenue at Floodgate, West (#7602404)			
3.91 (1980)	-2.03 (1978)	----	----
Bayou Bienvenue at Floodgate, East (#7602504)			
7.52 (1983)	-1.89 (1979)	----	----
Bayou Terre aux Boeufs at Delacroix (#8578004)			
3.44 (1983)	-1.29 (1978)	----	----
Mississippi River Gulf Outlet at Shell Beach (#8580004)			
11.06 (1969)	-2.7 (1965)	----	----
<u>Pontchartrain Basin</u>			
Intracoastal Waterway near Paris Road Bridge, New Orleans (#7604003)			
10.04 (1965)	-2.19 (1965)	----	----
Inner Harbor Navigation Canal near Seabrook Bridge, New Orleans (#7606006)			
6.47 (1969)	-1.82 (1984)	----	----
Inner Harbor Navigation Canal (IWW) at Florida Ave. Bridge, New Orleans (#7612007)			
9.82 (1969)	-1.95 (1983)	----	----
Inner Harbor Navigation Canal (IWW) at New Orleans (#7616007)			
10.61 (1965)	-1.85 (1975)	----	----
Amite River at Port Vincent (#8517509)			
14.59 (1983)	-1.60 (1954)	----	----
Amite River at French Settlement (#8522509)			
7.4 (1978)	-1.50 (1954)	----	----
Petite Amite River near St. Paul (#8525006)			
4.72 (1973)	-1.60 (1956)	----	----
Reserve Canal near Lake Maurepas (#8527506)			
3.65 (1980)	-1.14 (1981)	----	----
Tickfaw River near Springfield (#8530006)			
6.19 (1983)	-1.43 (1954)	----	----

Table 3. Maximum and minimum stages of record in coastal Louisiana (converted to mean sea level from U.S. Army Corps of Engineers 1985) (continued).

STAGE (ft MSL)			
Maximum	Minimum	Bankfull	Low water
Pass Manchac near Pontchatoula (#8542006)			
4.80 (1979)	-2.0 (1961)	----	----
Bayou Bonfouca at Slidell (#8554003)			
6.80 (1969)	-0.6 (1963)	----	----
Lake Pontchartrain at Frenier (#8555006)			
12.09 (1965)	-2.1 (1938)	----	----
Lake Pontchartrain at Mandeville (#8557506)			
6.95 (1947)	-2.25 (1938)	----	----
Lake Pontchartrain at Midlake near New Orleans (#8556006)			
5.53 (1965)	-1.28 (1965)	----	----
Lake Pontchartrain at West End (#8562506)			
5.37 (1965)	-2.2 (1938)	----	----
Lake Pontchartrain (Irish Bayou) near South Shore (#8567503)			
7.16 (1969)	-1.30 (1954)	----	----
Rigolets near Lake Pontchartrain (#8570003)			
9.00 (1969)	-1.9 (1938)	----	----
Lake Borgne at Rigolets (#8572503)			
12.25 (1969)	-2.04 (1978)	----	----
Chef Menteur Pass near Lake Borgne (#8575003)			
9.07 (1965)	-1.69 (1978)	----	----
Pearl River Basin			
None in coastal Louisiana			

Dissolved oxygen, turbidity, and suspended solids concentrations were collected by the Department of Environmental Quality by placing a water sampler in the center of the channel approximately 3' below the surface or at mid-depth in cross sections less than 6' deep (Office of Water Resources 1987). The sampler used was a three-quart stainless steel wastewater sampler, which is not designed for obtaining isokinetic measurements. Single-point sampling, particularly for suspended solids or sediment, is less accurate than multiple-point sampling because it does not adequately represent the mean value of the cross section; the solids or sediment concentration in a stream usually varies from the surface to the bottom, and in some instances from side to side (Federal Inter-Agency Sedimentation Project 1963). Surface sampling may provide results comparable to depth-integrated samples of suspended solids or sediment concentration in streams that carry small amounts of sand, or less than 10% of the total concentration; however, in streams that average over 10% sand concentration, such comparisons are not recommended (Welborn 1969). Problems with the results acquired with this sampler and the sampling methods were recognized. The values for suspended solids in particular were extremely low (several samples measured below 10 ppt) probably due to the sampling methods.

U.S. Geological Survey procedures for water quality and suspended sediment sampling follow those discussed by the Federal Inter-Agency Sedimentation Project (1963) and Guy and Norman (1970). Samples were acquired with either a depth-integrating sampler or a point-integrating P-61 sampler in three verticals, spaced at equal width increments; on occasion, when flow velocities were less than 1 cfs, a bottle sampler was used (Dupuy 1989). Suspended sediment concentration and the percentage of silt and clay (d <0.062 mm) in the sample are determined in the laboratory according to the procedures discussed by Guy and Norman (1970). Instantaneous flow measurements are collected at the same time as the suspended sediment sampling measurement. Suspended solids or sediment discharge in tons per day can be approximated by multiplying sediment concentration and flow discharge by a conversion factor of 0.027 (Porterfield 1972).

The water quality index is an aggregation of a standard set of water quality parameters and their associated criteria, and provides a means for relative measurement and comparison of water quality throughout the state with respect to federal water quality standards (Louisiana Department of Transportation and Development 1984). The water quality index scale ranges from 0 (no measured evidence of pollution) to 100 (severe pollution in most criteria/parameter groups at all times). The scale is divided into three categories: 1) 0-20: water body either has no pollution or is minimally polluted; 2) 21-60: water body is intermittently and/or moderately polluted; and, 3) 61-100: water body is polluted and is considered unacceptable. Those streams with water of good quality and that are providing all of their designated uses are classified as "effluent-limited." The "water quality limited" classification is given to those water bodies not meeting water quality standards or for segments where no water quality data are available.

Salinity

Wiseman and Swenson (1987) examined historical data sets collected by the Department of Wildlife and Fisheries and of the U.S. Army Corps of Engineers over the past 30-40 years. Daily means, standard deviations, and the number of days sampled are shown in table 4. In addition, the authors conducted several sophisticated analyses which are not described in this report.

Tide Gage Records

Ramsey (1989) and Penland et al. (1989) have conducted the most comprehensive analysis of tide gage stations in coastal Louisiana. Data have been collected by the National Ocean Survey since 1939 and by the U.S. Army Corps of Engineers since 1933. The analysis of tide gage records is used for measuring rates of relative sea level rise (Byrne et al. 1976; Le Baron 1905; Marmer 1954). Typically, the longer the period of record, the more accurate the calculation of relative sea level rise that results. A period of record covering at least one lunar nodal cycle (18.6 yr) is recommended (Stapor 1982), because it balances effects of moon-induced water level variations as well as variations in non-tidal factors such as wind, atmospheric pressure, river discharge, currents, water temperature, and salinity (Hicks 1968). Not all of the stations in coastal Louisiana have data for the recommended time span, as shown in the summary of results in table 5.

Daily mean values were used to calculate monthly mean and annual mean water levels for each station. Time-series plots were constructed and a linear regression was performed on the complete data set to produce a best-fit straight line with a slope equal to the rate of change in relative sea level. The maintenance history of each station was also reviewed so that any errors in the data due to repositioning of, or damage to, a station could be removed. Subsidence can be computed by subtracting the rate of eustatic change in the Gulf of Mexico from the rate of relative sea level rise. In some cases, data show that the elevation of the land surface rose once sea level rise was factored out; such increases are probably attributable to sedimentation of water bottoms.

Table 4. Mean salinities at Corps of Engineers (COE) and Louisiana Department of Wildlife and Fisheries (LDWF) stations in coastal Louisiana, by hydrologic basin (Wiseman and Swenson 1987).

LOCATION	MEAN (ppt)	STD. D. (ppt)	DAYS
Sabine Basin			
None in coastal Louisiana			
Calcasieu Basin			
Cameron (LDWF, #719)	15.89	5.86	2939
Mermentau Basin			
Rockefeller South (LDWF, #701)	13.55	6.83	1490
Rockefeller North (LDWF, #702)	11.74	6.79	1283
Mermentau River (COE, #70675)	1.35	2.86	9387
Schooner Bay (COE, #76690)	1.33	1.04	647
Gulf Intracoastal Waterway at Vermilion Lock, West (COE, #76800)	1.32	1.96	5874
Vermilion Basin			
Cypremort Point (LDWF, #619)	4.90	3.46	7027
Southwest Pass (LDWF, #620)	6.07	4.07	701
Charenton Drainage Canal at Baldwin (COE, #64450)	0.24	0.56	9772
Gulf Intracoastal Waterway at Vermilion Lock, East (COE, #76720)	1.73	2.28	3288
Cypremort Point (COE, #88850)	4.90	3.46	7027
Atchafalaya River Basin			
Wax Lake Outlet (COE, #03720)	0.06	0.04	5561
Lower Atchafalaya River at Morgan City (COE, #03780)	0.07	0.05	6134

Table 4. Mean salinities at Corps of Engineers (COE) and Louisiana Department of Wildlife and Fisheries (LDWF) stations in coastal Louisiana, by hydrologic basin (Wiseman and Swenson 1987) (continued).

LOCATION	MEAN (ppt)	STD. D. (ppt)	DAYS
Atchafalaya Bay at Eugene Island (COE, #88600)	4.93	7.16	3119
Terrebonne Basin			
Cocodrie (LDWF, #416)	9.44	5.49	3370
Caillou Lake Camp (LDWF, #518)	10.76	5.14	2763
Intracoastal Waterway at Houma (COE, #76320)	0.34	1.04	10426
Bayou Grand Caillou at Dulac (COE, #76323)	1.20	2.79	11117
Barataria Basin			
Marine Lab at Grand Terre (LDWF, #315)	20.90	5.71	7664
St. Mary's Point (LDWF, #317)	12.90	6.36	2984
Galliano (COE, #82300)	1.72	3.17	6527
Bayou Lafourche at Larose (COE, #82203)	0.56	1.19	7951
Bayou Lafourche at Leeville (COE, #82350)	15.50	5.45	7621
Bayou Barataria at Barataria (COE, #82750)	1.93	1.58	168
Lower Mississippi River Basin			
Mississippi River at Port Sulphur (COE, #01420)	0.17	0.38	14862
The Jump (COE, #01500)	0.42	1.25	1408
Breton Sound Basin			
Bay Gardene (LDWF, #221)	13.61	5.07	2023
Long Bay (LDWF, #251)	11.29	5.72	991
California Bay (LDWF, #252)	17.14	5.85	806
Sable Island (LDWF, #253)	19.29	6.35	788

Table 4. Mean salinities at Corps of Engineers (COE) and Louisiana Department of Wildlife and Fisheries (LDWF) stations in coastal Louisiana, by hydrologic basin (Wiseman and Swenson 1987) (continued).

LOCATION	MEAN (ppt)	STD. D. (ppt)	DAYS
Pontchartrain Basin			
Chef Menteur (LDWF, #102)	5.38	2.98	8189
Grand Pass (LDWF, #117)	16.25	5.85	856
The Rigolets (LDWF, #118)	4.84	3.57	6378
Gulf Intracoastal Waterway at Paris Road (COE, #76042)	9.90	4.66	242
Lake Pontchartrain North Shore (COE, #85683)	4.01	2.41	976
Little Woods (COE, #85650)	3.95	2.35	10830
The Rigolets near Lake Pontchartrain (COE, #85700)	4.84	3.57	6378
Chef Menteur Pass near Lake Borgne (COE, #85750)	5.38	2.98	8189
Mississippi River Gulf Outlet at Navig. Light 101 (COE, #85820)	15.28	6.97	275
Pearl River Basin			
None in coastal Louisiana			

Data from Wiseman and Swenson (1987)

Table 5. Relative sea level rise rates by hydrologic basin in coastal Louisiana (converted from Ramsey, unpublished and Penland and others, 1989).

LOCATION	PERIOD OF RECORD	CHANGE IN RSL (in/yr)
<u>Sabine Basin</u>		
None in coastal Louisiana		
<u>Calcasieu Basin</u>		
Calcasieu River and Pass Hackberry (#7360021)	1943-1988	0.22
Calcasieu River and Pass near Cameron (#7365022)	1942-1988	0.22
Intracoastal Waterway at Calcasieu Lock (West Staff) (#7692021)	1951-1983	0.43
<u>Mermentau Basin</u>		
Mermentau River at Grand Cheniere (#7090017)	1957-1983	0.19
Mermentau River at Catfish Point Control Structure (South Auto) (#7075017)	1949-1988	0.24
Freshwater Canal at Freshwater Bayou Lock (South) (#7659317)	1968-1983	0.21
Freshwater Canal above Beef Ridge (#7659017)	1963-1983	0.50
Schooner Bayou at Control Structure (East Auto) (#7660017)	1942-1988	0.24
Schooner Bayou at Control Structure (East Staff) (#7664017)	1942-1988	0.23
Intracoastal Waterway at Vermilion Lock (East Auto) (#7672013)	1942-1988	0.20
Intracoastal Waterway at Vermilion Lock (East Staff) (#7676013)	1943-1988	0.22
Intracoastal Waterway at Vermilion Lock (West) (#7680013)	1942-1988	0.26

Table 5. Relative sea level rise rates by hydrologic basin in coastal Louisiana (converted from Ramsey, unpublished and Penland and others, 1989) (continued).

LOCATION	PERIOD OF RECORD	CHANGE IN RSL (in/yr)
Vermilion Basin		
Charenton Drainage Canal at Baldwin (#6445013)	1942-1983	-0.02
East Cote Blanche Bay at Luke's Landing (#8880013)	1957-1983	0.67
Atchafalaya River Basin		
Lower Atchafalaya River at Morgan City (#0378010)	1933-1987	0.47
Lower Atchafalaya below Sweet Bay Lake (#0382010)	1956-1982	0.53
Wax Lake Outlet vicinity at Belle Isle (#0383010)	1973-1983	0.02
Round Bayou at Deer Island (#0385010)	1974-1983	0.34
Belle River near Pierre Pass (#5264010)	1957-1983	0.32
Intracoastal Waterway at Wax Lake West Control Structure (#7657010)	1942-1988	0.74
Atchafalaya Bay at Eugene Island (#8860010)	1944-1986	0.46
Terrebonne Basin		
Bayou Boeuf at Bayou Boeuf Lock (East) (#7636010)	1955-1983	0.30
Bayou Blue near Catfish Lake (#8230107)	1976-1983	0.40
Barataria Basin		
Bayou Lafourche at Leeville (#8234007)	1957-1983	0.29
Bayou Chevreuil near Chegby (#8252507)	1952-1983	0.07
Bayou Des Allemands at Des Allemands (#8270007)	1950-1983	0.15
Bayou Barataria at Barataria (#8275007)	1952-1983	0.19
Bayou Barataria at Lafitte (#8287507)	1967-1983	0.14
Bayou Rigaud at Grand Isle (#8840004)	1949-1986	0.36

Table 5. Relative sea level rise rates by hydrologic basin in coastal Louisiana (converted from Ramsey, unpublished and Penland and others, 1989) (continued).

LOCATION	PERIOD OF RECORD	CHANGE IN RSL (in/yr)
Mississippi River Basin		
Mississippi River at Donaldsonville (#0122009)	1891-1983	-0.05
Mississippi River at West Point a la Hache (#0140004)	1930-1983	0.24
Mississippi River at Port Sulphur (#0142004)	1959-1983	0.18
Mississippi River at Empire (#0144004)	1960-1982	0.11
Mississippi River at Venice (#0148004)	1953-1983	0.22
Mississippi River at Head of Passes (#0154504)	1943-1983	0.01
Southwest Pass at Mile 9.2 (#0157504)	1971-1983	0.09
Mississippi River at Southwest Pass East Jetty (#0167004)	1953-1983	0.04
South Pass at Port Eads (#0185004)	1944-1988	0.36
West Bay near Burwood (#8835004)	1975-1983	1.54
Breton Sound Basin		
Bayou Dupre at Floodgate (West) (#7600504)	1975-1983	-0.02
Bayou Dupre at Floodgate (East) (#7601004)	1975-1983	-0.37
Bayou Terre Aux Boeufs at Delacroix (#8578004)	1975-1983	0.20
Mississippi River - Gulf Outlet at Shell Beach (#8580004)	1961-1983	-0.01
Pontchartrain Basin		
Pass Manchac near Pontchatoula (#8542006)	1957-1983	0.06
Bayou Bonfouca at Slidell (#8554003)	1962-1983	-0.11
Lake Pontchartrain at Frenier (#8555006)	1931-1983	0.14
Lake Pontchartrain at Mandeville (#8557506)	1931-1983	0.18
Lake Pontchartrain at Midlake near New Orleans (#8560006)	1957-1983	0.24

Table 5. Relative sea level rise rates by hydrologic basin in coastal Louisiana (converted from Ramsey, unpublished and Penland and others, 1989) (continued).

LOCATION	PERIOD OF RECORD	CHANGE IN RSL (in/yr)
Lake Pontchartrain at West End (#8562506	1931-1983	0.16
Lake Pontchartrain near South Shore (#8567503)	1949-1988	0.39
Rigolets near Lake Pontchartrain (#8570003)	1931-1983	0.13
Lake Borgne at Rigolets (#8572503)	1967-1983	-0.50
Chef Menteur Pass near Lake Borgne (#8575003)	1967-1983	-0.59
Lake Pontchartrain at Little Woods (#8565003)	1931-1977	0.43
Pearl River Basin		
None in coastal Louisiana		

Data from Penland et al. (1989) and Ramsey (1989)

CHAPTER II
PHYSICAL CHARACTERISTICS OF BASINS IN COASTAL LOUISIANA

Joann Mossa

Basin Descriptions

The U.S. Geological Survey recognizes 10 hydrologic basins in coastal Louisiana. These include the Sabine River basin, the Calcasieu River basin, the Mermentau River basin, the Vermilion-Teche River basin, the Atchafalaya River basin, the Terrebonne basin, the Barataria basin, the Mississippi River basin, the Lake Pontchartrain basin, and the Pearl River basin. The U.S. Army Corps of Engineers recognizes nine hydrologic basins in coastal Louisiana, but with different geographical boundaries. These include the Calcasieu-Sabine basin, the Mermentau basin, the Vermilion basin, the Atchafalaya basin, the Terrebonne basin, the Barataria basin, the Mississippi delta basin, the Breton Sound basin, and the Pontchartrain basin. The U.S. Geological Survey boundaries follow drainage divides, whereas the U.S. Army Corps of Engineers boundaries partly follow both physical and political divisions, and often fall along the center of major rivers.

Hydrologic basins for environmental descriptions in this investigation were based principally on physical characteristics used in previous delineations. The basins include the Sabine River basin, the Calcasieu River basin, the Mermentau River basin, the Vermilion-Teche River basin, the Atchafalaya River basin, the Terrebonne basin, the Barataria basin, the Mississippi River basin, the Breton Sound basin, the Pontchartrain basin, and the Pearl River basin. The adjective "river" serves as an important physical distinction for basins with appreciable freshwater input. The distinction is recognized here, although the adjective will not be repeated throughout the report.

Sabine River Basin

The Sabine River and its tributaries drain approximately 20,944 mi^2 (54,455 km^2) of eastern Texas and southwestern and central western Louisiana. In coastal Louisiana, the basin is bounded by Texas on the west, the Calcasieu River basin on the east, the coastal zone boundary on the north, and the Gulf of Mexico to the south (see habitat section for area). In Louisiana, the basin is developed exclusively in Tertiary and Quaternary sediments. The Sabine River has a southerly course and forms the Louisiana-Texas boundary for the southern portion of the state. Within the coastal basin on the lower end is Sabine Lake, a large oval-shaped estuary that connects the alluvial portion of the river with the Gulf of Mexico. Upstream of Sabine Lake, the river has an anastomosing pattern; there are multiple channels of high sinuosity with islands that are densely vegetated. In addition to Sabine Lake, large ponded areas include the Sabine National Wildlife Refuge and Hamilton Lake. Bayous include Black, North, Johnson, Greens, and Old East bayous.

The coastal Sabine basin lies predominantly within the chenier plain, composed of alternating sand-shell ridges and mudflats. Localized inliers of the late Pleistocene Prairie Terraces are surrounded by coastal marsh. Predominant soils in the coastal Sabine basin include, in order of dominance: 1) Haplaquolls-Hydraquents, moderately saline, across much of the project area; 2) Haplaquolls-Udipsamments, moderately saline, developed on the chenier ridges; 3) Haplaquolls-Hydraquents, saline, along the Gulf and Sabine Lake in the western part of the basin; 4) Morey-Mowata-Verrett, 0-1%, developed on late Pleistocene Prairie Terraces deposits; and 5) Judice-Morey-Midland, 0-1%, developed on late Pleistocene Prairie Terrace deposits (figure 2).

The coastal wetland hydrology of the Sabine basin is influenced by the chenier ridges in the vicinity of the Gulf, the Gulf Intracoastal Waterway, and embankments associated with Louisiana highway 82. Major canals in addition to the Gulf Intracoastal Waterway include Starks Canal, Starks North Canal, Willow Bayou Canal, Bancroft Canal, Beach Canal, Magnolia Vacuum Canal, and several unnamed canals. These waterways run east-to-west, providing a hydrologic connection between Sabine Lake and Calcasieu Lake. Therefore, high-salinity water from the Calcasieu ship channel is able to move westward across the eastern Sabine basin. The cheniers inhibit the influx of saline water from the Gulf. Water control structures are present throughout the marsh. Many of these are dedicated to enhancement of the Sabine National Wildlife Refuge, and for several purposes, including wildlife and agricultural enhancement, on private holdings.

A large reservoir, Toledo Bend Reservoir, has been constructed along the central portion of the Sabine River, with its downstream end near Burkeville just north of 31°N latitude. A ship channel has been constructed through the central portion of Sabine Lake. Land use within the coastal Sabine basin in Louisiana is rural, with major activities including cattle grazing, fisheries, and mineral extraction. There is extensive rice production along the northern boundary of the basin. Some industrialization occurs along the west and north side of Sabine Lake.

There are no water level gages or discharge stations in the Sabine River basin in coastal Louisiana. A discharge station upstream near Ruliff, Texas, gives an indication of the maximum, mean, and minimum discharges over the period of record (figure 3). Maximum and minimum daily discharges during the period of record were 120,000 cfs on May 22, 1953, and 270 cfs in 1956 and 1957. The approximate reach of tidal influence is shown in figure 4.

There are no Department of Environmental Quality or U.S. Geological Survey water quality stations in the basin. Water quality assessments have determined that the Sabine River from Morgan's Bluff to the Gulf of Mexico and all tributaries and adjacent coastal waters are classified as effluent limited, with a water quality index of 29.2 (Louisiana Department of Transportation and Development 1984). This is considered good; the major problem in these waters is dissolved solids. No areas in the coastal basin are closed to oyster harvesting.

There are no Louisiana Department of Wildlife Fisheries or U.S. Corps of Engineers salinity stations in the coastal Sabine basin in Louisiana. Sabine Lake and the surrounding marsh are brackish and saline because there is water exchange between the lake and the Gulf of Mexico. Salinity generally decreases inland away from the lake and the Gulf. Assessments of relative sea level rise and subsidence are not available because of the absence of water level stations.

Projects in the coastal basin include the Sabine-Neches Waterway, authorized in 1921, which consists of the construction and maintenance of 85.0 mi of deep water from the Gulf of Mexico, through a jettied entrance at the mouth of Sabine

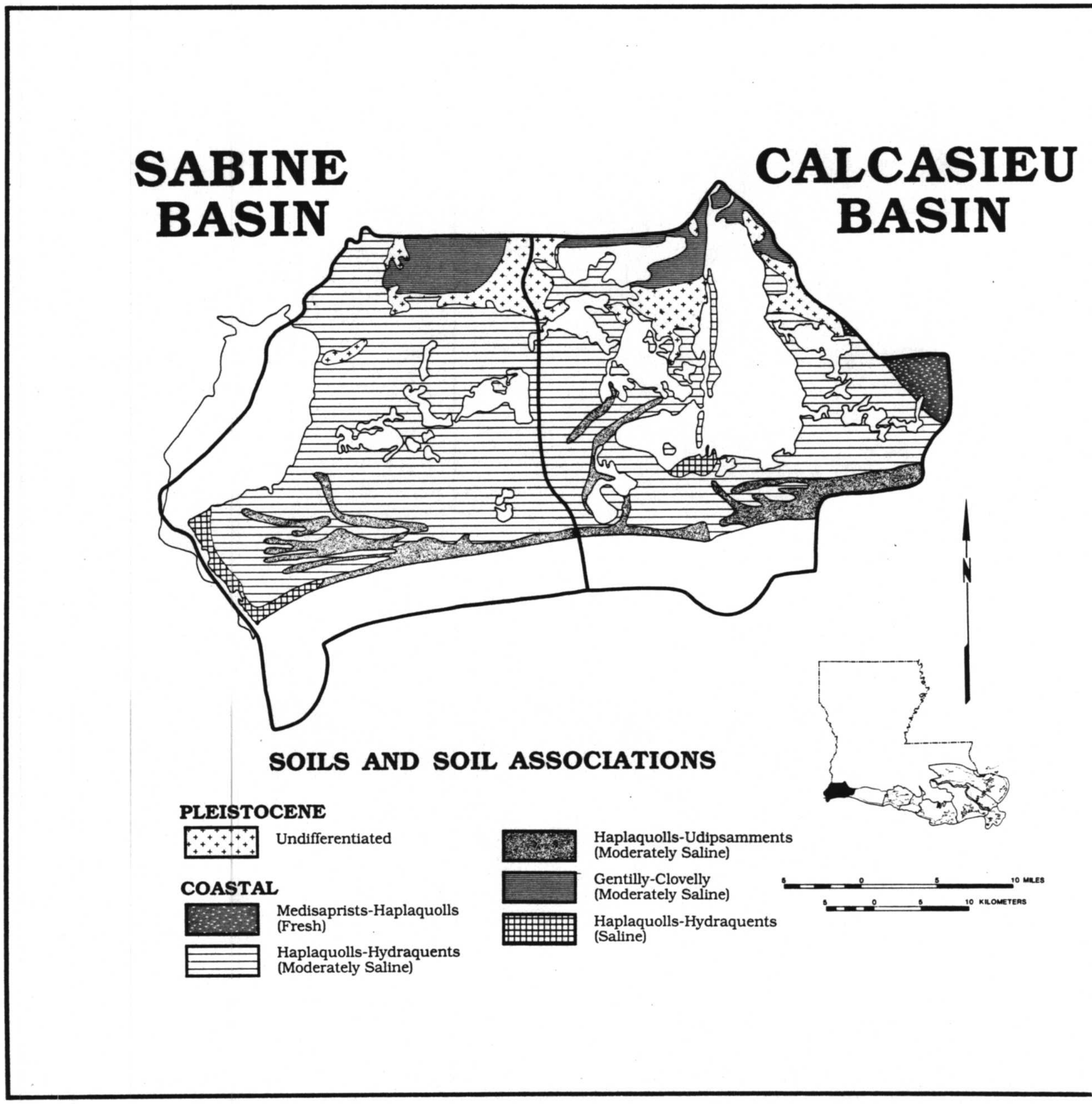


Figure 2. Major soil associations of the coastal Sabine and Calcasieu basins (Spicer 1981).

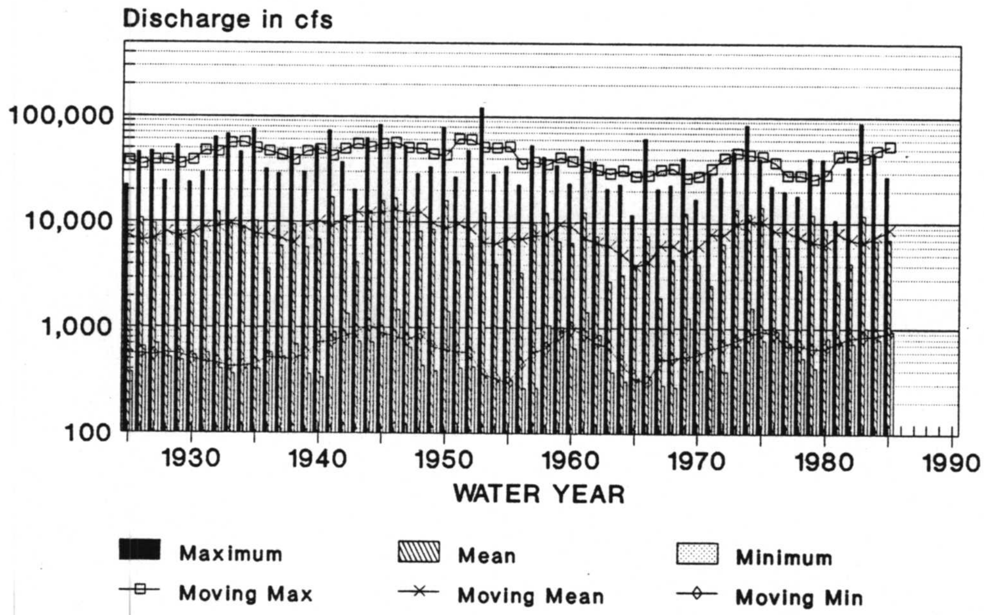


Figure 3. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for the Sabine River at Ruliff; 1925-1985.

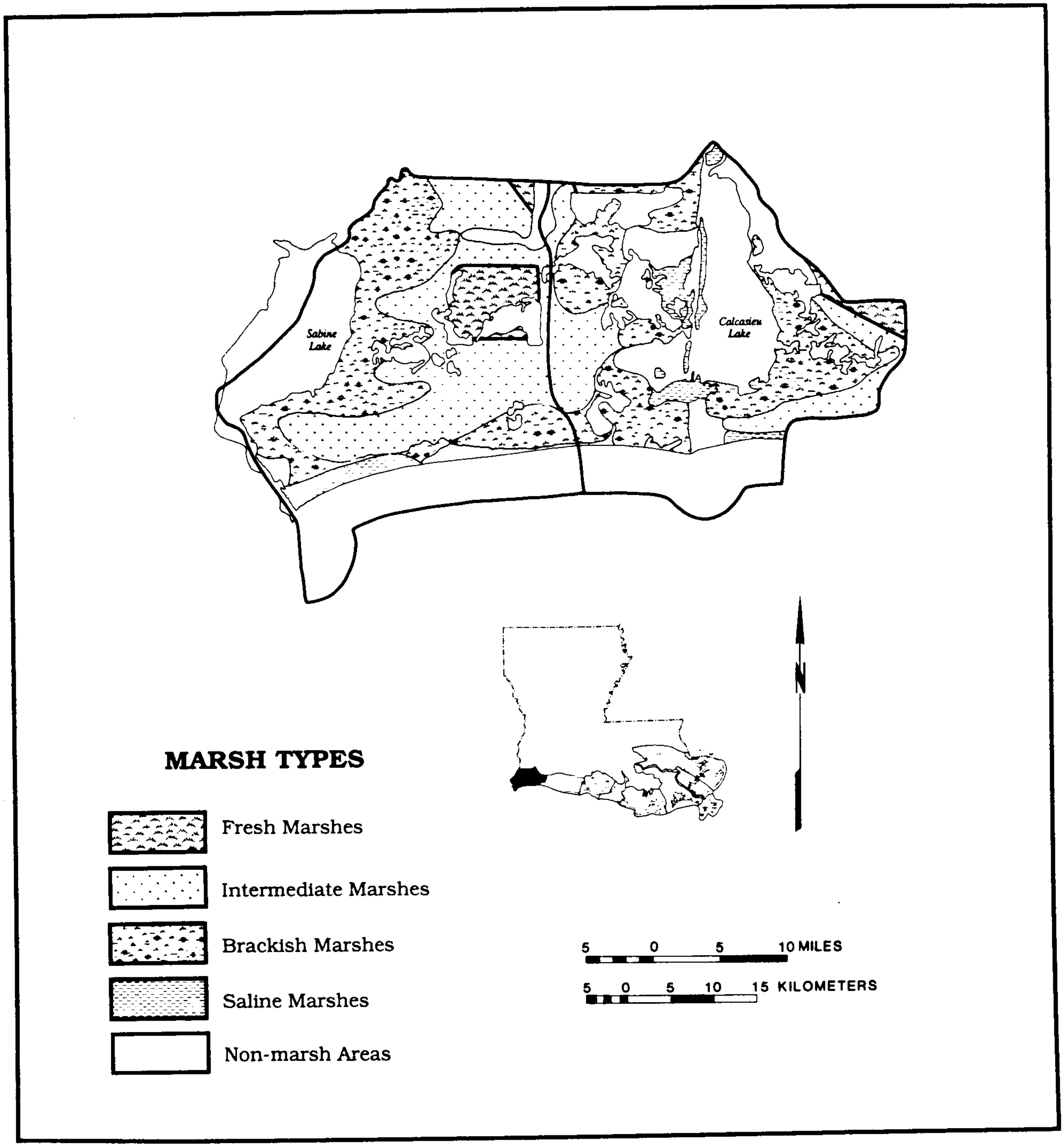


Figure 4. Marsh types in the Sabine and Calcasieu basins (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.

Pass to Orange, Texas, via the Port Arthur Canal, Sabine-Neches Canal, and the Neches and Sabine rivers (figure 5) (U.S. Army Corps of Engineers 1988). The existing authorized project provides for a channel 30' deep and 200' wide from the mouth to Orange, and a 25' deep and 150' wide channel around Harbor Island. A small channel improvement 0.5 mi long and 6' deep was completed in 1899; the project is in the inactive category for maintenance (U.S. Army Corps of Engineers 1988).

Calcasieu River Basin

The Calcasieu River and its tributaries drain approximately 3,776 mi^2 (9,780 km^2) of late Tertiary and Quaternary sediments in southwestern Louisiana. In coastal Louisiana, the basin is bounded by the Sabine basin to the west, the Mermentau basin to the east, the coastal zone boundary to the north, and the Gulf of Mexico to the south (see the habitat section for area). Water is supplied to the Calcasieu River by numerous tributaries, mostly entering the river from the west. The flow is divided in to multiple channels throughout much of its valley length. The principal confluences with tributaries are the Whisky Chitto, north of Kinder, and the Houston River near Moss Bluff. The river follows a southward course and discharges through Calcasieu Lake and Calcasieu Pass into the Gulf of Mexico. The channel widens from 100' in the vicinity of Kinder to 700' near Lake Charles (30 m to 200 m) and deepens from 3' to as much as 50' (1 to 15 m) (Cry 1978). Calcasieu Lake, with components West Cove and Long Point Lake, is the largest in the coastal basin at 67 mi^2; the other significant lakes are Black, Mud, Sweet, Willow, and Browns lakes. Bayous in the basin include Grand Bayou, Oyster Bayou, Mud Pass, and Bayou Bois Connine.

The coastal Calcasieu basin lies on the chenier plain, with alternating sandy ridges and mudflats, and contains localized inliers of the late Pleistocene Prairie Terraces. Predominant soils in the coastal Calcasieu basin include, in order of dominance: 1) Haplaquolls-Hydraquents, moderately saline, across much of the project area; 2) Haplaquolls-Udipsamments, moderately saline, developed on the chenier ridges; 3) Morey-Mowata-Verrett, 0-1%, developed on late Pleistocene deposits; 4) Mowata-Morey-Crowley, 0-1%, developed on late Pleistocene deposits; and 5) Haplaquolls-Hydraquents, saline, along the southern end of Calcasieu Lake near the Ship Channel (figure 2).

Wetland hydrology is influenced by the presence of chenier ridges, canals, levees, and roads. The Gulf Intracoastal Waterway, Beach Canal, Starks Canal, Starks North Canal, Back Ridge Canal, Sweet Lake Canal, and Creole Canal are some of the waterways that influence local hydrology. Louisiana highway 82, which follows the Gulf and Grand Chenier, highway 27, which follows the Gulf and then turns northward, and highway 1143 also influence local hydrology because of their large embankments.

Human activities in the basin include agriculture, principally with some rice farming and cattle grazing, and activities related to oil and gas development. The principal communities in the coastal area are Cameron and Holly Beach. Major urban and industrial areas in the non-coastal parts of the basin include Lake Charles and Sulphur. South of Lake Charles, meanders have been artificially cut off to improve navigation. Calcasieu Lake also has been dredged for navigation and contains two parallel spoil banks. Part of the Sabine National Wildlife Refuge lies in the Calcasieu basin.

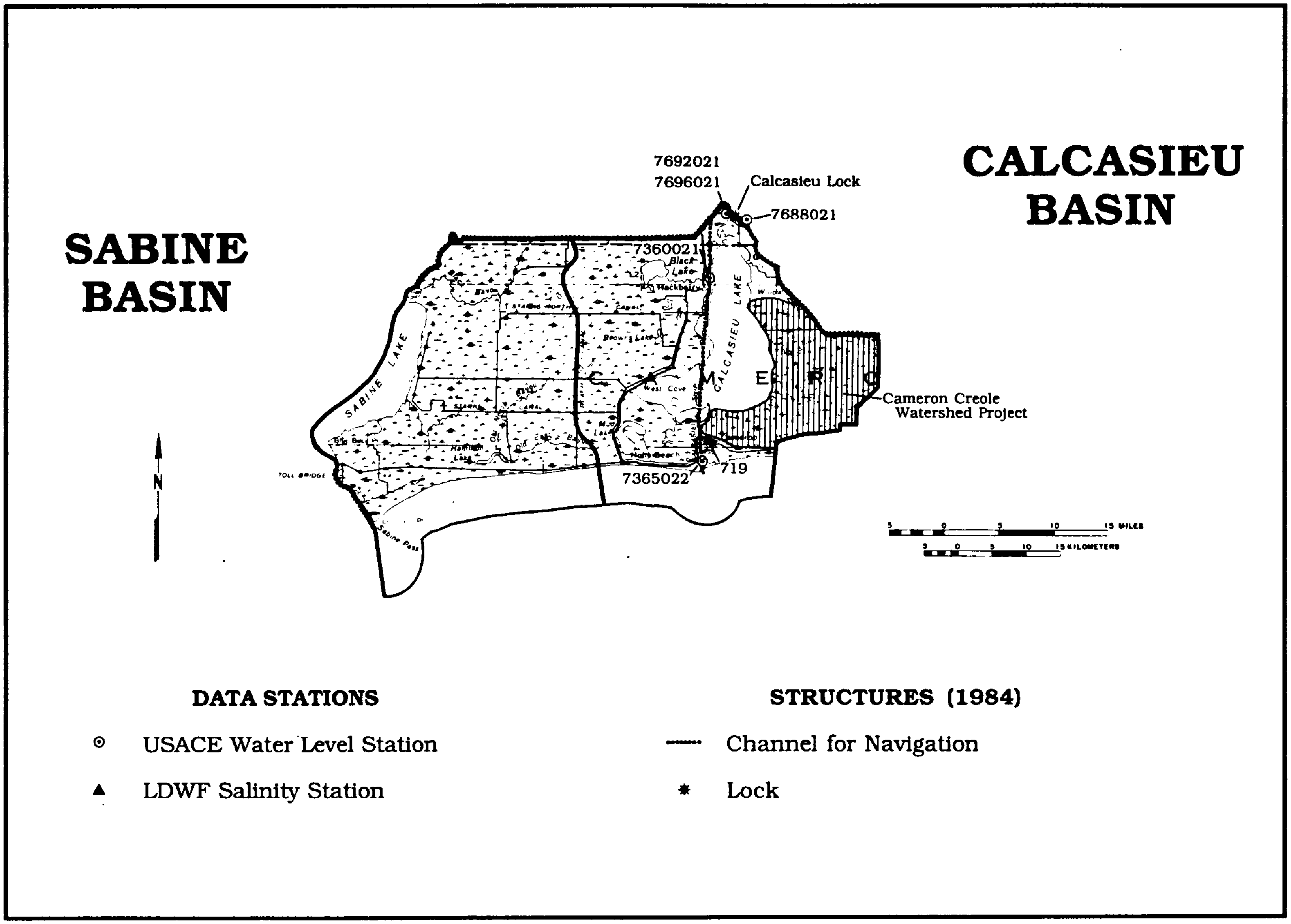


Figure 5. Data stations and major structures in the coastal Sabine and Calcasieu basins.

The Calcasieu basin has five water level stations in coastal Louisiana (table 3). The maximum water levels for the period of record for all five stations occurred during Hurricane Audrey in 1957. The highest and lowest water levels were recorded at the Calcasieu River and Pass near Cameron; these were 12.90′ on June 27, 1957, and -3.12′ on February 25, 1965. Discharge measurements are not collected within the coastal zone; the nearest location is on the Calcasieu River near Kinder. Surface water is derived largely from interbasin transfers and runoff from watersheds lying wholly within the basin. Maximum and minimum daily discharges during the period of record at Kinder were 166,000 cfs on May 19, 1953, and 192 cfs in 1954 (figure 6). Mean discharge over the period of record (WY 1923-24; 1939-57; 1962-87) is 2,586 cfs. The approximate reach of tidal influence is shown in figure 4.

There are no U.S. Geological Survey or Department of Environmental Quality water quality stations in the coastal basin although, historically, the Calcasieu basin has had a number of significant water quality problems upstream. The seasonal low flows, coupled with industrial discharges, have resulted in a water quality limited classification for the coastal Calcasieu basin flanking the river and lake (Louisiana Department of Transportation and Development 1984). Violations of water quality standards have occurred for chloride, sulfate, dissolved oxygen, pH, and temperature. The major problem is dissolved oxygen. The lower end of the basin is affected by salt water from the Gulf of Mexico, particularly during periods of high pumpage for rice irrigation. Areas within and to the east of Calcasieu Lake are closed intermittently to oyster harvesting.

The Calcasieu River from Oakdale to the Gulf of Mexico is considered to have the most acute water quality problem in the state (Louisiana Department of Transportation and Development 1984). There are frequent violations of water quality criteria because of oxygen depletion, high bacterial counts, and oily materials. The Calcasieu River from the saltwater barrier to the Gulf of Mexico, including Lake Charles, Prien Lake, Calcasieu Lake, Calcasieu Pass, and East and West Fork, has been assigned a water quality index of 64.2, with the major problem being dissolved solids. The U.S. Geological Survey found high levels of toxic and carcinogenic hydrocarbons in the sediment and in certain marine organisms in Bayou D'Inde near Sulphur and the surrounding area; in 1987, the Louisiana Department of Health and Human Resources and the Department of Environmental Quality issued joint advisories against swimming, wading, water sports, and consumption of seafood.

As in the Sabine basin, salinity gradients are oriented away from the major water bodies, namely, the Gulf of Mexico and Calcasieu Lake. The cheniers in the Calcasieu basin are not as effective as in the Sabine basin for reducing influx of saline water because they are less numerous and more localized. Saltwater intrusion from Grand Bayou into fresh wetlands of the eastern Calcasieu basin has resulted in development of the Cameron-Creole watershed plan. The plan includes a levee along the eastern shore of Calcasieu Lake, with control structures on the major channel crossings. Mean salinity at Cameron, the only station in the basin recorded by the Louisiana Department of Wildlife and Fisheries, is 15.89 ppt (see table 4).

Relative sea level rise rates have been computed for three locations in the basin (table 5), and range from 0.22 to 0.43"/yr (0.55 to 1.08 cm/yr). The maximum rate of rise from 1951 to 1983 occured at the Gulf Intracoastal Waterway at Calcasieu Lock. The Calcasieu River and Pass at Hackberry (1943-1988) and the Calcasieu River and Pass near Cameron (1942-1988) both showed an increase

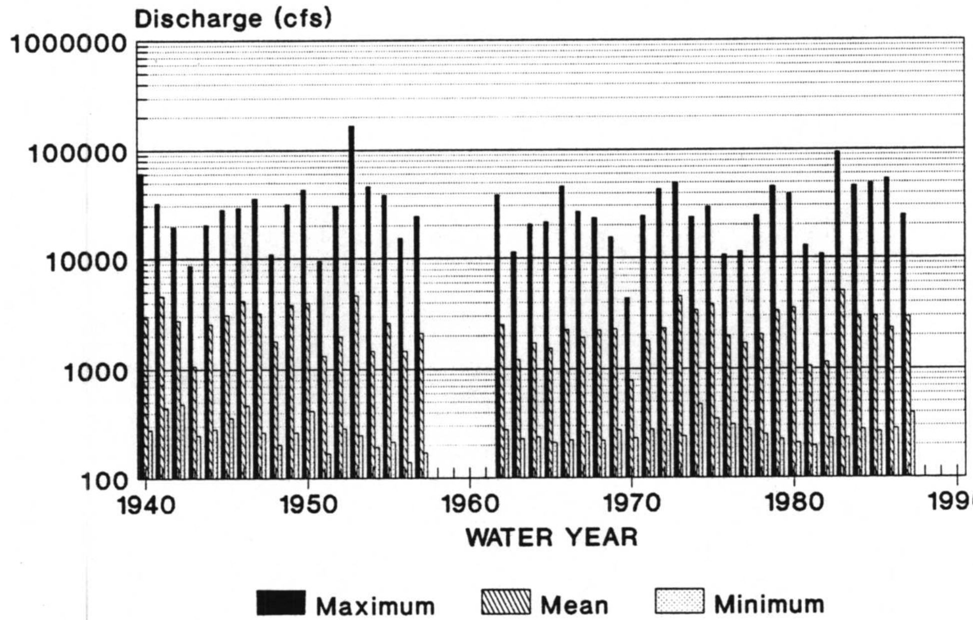


Figure 6. Maximum, mean, and minimum daily discharges on an annual basis for the Calcasieu River at Kinder; 1940-1957 and 1962-1987.

in relative sea level of 0.22"/yr (0.55 to 0.56 cm/yr). Subsidence, or the difference between relative sea level rise and eustatic change rates for the Gulf of Mexico, range from 0.13 to 0.34"/yr (0.32 to 0.85 cm/yr).

There are several navigation and water control projects in the Calcasieu basin. In 1941, the U.S. Army Corps of Engineers dredged a 40-by-400' channel from old Highway 90 at Lake Charles to the Gulf, where existing jetties were enlarged and straightened. Additional features included an approach channel from the Gulf that was opened to provide access to deep water, a mooring and turning basin, a ship channel to Cameron, and a saltwater guard lock at the intersection of the river and the Gulf Intracoastal Waterway. The extensive modifications have resulted in a complex system of interlaced natural and artificial channels.

The Cameron-Creole project's goals are watershed protection, flood prevention, and agricultural water management. The original project consisted of 19 mi of single-purpose levee and 35 mi of multi-purpose channel improvements, and has been supplemented by five multi-purpose water control structures to stabilize fluctuations of water levels and salinities.

Another major project is the Calcasieu saltwater barrier, authorized in 1962, constructed to prevent saltwater intrusion in the Calcasieu River above Lake Charles. The project consists of a tainter gate in a new channel excavated across a narrow neck of land between miles 38.6 and 43.5, an earth dam in the old channel at mile 43.2, and bank revetment along the left bank of the existing channel between miles 43.6 and 44.2 and along the left bank opposite the downstream end of the structure. A navigation channel with a gated structure 56' wide and sills 13' below mean Gulf level is located north of the new barrier channel.

Mermentau River Basin

The Mermentau River basin, which drains 3,820 mi^2 (9,896 km^2) of southwestern Louisiana, is formed by the confluence of Bayou Nezpique and Bayou Des Cannes; the coastal basin comprises considerably less area. It is bounded by the Calcasieu basin on the west and north, the Vermilion basin to the east, and the Gulf of Mexico to the south. The basin is developed exclusively in Quaternary sediments. The river flows southwestward through Lake Arthur and Grand Lake before it reaches the Gulf of Mexico. The connection with the Gulf is through both Lower Mud Lake and a canal framed by jetties out of Lower Mud Lake. The Mermentau River is connected by navigation and flood control canals to Vermilion Bay on the east and the Calcasieu River on the west. Flood control structures, including the Catfish Point and Schooner Bay control structures, and Calcasieu and Vermilion locks, impound winter runoff for irrigation. The structures also protect impounded water from saltwater intrusion.

In the central part of the coastal basin are two large lakes, White Lake and Grand Lake, with surface areas of 81 mi^2 and 50 mi^2, respectively. Other lakes include Lake Misere, Callicon Lake, Lower and Upper Mud lakes, Miller Lake, Deep Lake, Big Constance, East Constance, and Little Constance lakes, Flat Lake, Little Pecan Lake, Turtle Lake, Alligator Lake, and Lake le Beau, along with several others. Many of these lakes are near-circular in shape. Significant bayous include Bayou Lacassine, Bayou Misere, Hog Bayou, Pigeon Bayou, Rollover Bayou, Bayou Labauve, Little Chenier Bayou, Little Peach Bayou, and Schooner Bayou.

The coastal Mermentau basin is located in the chenier plain, with alternating sandy ridges and mudflats, and contains localized inliers of the late Pleistocene Prairie Terraces. Predominant soils in the coastal Mermentau basin include, in order of dominance: 1) Medisaprists-Haplaquolls, fresh, developed on fresh marsh and mudflats across the northern part of the basin; 2) Haplaquolls-Hydraquents, moderately saline, across much of the southern part of the basin; 3) Haplaquolls-Udipsamments, moderately saline, developed on the chenier ridges; 4) Haplaquolls-Morey-Mowata, drained, developed on drained late Pleistocene deposits; and 5) Judice-Morey-Midland, 0-1%, developed on late Pleistocene deposits (figure 7).

Wetland hydrology is influenced by water control structures at Schooner Bayou and the Gulf Intracoastal Waterway, roads, spoil banks and canals, and chenier ridges. Major structures include those on Freshwater Bayou, the Superior Canal, and the Catfish Point Control Structure on the Mermentau River at Grand Lake. Major roads include Louisiana highways 82, 27, 1143, and 3147. Unregulated exchange with the Calcasieu system occurs through a series of culverts under the highways.

The basin is predominantly rural, with no major population centers in the coastal area. Much of the development and roads follow Grand Chenier, one of the largest and most continuous chenier ridges. Human activities are related to the oil and gas industry, fishing and trapping, cattle grazing, and rice farming. The latter two, in particular, have resulted in some wetlands conversion. These activities, along with navigation and wildlife management, have resulted in much of the area being under water-level control. The major wildlife management area in the basin is Rockefeller Wildlife Refuge and Game Preserve. Lacassine National Wildlife Refuge is located in the northern part of the basin near Lake Misere.

The Mermentau basin has 13 water-level stations in coastal Louisiana (figure 8; table 3). The maximum water levels at eight of these stations occurred during Hurricane Audrey in 1957. The highest and lowest water levels were 13.0' on the Mermentau River at Grand Cheniere on June 27, 1957 and -2.9' at Schooner Bayou (Inland Waterway) at Control Structure, East Automatic and the Gulf Intracoastal Waterway at Vermilion Lock, East Staff. Discharge measurements are not collected within the coastal zone of the Mermentau basin; two locations where discharge measurements were collected lie on tributaries just upstream of the confluence that forms the Mermentau River. At both locations, the most severe flood of record was during the same time period as in the Sabine and Calcasieu basins. On the Bayou Des Cannes near Eunice, maximum and minimum daily discharges were 11,700 cfs on May 20, 1953 and 0 cfs for nine of the years during the period of record (figure 9). On Bayou Nezpique near Basile, maximum and minimum discharges were 35,100 cfs on May 20, 1953 and 0.1 cfs in 1944 and 1948 (figure 10). The approximate reach of tidal influence is shown in figure 11.

The Mermentau basin has one water quality station monitored by the Department of Environmental Quality in the coastal zone on the Mermentau River near Grand Cheniere (figure 12). Dissolved oxygen levels are seasonally low; eight observations since 1978 had values of 5 ppt or mg/l or less. The dissolved oxygen record does not show obvious trends over the period of record and water quality is variable from year to year. Turbidity shows large variations from 2 to 324 NTU and no obvious suspended solids also ranged considerably from 2 to 6,226 mg/l, the greatest range of any station. Although it is possible the

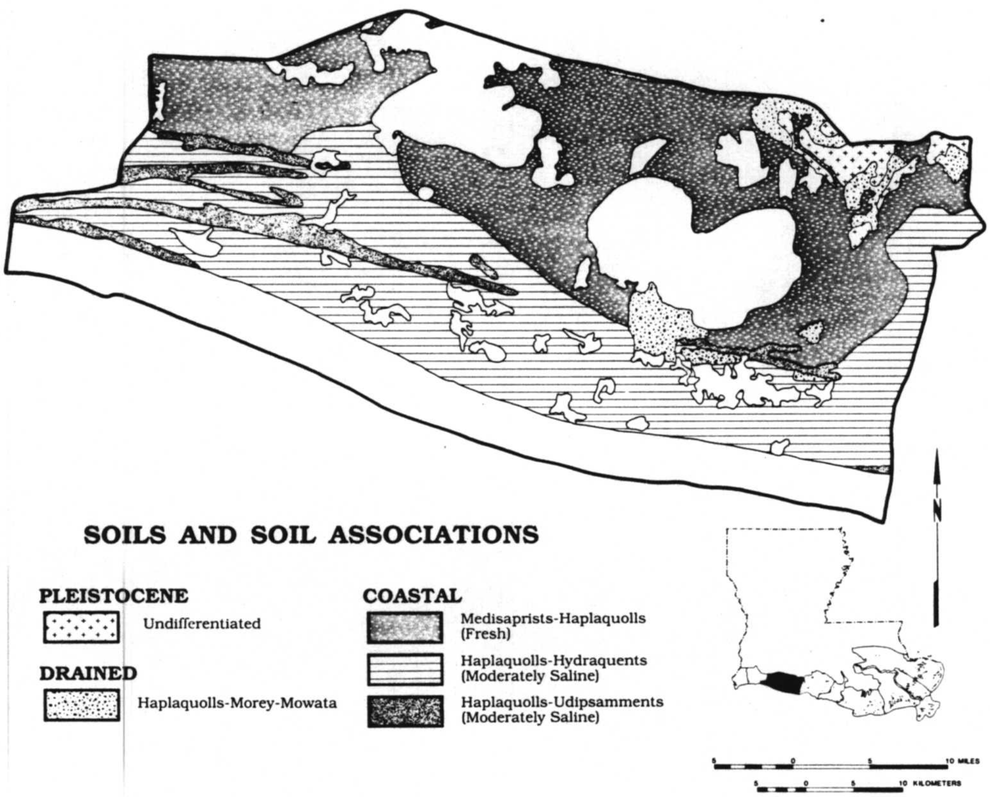


Figure 7. Major soil associations of the coastal Mermentau basin (Spicer 1981).

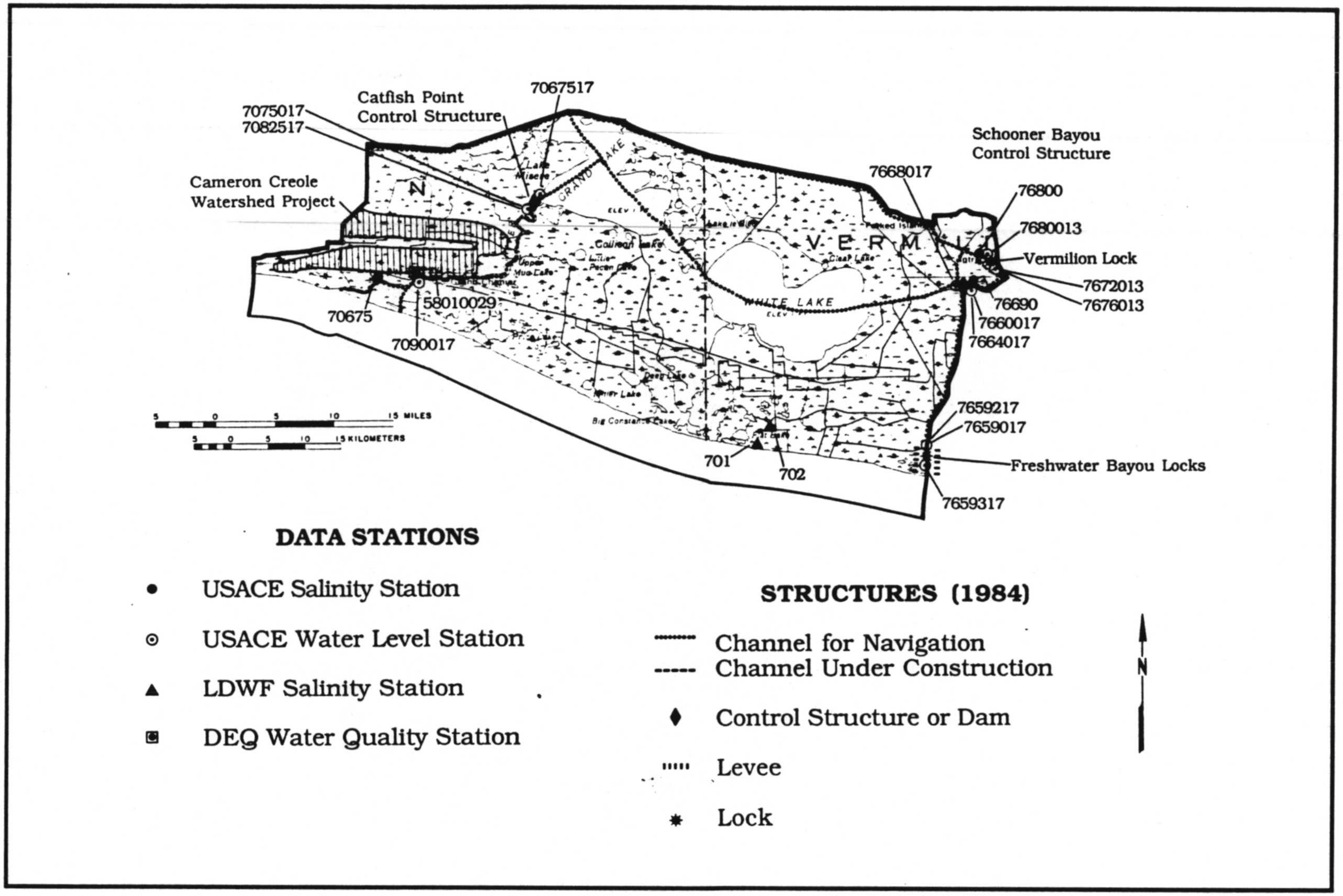


Figure 8. Data stations and major structures in the coastal Mermentau basin.

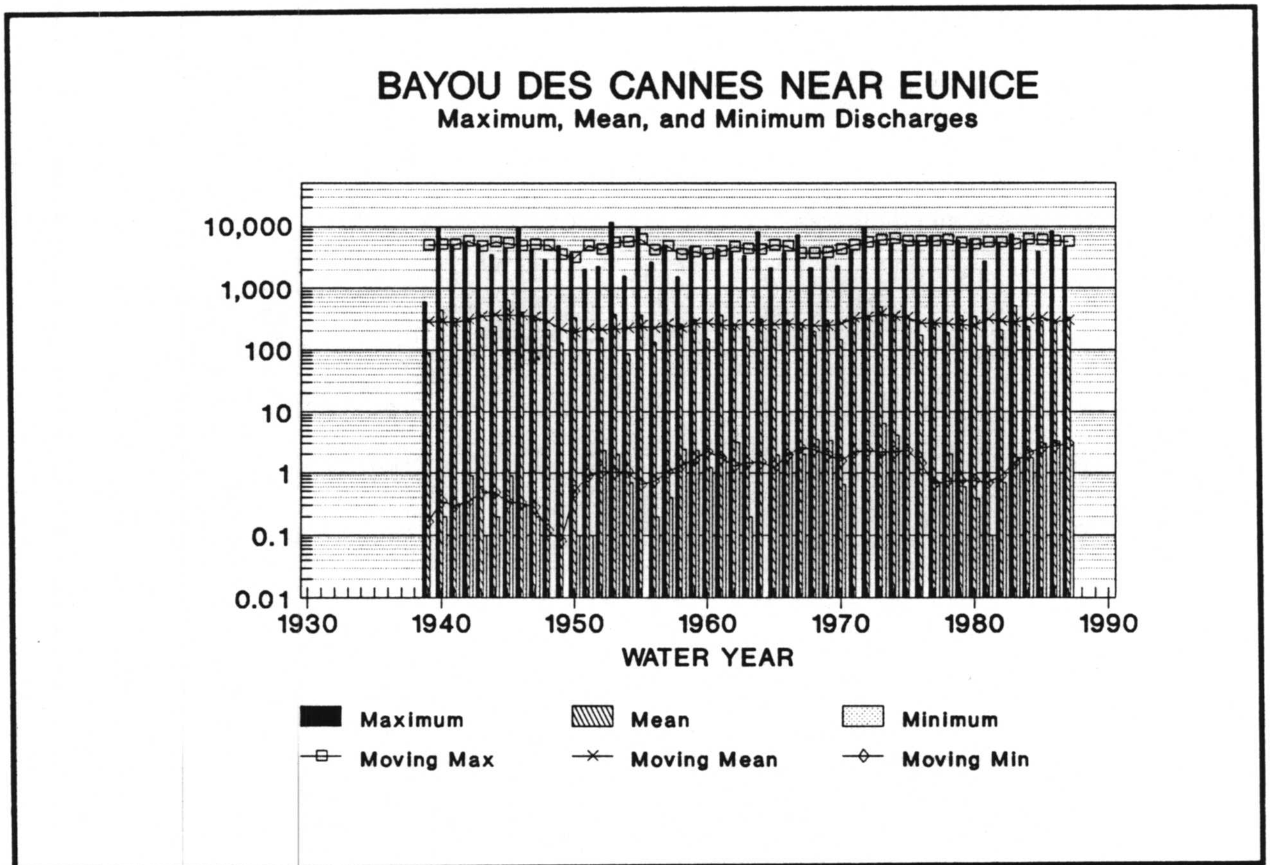


Figure 9. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Bayou des Cannes near Eunice; 1939-1987.

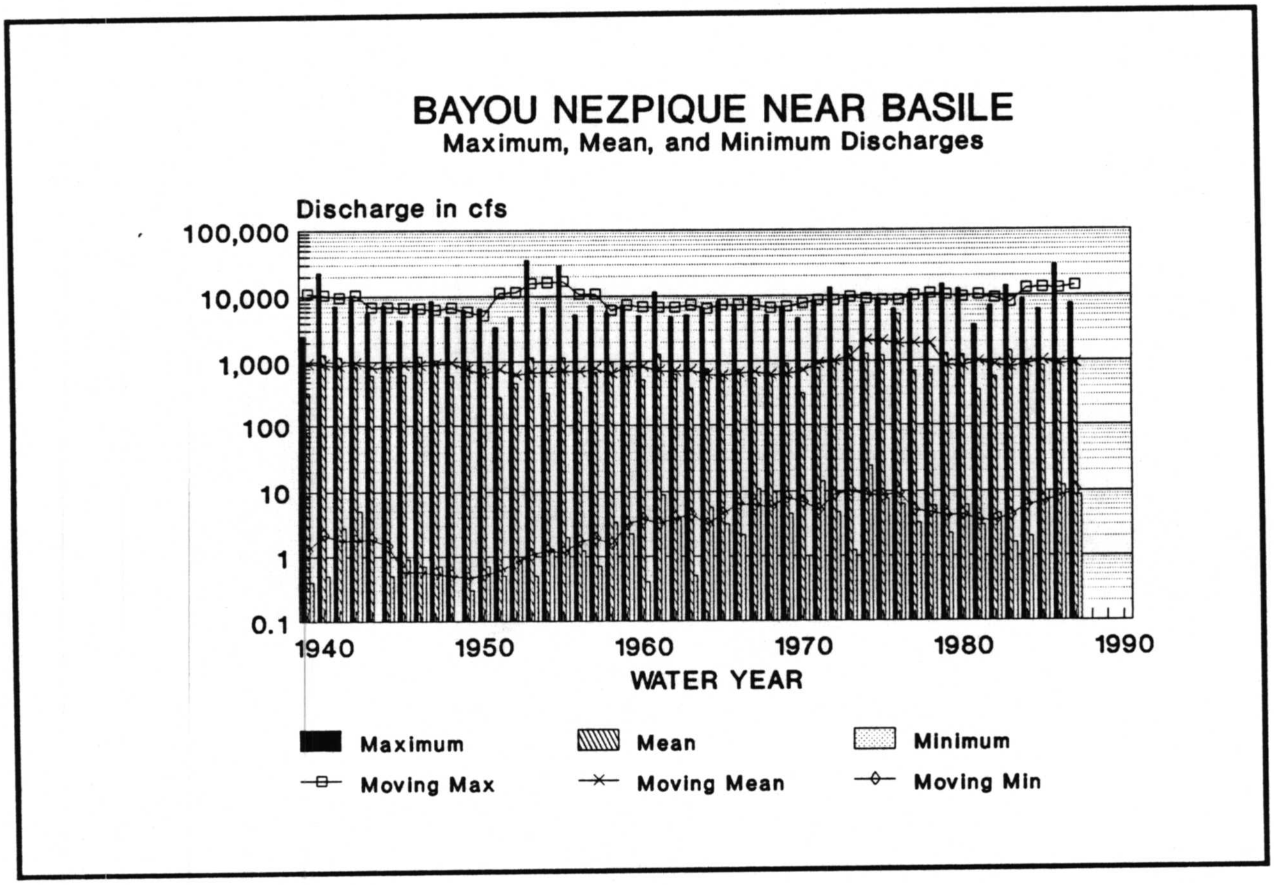


Figure 10. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Bayou Nezpique near Basile; 1939-1987.

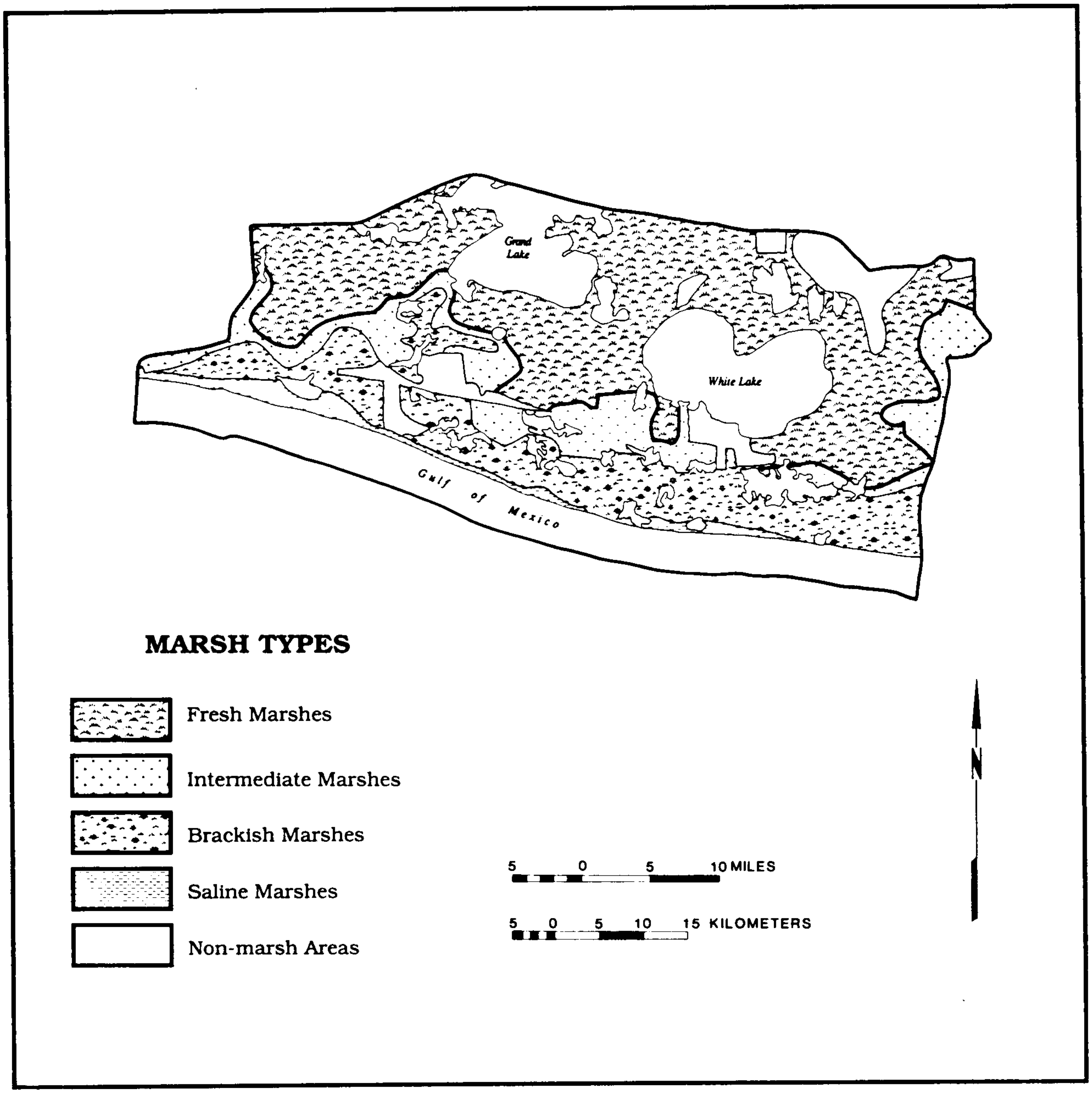


Figure 11. Marsh types in the Mermentau basin (Chabreck 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.

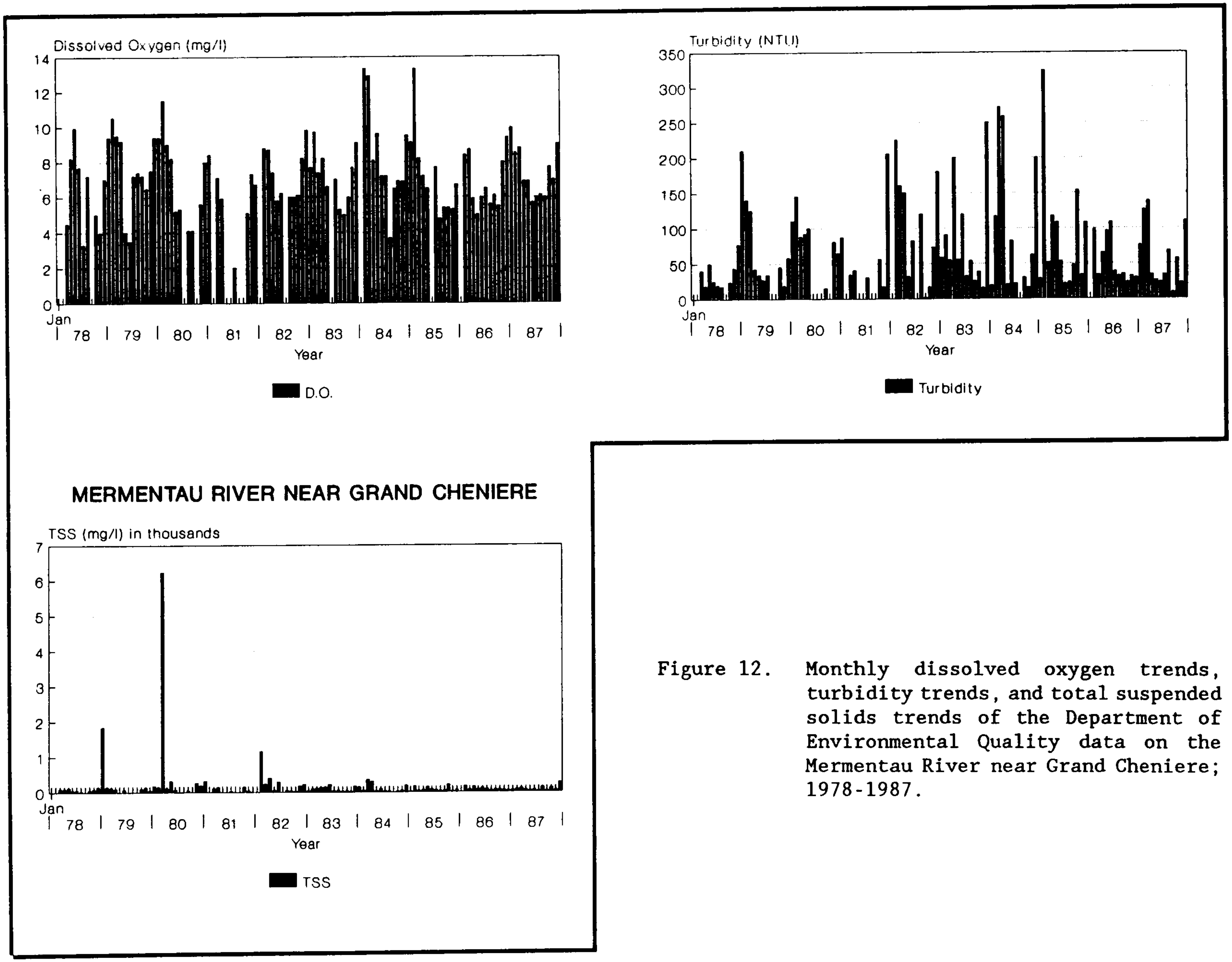


Figure 12. Monthly dissolved oxygen trends, turbidity trends, and total suspended solids trends of the Department of Environmental Quality data on the Mermentau River near Grand Cheniere; 1978-1987.

larger value could be an error, the next two highest measurements of 1,830 mg/l and 1,148 mg/l were also far higher than all of the other locations in coastal Louisiana. There were no obvious relationships between the monthly turbidity values and hydrology.

The Mermentau basin, unlike the Calcasieu, is predominantly agricultural, with few industrial or municipal point source discharges. Bayou Lacassine, Grand and White lakes, and the Mermentau River below Catfish Point all have maximum values of mercury and dieldrin which exceed the water quality criteria for aquatic life. Lake Arthur is still a viable fishery, but its condition could worsen easily due to nutrient and pollutant loading. The water levels in Grand and White lakes are controlled by the U.S. Army Corps of Engineers for a multitude of purposes, although there is sometimes a problem with conflicting demands. Mermentau River from Mermentau to Grand Lake, including Lake Arthur and tributaries, has been assigned a water quality index of 70.0, and Lacassine Bayou from the headwaters to Grand Lake, including Lake Misere, Bayou Misere, the Gulf Intracoastal Waterway, and the area west of the Mermentau River, has a water quality index of 62.6 (Louisiana Department of Transportation and Development 1984). In both areas, the major problem is turbidity. The Mermentau River below the Catfish Point control structures, including Upper and Lower Mud lakes, and tributaries were assigned a water quality index of 73.1, with the major problem being dissolved solids. All areas of the Mermentau basin are considered effluent limited, but sections of the eastern part of the basin north and east of White and Grand lakes are closed to oyster harvesting.

Salinity gradients lie approximately parallel to the Gulf, except for some intrusion upstream and flanking the Mermentau River. Salinity is measured at five locations in the Mermentau basin (figure 8; table 4). Mean values in the basin range from 13.55 ppt at Rockefeller South, 11.74 ppt at Rockefeller North, 1.35 ppt in the Mermentau River, 1.33 ppt at Schooner Bayou, and 1.32 ppt at the Gulf Intracoastal Waterway at Vermilion Lock, West.

Relative sea level rise rates have been computed for nine locations in the study area, and range from 0.19 to 0.50"/yr (0.49 to 1.28 cm/yr). The maximum rate of rise was at Freshwater Canal above Beef Ridge, where the period of record was 1963 to 1983. Stations with a longer period of record, however, generally show much lower rates of relative sea level rise. Rates at some of the long-term stations include 0.20 to 0.24"/yr (0.51 to 0.67 cm/yr) for stations on the Intracoastal Waterway at Vermilion Lock and Schooner Bayou. The lowest rate of change in relative sea level was 0.19"/yr (0.49 cm/yr) on the Mermentau River at Grand Chenier. Subsidence is computed as the difference between relative sea level and eustatic change in the Gulf of Mexico; it ranges from 0.10 to 0.41"/yr (0.26 to 1.05 cm/yr) in the Mermentau basin.

Engineering work authorized on the Mermentau River includes channel improvements below Grand Lake and between Grand and White lakes and White Lake and Vermilion Bay that increase cross-sectional area to 3,000 ft^2 below mean low Gulf to reduce flood flows, the construction of control structures in the enlarged channels near Grand Lake at Catfish Point and Schooner Bayou to prevent saltwater intrusion into the Mermentau basin, and the enlargement of Schooner Bayou Cutoff and North Prong of Schooner Bayou to provide 6'-by-60' channels for navigation. The Calcasieu and Leland Bowman Locks were completed in 1950 and 1985 to prevent saltwater intrusion into the Mermentau basin through the Gulf Intracoastal Waterway, and are operated in conjunction with the Schooner Bayou and Catfish Point Control Structures for regulation of the water levels in Grand

and White lakes. In 1924, a 5'-by-40' channel was dredged from Bayou Teche near Franklin through Hanson Canal;Bayou Portage; the Gulf Intracoastal Waterway; Schooner Bayou Cutoff; a landcut to White Lake through White, Turtle, Alligator, and Collicon lakes and connecting channels; and through Grand Lake to the Mermentau River.

Vermilion-Teche River Basin

The drainage area of the Vermilion-Teche basin is approximately 3,025 mi^2 (7,865 km^2); the much smaller area of the coastal basin is described in the habitat section of this report. The Vermilion-Teche basin is bounded by the Mermentau basin on the west, the Atchafalaya basin to the east, and the Gulf of Mexico to the south, and is formed exclusively in Quaternary sediments; the coastal basin is bounded to the north by the coastal zone boundary. The Vermilion River is formed by the confluence of Bayou Fusilier and Bayou Carencro. It connects with Bayou Teche through Bayou Fusilier and Ruth Canal. Bayou Teche begins with Bayou Courtableau at Port Barre and flows southeastward, with local drainage being away from the bayou, for about 125 mi (200 km) to enter the lower Atchafalaya Bay. The basin drains through Bayou Rapides, Bayou Cocodrie, Bayou Courtableau, and the west Atchafalaya system to the Vermilion River and lower Bayou Teche. The Vermilion and Teche rivers are strongly influenced by tides and are major sources of water for irrigation. Other natural channels and bayous include Bayou Cypremort, Weeks Bayou, Little Bayou, Isle Bayou, Toms Bayou, and Hog Bayou. Lakes include Oyster Lake on Marsh Island, Fearman Lake, Hog Lake, and Portage Lake. Large coastal water bodies include Vermilion Bay, West Cote Blanche Bay, and East Cote Blanche Bay.

The Vermilion-Teche basin includes sections of both the chenier and deltaic plains. The western part of the basin lies within the chenier plain, and the eastern part is in the deltaic plain. There are localized inliers of the late Pleistocene Prairie Terraces and loessal deposits, with the most prominent features being the Avery Island, Weeks Island, and Cote Blanche Island salt domes. Soils in the coastal Vermilion basin are developed in chenier plain deposits, delta plain deposits, alluvium, or late Pleistocene Prairie Terrace deposits. Those developed in chenier plain deposits are 1) Haplaquolls-Hydraquents, moderately saline, across much of the southwestern part of the basin; 2) Medisaprists-Haplaquolls, fresh, developed on fresh marsh and mudflats across the northwestern part of the basin; and 3) Haplaquolls-Udipsamments, moderately saline, developed on the chenier ridges (figure 13). Those developed on Pleistocene deposits include 1) Haplaquolls-Morey-Mowata, drained, developed on drained late Pleistocene deposits or on chenier plain deposits adjacent to Pleistocene terraces; 2) Judice-Morey-Midland, 0-1%, developed on late Pleistocene deposits; 3) Jeanerette-Patoutville, 0-3%, developed on broad areas of late Pleistocene loessal deposits; 4) Crowley-Patoutville, 0-3%, in the northwestern part of the basin on late Pleistocene loessal deposits; 5) Coteau-Patoutville, 0-3%, in the north-central part of the basin on late Pleistocene loessal deposits; 6) Memphis-Frost, 0-8%, developed on late Pleistocene loessal deposits of the Weeks and Avery islands salt domes; and 7) Memphis-Loring, developed on late Pleistocene sediments of the Avery Island salt dome. Soils developed in delta plain sediments include: 1) Medisaprists-Hydraquents, fresh, in the southeastern part of the basin, north of West Cote au Blanche Bay; 2)

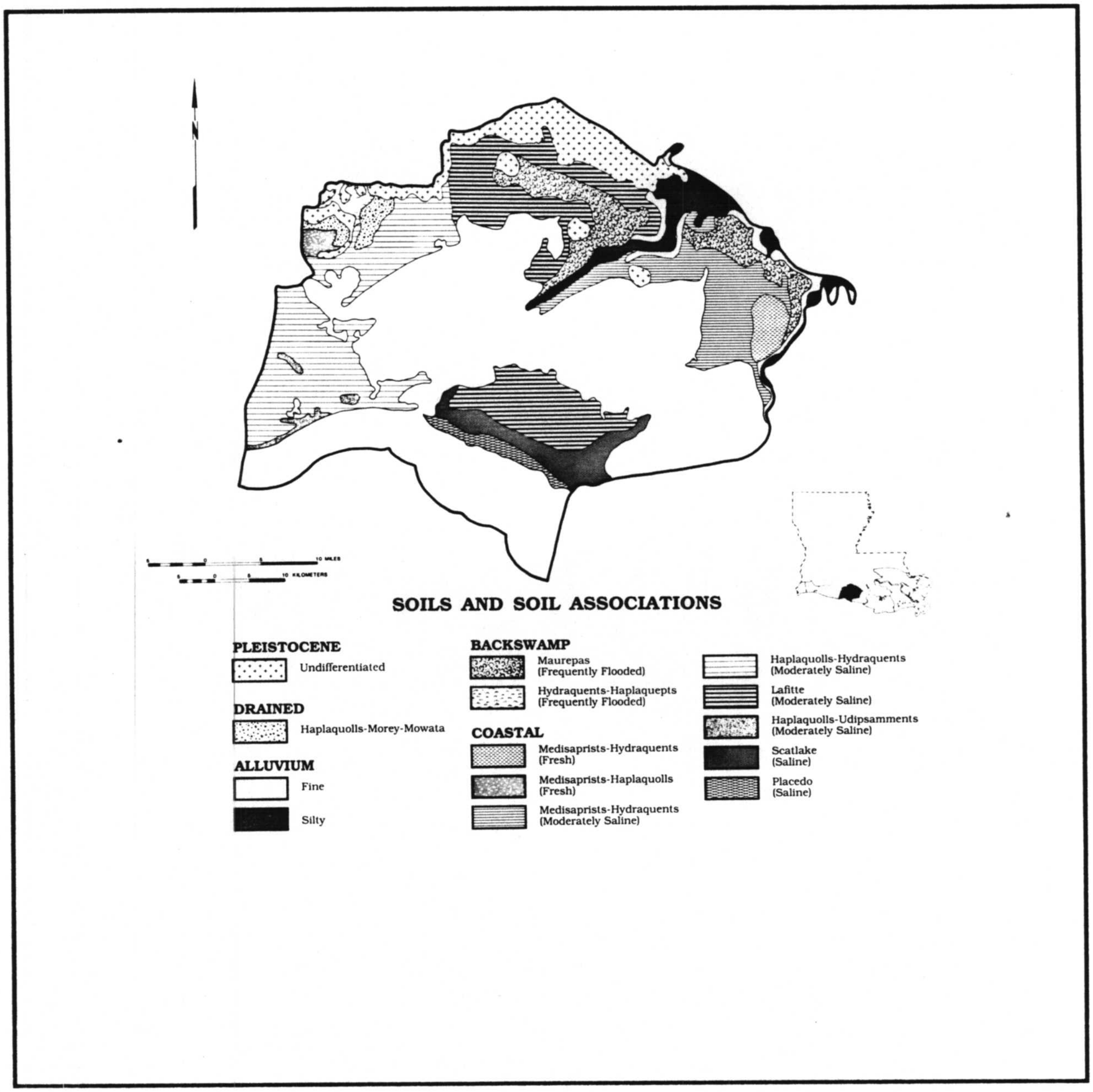


Figure 13. Major soil associations of the coastal Vermilion basin (Spicer 1981).

Medisaprists-Hydraquents, moderately saline, in the southeastern part of the basin from Bayou Cypremort to Point Chevreuil along the coast; 3) Lafitte, moderately saline, on the northern section of Marsh Island and along the northeastern edge of Vermilion Bay; 4) Scatlake, saline, along the central and southern part of Marsh Island; and 5) Placedo, saline, along the southern edge of Marsh Island. Alluvial soils include: 1) Maurepas, frequently flooded, along part of the northeastern section of Vermilion Bay; 2) Hydraquents-Haplaquepts, frequently flooded, developed in the northwestern part of the basin; 3) Baldwin-Iberia-Galvez, 0-1%, developed on silty alluvium of natural levees of Bayou Teche and Bayou Cypremort; 4) Hydraquents-Buxin-Portland, 0-1%, developed on clayey alluvium of adjacent to natural levees of Bayou Teche; 5) Iberia Baldwin, 0-1%, in the north-central part of the basin developed on fine-grained alluvium of Bayou Teche; and 6) Gallion-Galvez-Loreauville, 0-1%, in the north-central part of the basin, developed on silty alluvium of Bayou Teche.

Wetland hydrology is influenced by water control structures, roads, spoil banks and canals, and chenier and distributary ridges. Major roads include Louisiana highways 318 and 319 to Cypremort Point, highway 317 to Salt Point near Point Chevreuil, highway 329 to Avery Island, highway 83 to Weeks Island, and highways 85, 90, and 182, which follow the west bank of Bayou Teche. There are many canals in the basin, including the Charenton Drainage and Navigation Canal, Freshwater Bayou Channel, Last-Point Canal, McIlhenny Canal, Cutoff Canal, Belle Isle Canal, Magee Canal, Boston Canal, New Iberia Drainage Canal, Avery Canal, Wilkins Canal, Iberia-St. Mary Canal, Pipeline Canal, Franklin Canal, Thorgenson Canal, and several others.

The basin is predominantly rural, with no major population centers in the coastal area. Much of the human activities are related to 1) the oil and gas industry, particularly near salt domes; 2) agricultural grazing and rice farming, particularly near the Pleistocene terraces; 3) navigation; 4) wildlife management, particularly on the Russell Sage and Marsh Island Wildlife Refuge and Game Preserve, and the Paul J. Rainey and Louisiana State Wildlife Refuge and Game Preserve, which have been designated as special management areas. Urban and industrial canal and spoil bank areas have increased markedly due to oil and gas development. Developed areas close to the coastal basin include Abbeville and New Iberia. Most of the urban development in the coastal basin follows Bayou Teche, and occurs on or near Pleistocene surfaces, or on chenier ridges. Dredging of shell reefs and islands in the Vermilion basin seaward from Marsh Island has reduced bottom stabilization, increased wave energy, and reduced fishing grounds. The Coastal Management Division of the Department of Natural Resources has designated restricted areas and limits to two the number of dredges operating concurrently in the Vermilion-Atchafalaya coastal areas. The Vermilion basin has four water-level stations in coastal Louisiana (figure 14; table 3). The highest water-level recorded in the basin was 8.91' in 1971, offshore at East Cote Blanche Bay at Luke's Landing. Maximum water levels at two of the four stations for the period of record occurred during Hurricane Audrey in 1957: 7.00' on Delcambre Bayou at Delcambre and 5.36' on the Charenton Drainage Canal at Baldwin. The lowest water levels recorded were -3.66' at the same station in 1957 and -3.8' in 1970 on the Freshwater Canal at Freshwater Bayou Lock South. Discharge measurements are not collected within the coastal zone of the Vermilion-Teche basin; however, there are several discharge stations farther upstream in the basin. One is on the Vermilion River at Surrey Street at Lafayette, where the maximum daily discharge recorded was 4,960 cfs on May 22,

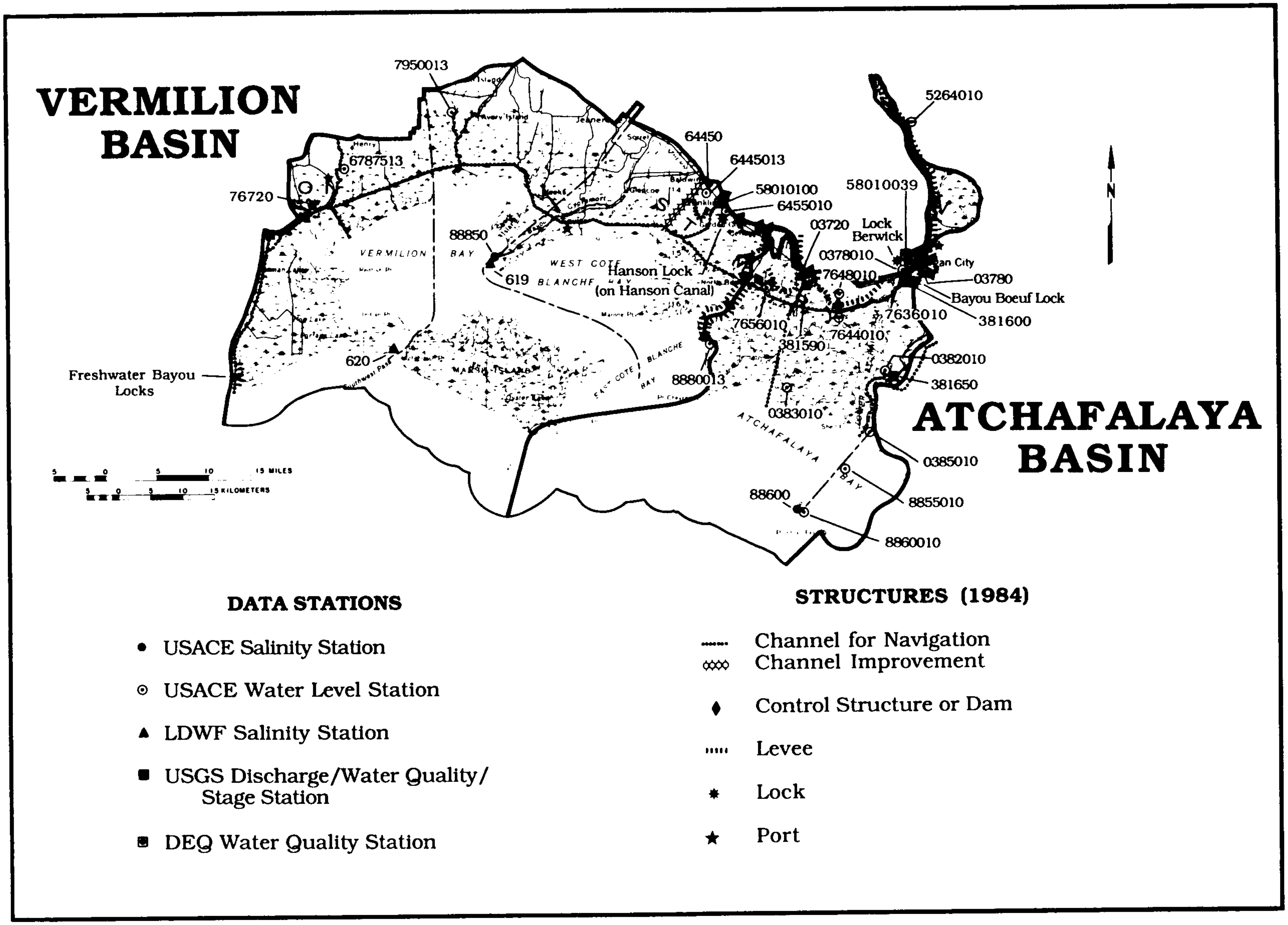


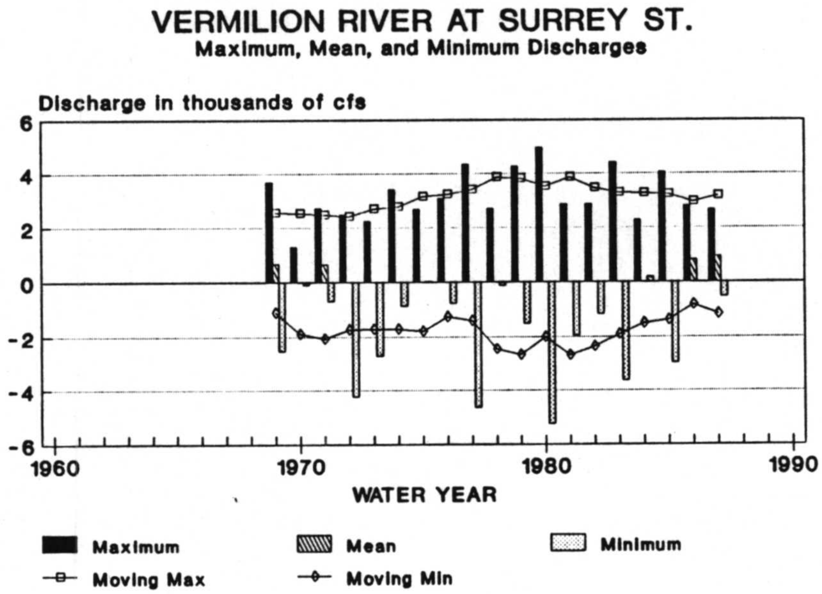
Figure 14. Data stations and major structures in the coastal Vermilion and Atchafalaya basins (Department of Transportation and Development 1984).

1980. Mean discharges were not available for most years and could not be computed. Minimum daily discharge recorded was -5,230 on May 17, 1980, and minimum values were negative for most years (figure 15). Gage heights at this station ranged from 15.02' on May 17, 1980 to 0.79' on November 20, 1969. Ruth Canal at Ruth, which connects the Vermilion River near Lafayette with the Bayou Teche near Ruth, had a maximum daily discharge of 802 cfs on April 21, 1966, and a maximum reverse flow (or minimum measurement) of -13 cfs on May 28, 1989, as backwater from the Vermilion River (figure 15). Mean flow has ranged from 43.5 cfs to 344 cfs, with no estimated long-term mean. On Bayou Teche, there are two discharge measurement stations, one at Arnaudville north of Lafayette and the other at Keystone Lock (figure 16) near St. Martinville and New Iberia. Bayou Teche has a maximum daily discharge of 4,630 cfs on May 24, 1953, with a maximum stage of 24.27' on May 23, 1953. Minimum discharge was 53 cfs on August 12, 1965. At Keystone Lock, maximum daily discharge was 3310 cfs on September 5, 1973, with a maximum gage height of 16.15' on October 23, 1984. The minimum daily discharge was no flow, recorded on several occasions. Decreases in discharge downstream are the result of water use for irrigation and diversion into the Vermilion River through Ruth Canal. The approximate reach of tidal influence is shown in figure 17.

The coastal Vermilion-Teche basin has one water quality station monitored by the Department of Environmental Quality on Bayou Teche at Franklin (figure 18). Dissolved oxygen here has been extremely low on several occasions; 56 observations since 1966 had values of 5 ppt or less, and 18 of these were 3 ppt or less. Most occurrences of dissolved oxygen below 5 ppt were in 1973, 1974, and 1975. Turbidity shows values from 4 to 330 NTU, with no obvious relationship to discharge; the highest values occurred between 1966 and 1969. Total suspended solids ranged from 2 to 398 ppt or mg/l with no obvious relationships to flow.

The Vermilion River shows low dissolved oxygen concentrations, high BOD concentrations, and high fecal coliform concentrations (Louisiana Department of Transportation and Development 1984). Saltwater intrusion occurs upstream from near Abbeville north to Milton. Water quality problems are attributable to urban and agricultural non-point source discharges, and municipal and industrial source discharges. Fish samples from the Vermilion River also contain chlordane, probably as a result of pesticide use on agricultural land. The Lower Vermilion River below Lafayette is severely polluted, with a Water quality index of 86.3. Bayou Teche also has severe pollution in certain reaches, with a rating of 75.5, from Keystone Lock and Dam to the Charenton Drainage Canal (Louisiana Department of Transportation and Development 1984). Other reaches are much less polluted, including the section from Charenton Drainage Canal to the Wax Lake Outlet, with a water quality index of 45.6. Bayou Teche occasionally experiences low dissolved oxygen concentrations and high fecal coliform counts, the result of conditions similar to those in the Vermilion River, and of waterway traffic. These problems are aggravated by low flow, and are especially critical in the reach to Charenton Canal. Recently, some of the Atchafalaya river waters have been diverted to Bayou Courtableau at the head of Bayou Teche to alleviate the pollution levels.

Salinity gradients in the Vermilion-Teche basin run approximately parallel to the Gulf of Mexico. North of the central part of Vermilion Bay, saline marshes lie immediately adjacent to Pleistocene surfaces. The bay has experienced a freshening influence and sediment input from the Atchafalaya, which is partly enclosed in the bay by oyster reefs. Salinities are recorded



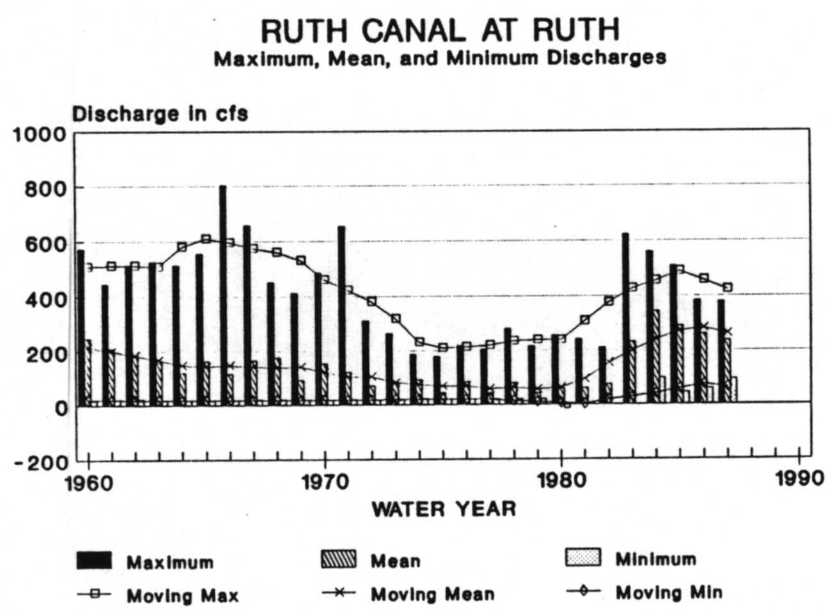


Figure 15. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima and minima for the Vermilion River at Lafayette at Surrey Street, 1969-1987; and for Ruth Canal at Ruth, 1960-1987.

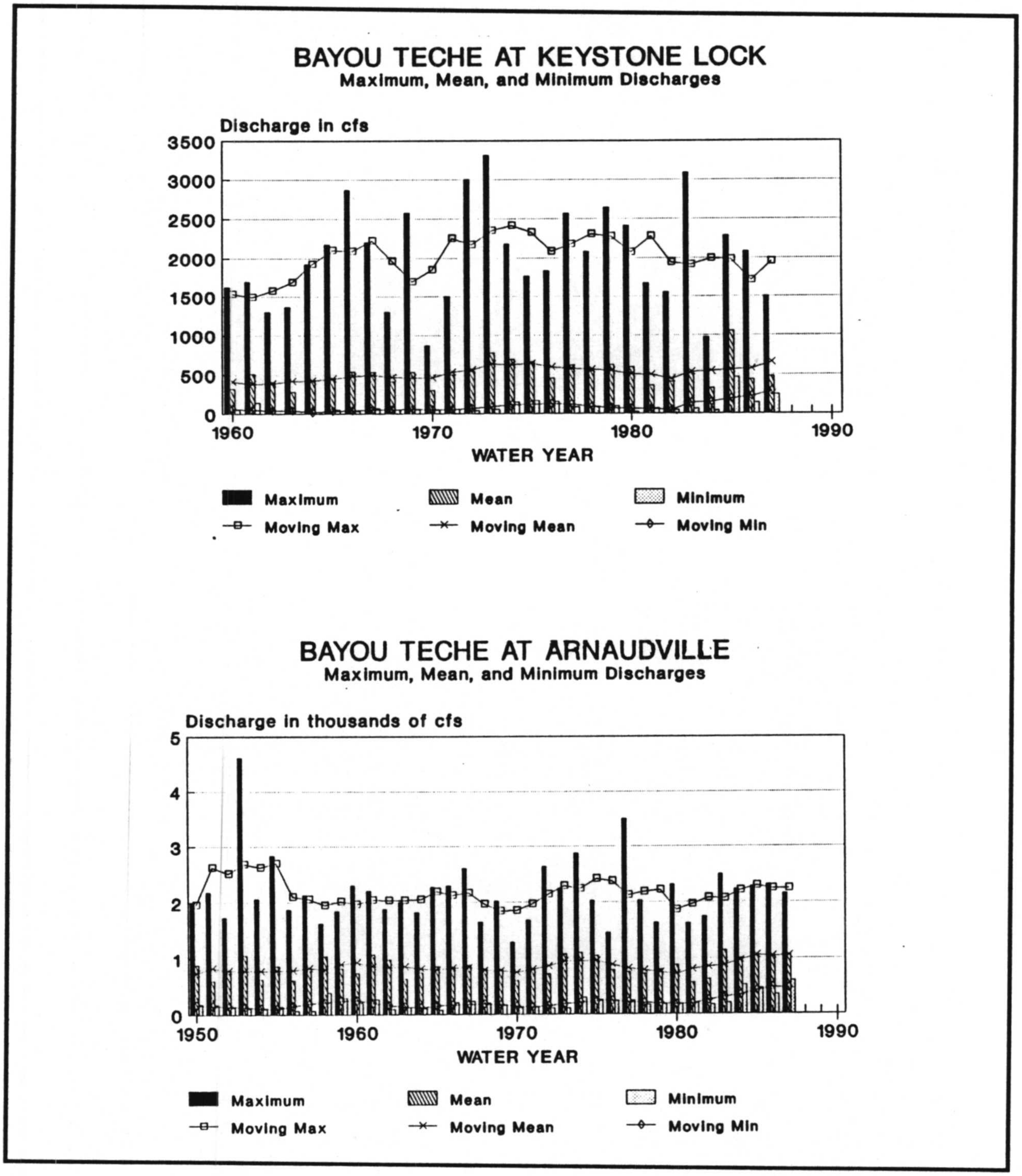


Figure 16. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Bayou Teche at Arnaudville, 1950-1987, and for Bayou Teche at Keystone Lock, 1960-1987.

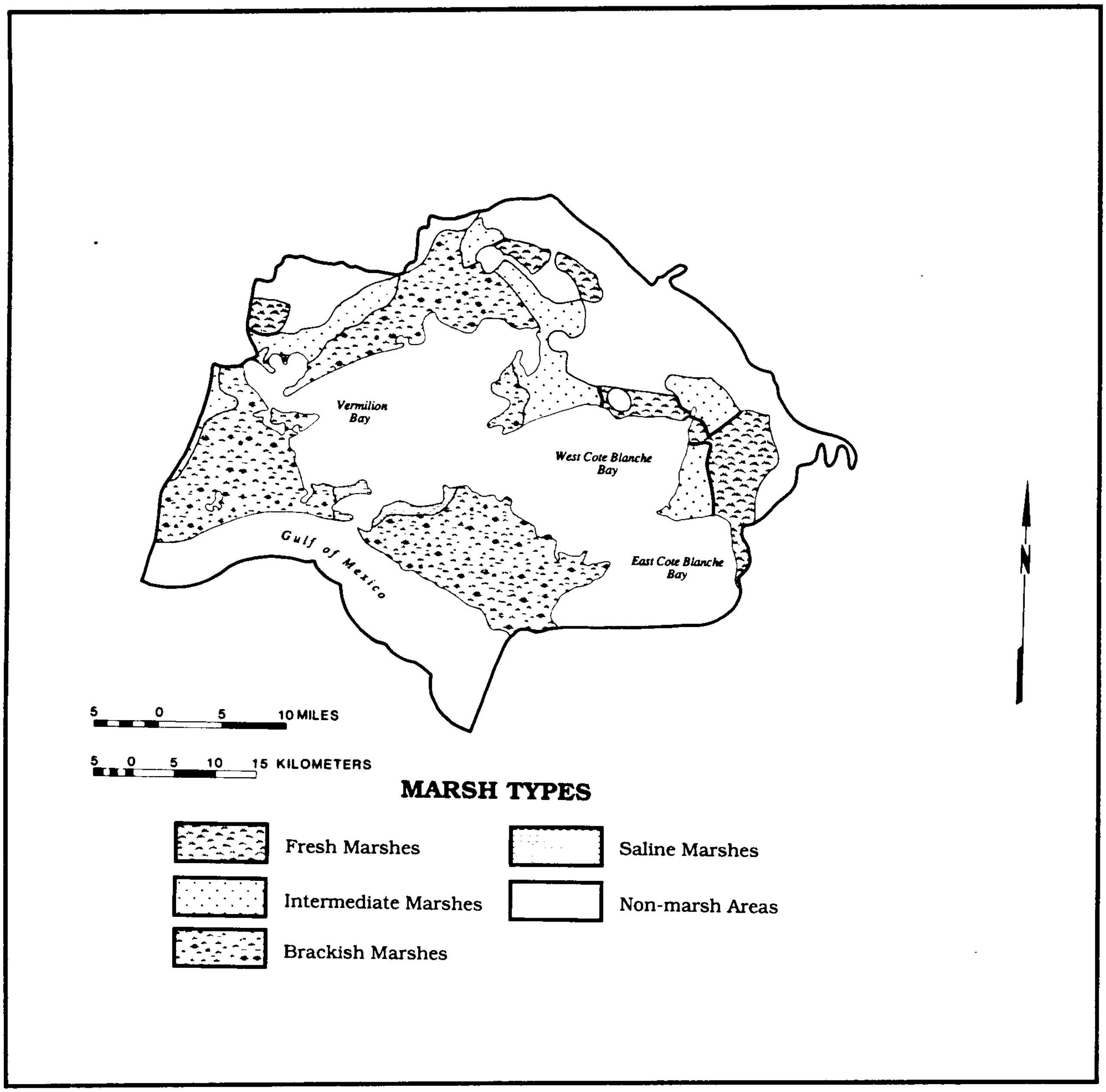
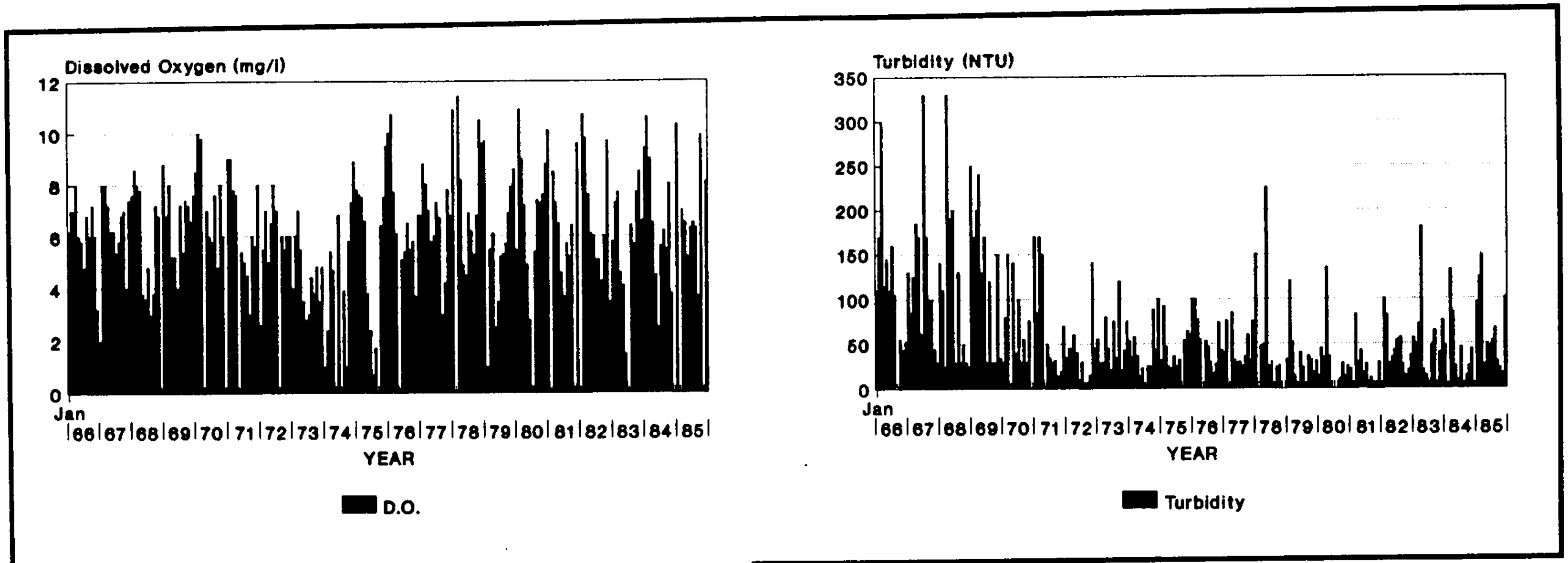


Figure 17. Marsh types in the Vermilion basin (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.



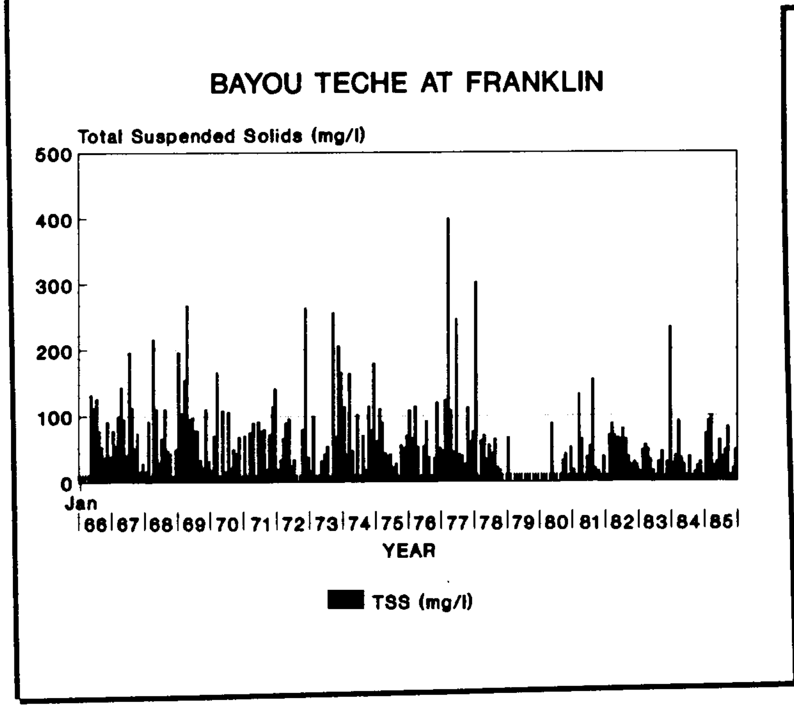


Figure 18. Monthly dissolved oxygen trends, turbidity trends, and total suspended solids trends of the Department of Environmental Quality data on the Bayou Teche at Franklin, 1966-1985.

at five locations in the basin, which are influenced predominantly by fresh water. Mean values range from a maximum of 6.07 ppt at Southwest Pass to 0.24 ppt at the Charenton Drainage Canal at Baldwin.

Relative sea level changes were assessed at two locations in the coastal Vermilion basin. Maximum rates were 0.67"/yr (1.70 cm/yr) at East Cote Blanche Bay at Luke's Landing, and minimum rates were -0.02"/yr (-0.06 cm/yr) at Charenton Drainage Canal at Baldwin. Land surface changes, or the difference between relative sea level and eustatic sea level rise for the Gulf of Mexico, ranges from -0.11 to 0.58"/yr (-0.29 to 1.47 cm/yr) for data stations in the coastal Vermilion basin.

Projects in the Vermilion basin include the Freshwater Bayou Channel and Lock, opened to navigation in 1968, and the Leland Bowman Lock, opened in 1985. The Freshwater Bayou Channel consists of a 12'-by-25' waterway between the Gulf Intracoastal Waterway in the vicinity of Vermilion and the Gulf of Mexico. The lock is located in the vicinity of Beef Ridge near the Gulf of Mexico and was designed to prevent saltwater intrusion; its dimensions are 84' by 600' by 16'.

The Leland Bowman Lock is a replacement of the Vermilion Lock. The Vermilion Lock was 1,182' long and 56' wide, with a depth over the sill of 11.3' below mean low Gulf datum. The Leland Bowman Lock lies just south of the Gulf Intracoastal Waterway and west of the existing lock. It is 110' wide, 1200' long, and has a depth over sill of 15' below mean low Gulf datum.

Atchafalaya River Basin

The Atchafalaya River in south-central Louisiana is the second largest river draining into the Gulf of Mexico. It is the largest distributary of the Mississippi River and is developed exclusively in Quaternary sediments. The coastal Atchafalaya River basin is bounded by the Vermilion-Teche basin on the west, the Terrebonne basin on the east, the coastal zone boundary to the north, and the Gulf of Mexico to the south. The drainage area of the Atchafalaya River is approximately 87,850 mi^2 (227,720 km^2) at Simmesport, not including non-contributing area or the Mississippi River area. It increases downstream indeterminately because of the low relief of the basin and the presence of the numerous channels which drain the low-lying swamps and marshes. The Atchafalaya Bay is a large coastal water body at the lower end of the Atchafalaya basin. Major lakes within the coastal basin include Wax Lake and Sweetbay Lake, both part of the Atchafalaya River system and therefore subject to riverine currents. The two larger channels, the Lower Atchafalaya River and the Wax Lake Outlet, carry substantial discharges and sediment loads. The lower Atchafalaya delta, which is located at the distal end of the river, entered a subaqueous phase in about 1952 (Shlemon 1972) and developed into a subaerial delta in 1972 (Cratsley 1975; Rouse et al. 1978); the Wax Lake Delta became more prominent afterwards. There are several interconnected bayous and larger channels including Big and Little Hog bayous, Hog Bayou, Big and Little Wax bayous, Bayou Blue, and Bayou Sale.

The coastal Atchafalaya basin lies in the western portion of the Mississippi River delta plain and contains broad areas of natural levee and other alluvial deposits. Belle Isle, a salt dome mapped as Prairie terraces, is the only Pleistocene outcrop in the coastal basin, but is not delineated on the soil associations map. Predominant soils in the coastal Atchafalaya basin (figure

19) include, in order of dominance: 1) Medisaprists-Hydraquents, fresh, on deltaic deposits across the southern part of the basin; 2) Hydraquents, frequently flooded, on alluvial deposits flanking both sides of the Wax Lake Outlet; 3) Maurepas, frequently flooded, on alluvial deposits between Bayou Cypremort and the Wax Lake Outlet; and 4) Baldwin-Iberia-Galvez, developed on early to mid-Holocene silty natural levee deposits of Bayou Teche and Bayou Cypremort. Other soils of lesser areal extent in the basin include the following alluvial soils in the vicinity of Morgan City and northward: 1) Barbary-Fausse, frequently flooded, developed on silty sediments; 2) Fausse-Convent, frequently flooded, developed in fine-grained alluvial deposits; and 3) Fausse, frequently flooded, developed in fine-grained sediments.

The Atchafalaya and lower Mississippi rivers have experienced several natural and human-induced changes in hydrologic regime in the past 500 years. The Atchafalaya River formed in the sixteenth cenephelometric turbidity unitsry when a westerward migrating meander of the Mississippi River intercepted the course of the Red River and captured its drainage. For years it remained an insignificant distributary of the Mississippi River because it was choked on its upstream end by a log jam on the outer end of Turnbull's bend, where the Red River flowed into the Mississippi. Lower Old River was formed in 1831, when Henry Shreve ordered that the channel at Turnbull's bend be dug to shorten the course of the Mississippi. In 1839, the State of Louisiana began to burn, blast, and dredge the log jam on the Atchafalaya. Flow through the connecting link changed from a situation where reversals occurred depending on whether flow was higher in the Mississippi or the Red River to a situation where the Atchafalaya continued to enlarge by receiving progressively greater amounts of flow from the Mississippi River. This enlargement could eventually result in diversion or capture of most of the Mississippi River by the Atchafalaya River.

Flow in the Atchafalaya River consists of that in the Red River and controlled diversion of about 25 to 30% of the total flow of the Mississippi River through the Old River outflow channel and the overbank control structure (mile 0 on the Atchafalaya; mile 313 on the Mississippi above Head of Passes), and through the Morganza Floodway (mile 278 above Head of Passes), used during overbank discharge. Part of the flow is diverted at the Wax Lake Outlet (mile 106). The Lower Atchafalaya River enters the Atchafalaya Bay at mile 135, while the Wax Lake Outlet enters the bay at mile 122. The distance to the Gulf of Mexico is approximately one-third that of the Mississippi River route. Diversion would occur because of this gradient advantage if flow were not controlled into the Atchafalaya River.

Wetland hydrology in the coastal Atchafalaya basin is influenced by the presence of levees, canals and associated spoil banks, and roads. There are several large-scale flood control and navigation projects in the coastal basin and farther upstream, described later in this section. The Gulf Intracoastal Waterway is the one of the larger canals in the basin, and most others are unnamed. U.S. Highway 90 crosses through the basin into Morgan City.

The increasing influence of the Atchafalaya River has caused numerous transformations in the basin with increases in freshwater habitats and land accretion. Oil and gas activities have greatly increased the area of spoil banks and canals, but accretion is still predominant. The disappearance of shell reefs and islands from the western end of Point au Fer Island to Marsh Island have caused increased bottom erosion, increased wave energy, and reduced the area of fishing grounds. The dredging of oyster shell deposits is a major

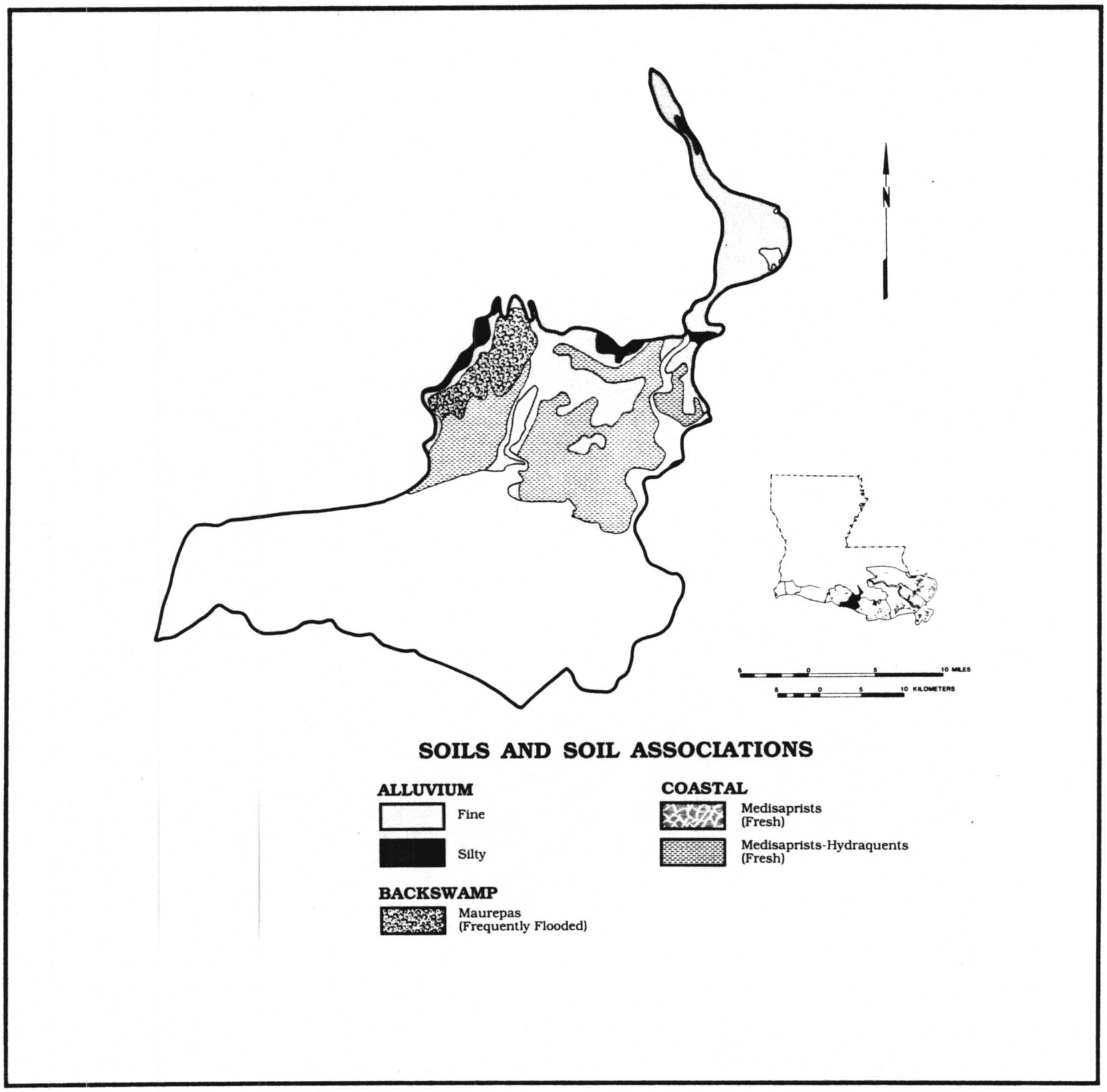


Figure 19. Major soil associations of the Atchafalaya basin (Spicer 1981).

economic activity in this area, and has been implicated in the loss of much of the shell reefs. The Coastal Management Division has established restricted areas and limits to two the number of dredges operating concurrently. Most of the development in the coastal basin occurs along the natural levee ridge of Bayou Teche. Morgan City is the major urban area in the vicinity of the coastal basin. There also has been some dredging for navigation and a number of activities related to oil and gas development and extraction. The Atchafalaya Delta Wildlife Management Area also lies within the coastal basin.

There are 10 water-level stations in or very near the coastal Atchafalaya basin (figure 20). The maximum water levels across the basin occurred in 1957 at five locations due to Hurricane Audrey, and in 1973 at three locations due to diversion from the Mississippi basin through Old River during a flood. The highest and lowest water levels in the basin occurred on the Lower Atchafalaya River at Morgan City, with a maximum water-level of 10.53' on May 28, 1973, and a minimum of -5.44' on August 25, 1926. The highest water level during Hurricane Audrey was 8.52' on June 27, 1957 on the Gulf Intracoastal Waterway at Wax Lake East Control Structure. Partial and discontinuous records of discharge are available for Morgan City. Stage and discharge records are also available for the Wax Lake Outlet at Calumet, but for a much shorter period of record than for the U.S. Army Corps of Engineers stations. Continuous discharge measurements in the basin were collected for the longest period upstream of the basin on the Atchafalaya River at Simmesport. The Corps of Engineers estimates that approximately 30% of the flow at Simmesport is diverted through the Wax Lake Outlet. Long-term discharge measurements also are available for one of the smaller channels upstream of the basin on Bayou Courtableau at Washington.

Maximum, mean, and minimum discharges at Simmesport are 781,000 cfs (22,120 m^3s^{-1}) (May 12, 1973), 253,700 cfs (7,610 m^3s^{-1}) (1900-1982), and 10,500 cfs (300 m^3s^{-1}) (1964), respectively (U.S. Army Corps of Engineers 1985). The maximum discharge recorded at Morgan City was 741,000 cfs (21,000 m^3s^{-1}), during the flood of June 8, 1927. Mean discharge at Morgan City is about 211,000 cfs (5,970 m^3s^{-1}), and the minimum recorded discharge is 10,500 cfs (300 m^3s^{-1}). Maximum, mean, and minimum discharges in the Atchafalaya River have shown appreciable variations during the 20th century (figure 21). Before the Old River Control Project was completed in 1963, maximum discharges rarely exceeded 600,000 cfs. Since their, maximum discharges have exceeded 600,000 cfs on three occasions. Mean and minimum discharges show a similar relationship, having exceeded threshold values more frequently after completion of the Old River Control project (figures 21, 22). The approximate reach of tidal influence is shown in figure 23.

Water quality is monitored at two locations in the coastal basin, the Lower Atchafalaya basin at Morgan City, which is measured by both the Department of Environmental Quality and U.S. Geological Survey (figures 24 and 25), and the Wax Lake Outlet at Calumet, which is measured only by the U.S. Geological Survey (figure 26). At the Lower Atchafalaya basin at Morgan City, the Department of Environmental Quality has recorded three dissolved oxygen measurements below 5 ppt since 1978. Turbidity ranged from 12 to 270 NTU, and total suspended solids from 2.4 to 364 ppt. The Lower Atchafalaya basin at Morgan City, as measured by the U.S. Geological Survey, has no dissolved oxygen measurements below 5 ppt since 1972. Turbidity ranged from 4.4 to 380 NTU, total suspended solids from 2 to 740 ppt, and suspended sediment from 54 to 981 ppt. Similarly, the U.S. Geological Survey station on the Wax Lake Outlet at Calumet has had no dissolved

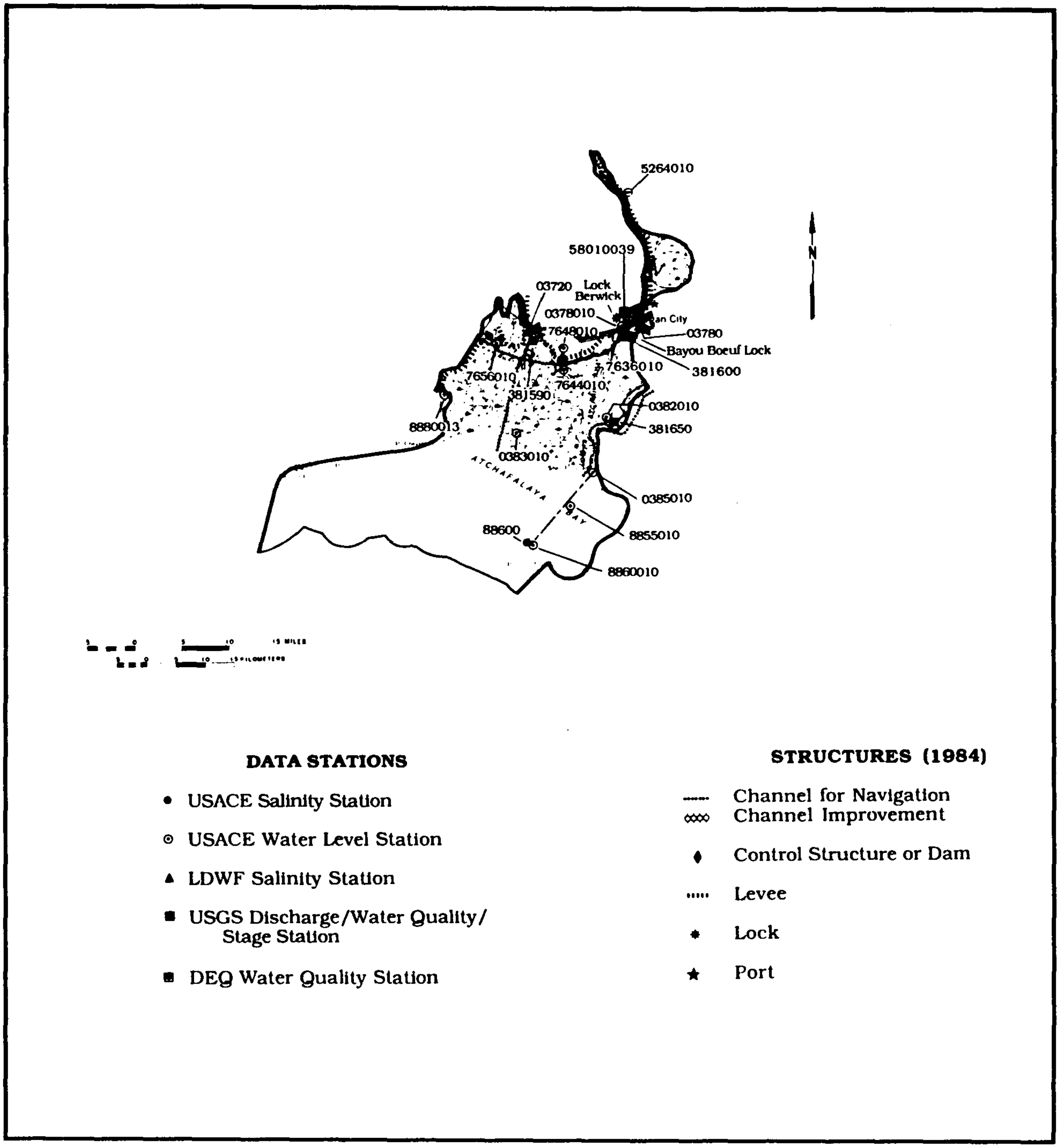


Figure 20. Data stations and major structures in the Atchafalaya basin (Department of Transportation and Development 1984).

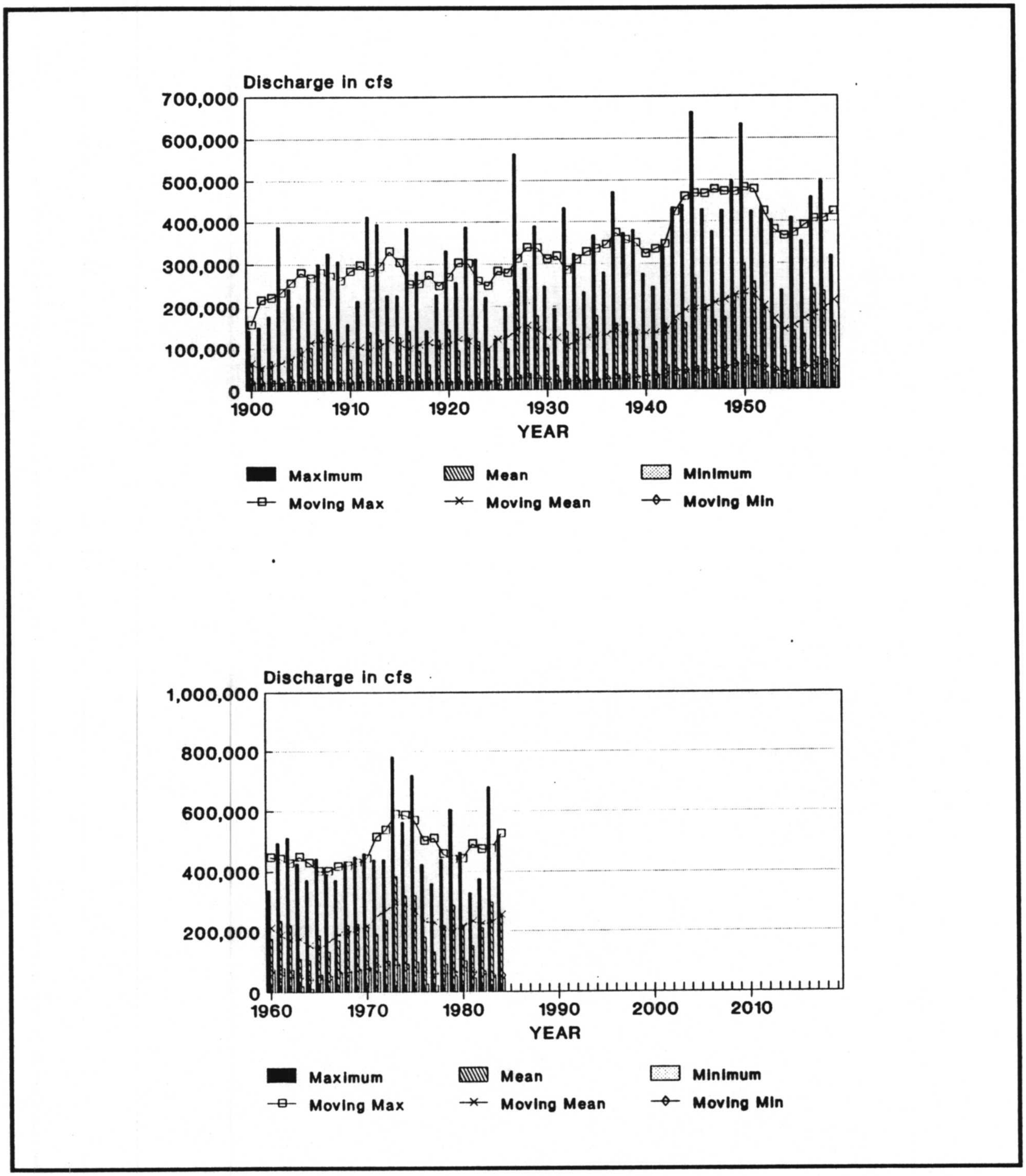


Figure 21. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Atchafalaya River at Simmesport, 1900-1959, and 1960-1985.

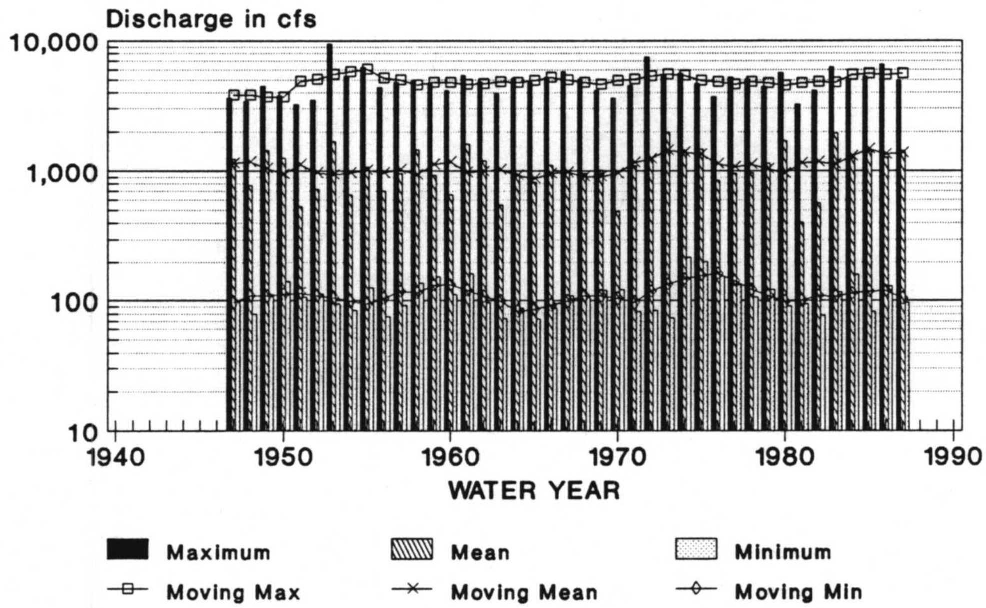


Figure 22. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Bayou Courtableau at Washington, 1947-1987.

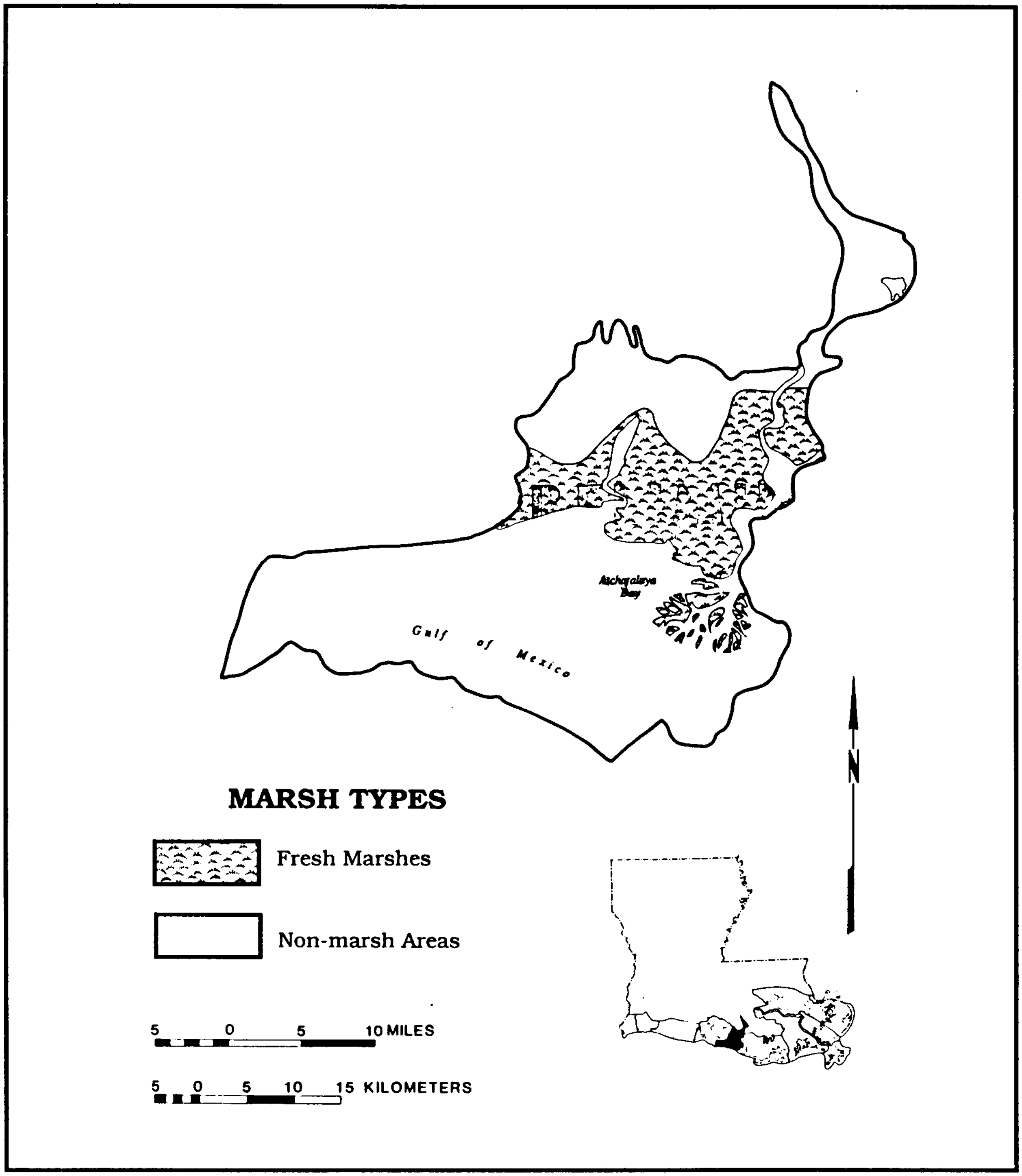


Figure 23. Marsh types in the Atchafalaya basin (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.

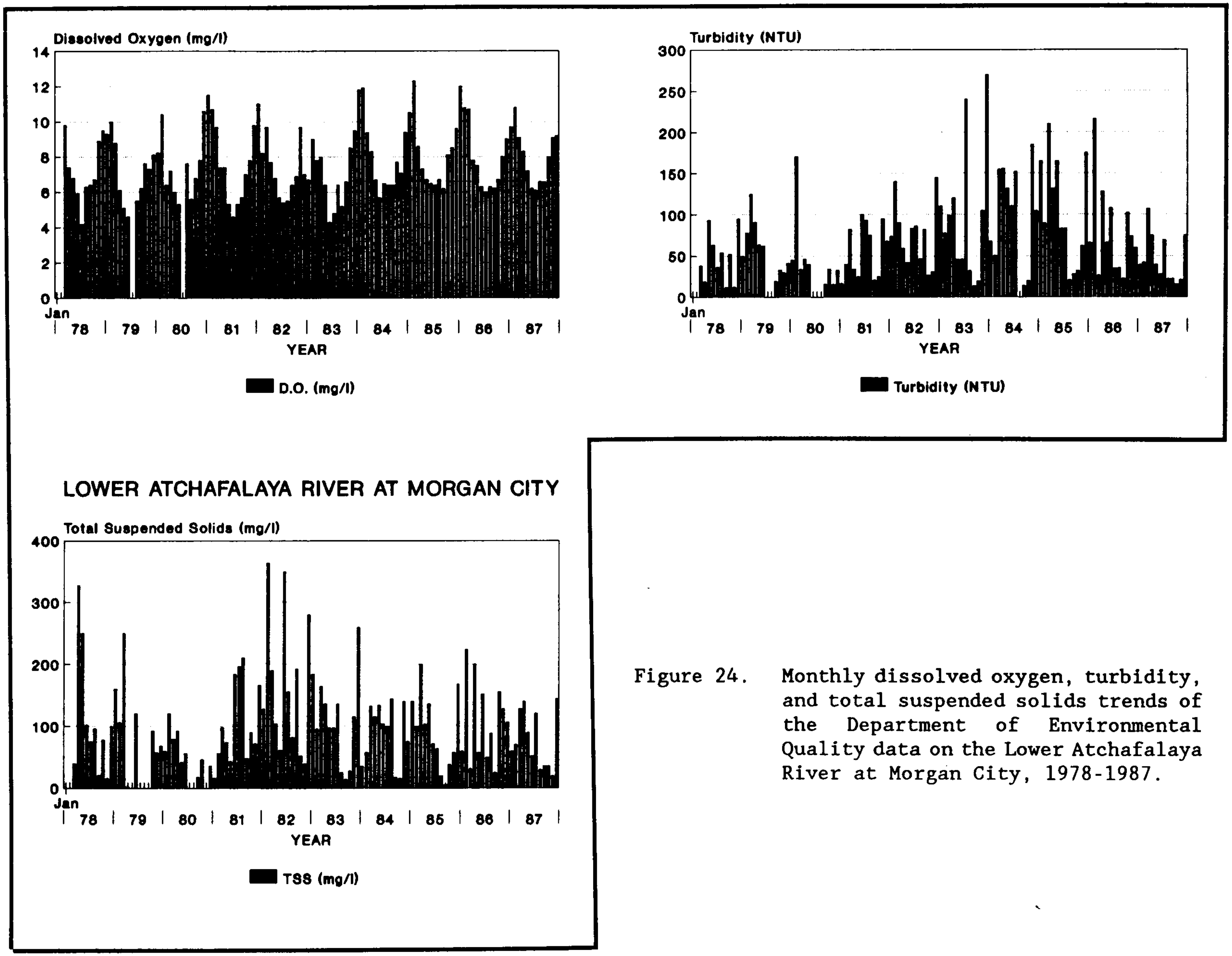


Figure 24. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Lower Atchafalaya River at Morgan City, 1978-1987.

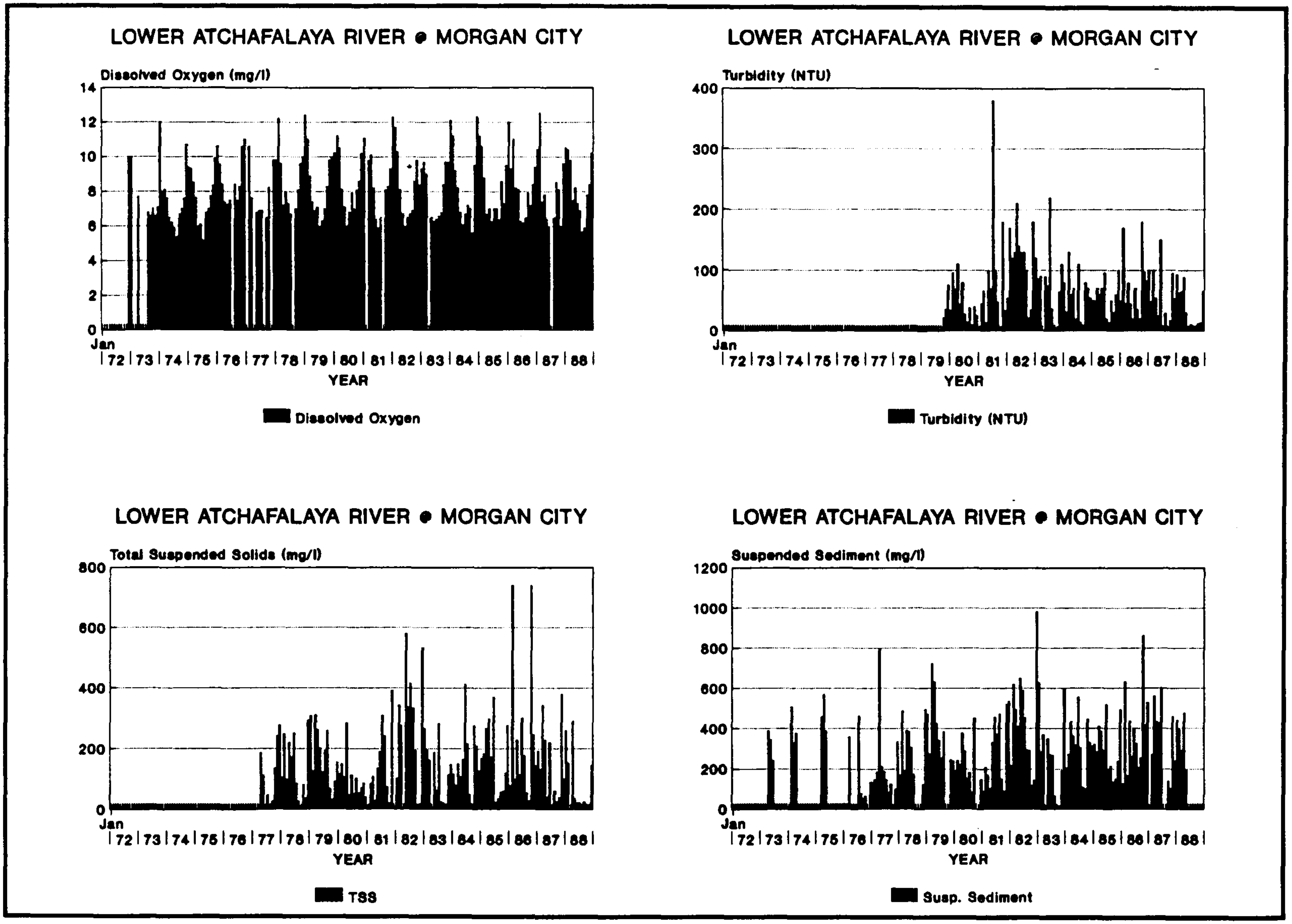


Figure 25. Monthly dissolved oxygen, turbidity, and total suspended solids, and suspended sediment trends of U.S. Geological Survey data on the Lower Atchafalaya River at Morgan City, 1972-1988.

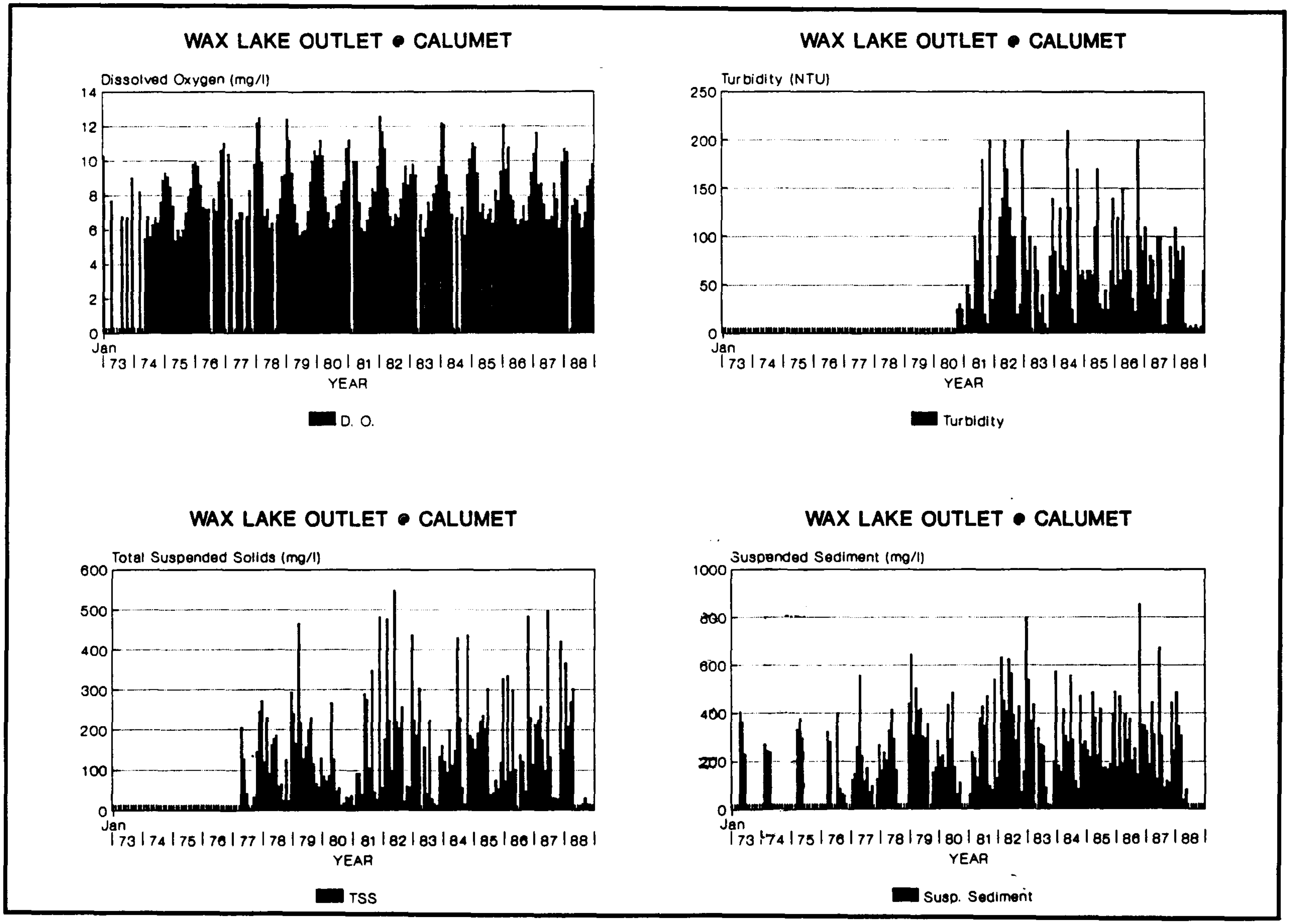


Figure 26. Monthly dissolved oxygen, turbidity, total suspended solids, and suspended sediment trends of U.S. Geological Survey data on the Wax Lake Outlet at Calumet, 1972-1988.

oxygen measurements below 5 ppt since 1972. Turbidity ranged from 3.3 to 210 NTU, total suspended solids from 1 to 548 ppt, and suspended sediment from 11 to 854 ppt.

Overall, water quality in the Atchafalaya basin is good (Louisiana Department of Transportation and Development 1984). Saltwater intrusion is common in the lower reaches of the Atchafalaya River during low flow. Low dissolved oxygen concentrations occur at times in swamps of the Atchafalaya basin. Lakes and streams near Flat Lake are subject to low dissolved oxygen levels as a result of natural discharges from these swamps at times of high flow; these discharges in turn have resulted in fish kills. Violations of chlorides, sulfate, dissolved oxygen, and fecal coliform have been observed in the area near Morgan City, but are believed to be a result of natural conditions. Fecal coliform violations have caused long-term closures of oyster grounds in Atchafalaya Bay. The deposition of tremendous quantities of sediment carried by the river each year and associated turbidity also causes some water quality problems. No water quality index has been assigned to the Lower Atchafalaya River, but a water quality index of 47.5 was assigned from the headwaters to mile 118.

Salinity gradients show that the inland coastal basin is relatively fresh throughout. Mean salinities inland at the Wax Lake Outlet and Morgan City are 0.06 ppt and 0.07 ppt, respectively. Offshore, at Eugene Island, mean salinities are 4.93 ppt. Assessments of relative sea level change show values that range from maxima of 0.74"/yr (1.87 cm/yr) on the Gulf Intracoastal Waterway at the Wax Lake Outlet West Control Structure, and 0.53"/yr (1.35 cm/yr) on the Lower Atchafalaya River below Sweet Bay Lake. The lowest rate of relative sea level change is -0.02"/yr (-0.05 cm/yr) at the Wax Lake Outlet, vicinity of Belle Isle. Land surface change rates based on Gulf of Mexico eustatic changes, according to the approach of Ramsey and Moslow (1987), therefore range from subsidence of 0.65"/yr (1.64 cm/yr) to increases of 0.11"/yr (0.28 cm/yr) (figure 26).

Navigation projects in the Atchafalaya Basin include the Atchafalaya River and Bayous Chene, Boeuf, and Black. The channel extends from Bayou Boeuf at Highway 90 to the 20' contour in the Gulf of Mexico. Dimensions are 20' deep with a bottom width of 400', except in Bayou Boeuf, where industrial development on both sides of the bayou necessitates a 300'-wide channel. The project includes a 20'-by-400' channel constructed from the major shipyard on Bayou Black at highway 90 through the Gulf Intracoastal Waterway to Bayou Chene. This project superseded the Atchafalaya River, Morgan City to the Gulf of Mexico project, authorized in 1910, which consisted of a 20'-by-200' channel, approximately 16 mi long from the 20' depth contour in Atchafalaya Bay to the same contour in the Gulf of Mexico.

Flood control projects in the Atchafalaya basin are numerous. Those that affect the coastal area include Morgan City and Vicinity Hurricane Project, Atchafalaya Basin Floodway, East Atchafalaya Basin Protection Levee-Landside Drainage Improvements, West Atchafalaya Basin Protection Levee-Landside Drainage Improvements, and Atchafalaya Basin Bank stabilization. The Morgan City and Vicinity Hurricane Project, which provides protection from the vicinity of Morgan City to the Charenton Drainage and Navigation Canal, consists of the construction of 9.2 mi of new levees, enlargement of 21.6 mi of existing levees, construction of flap-gated structures and a floodgate, and alteration of five existing pumping stations and 11 drainage culverts. The East and West Calumet floodgates are located in the East and West Wax Lake Outlet guide levees where the levees cross Bayou Teche. Each floodgate is a reinforced-concrete structure, 161' long, 45' clear width, a sill -9.8' NGVD, and steel sector gates. The floodgates allow navigation in Bayou Teche and can partially regulate flows. The Wax Lake Outlet is a dredged channel about 10 mi west of Berwick, which extends from Sixmile Lake through the Teche Ridge and Wax Lake into Atchafalaya Bay, a distance of about 15.7 mi. It has a capacity of 300,000 cfs, and is designed to provide protection by reducing stages during extreme floods. The channel has a depth of -45' NGVD and a bottom width of 300' from Sixmile Lake to 0.5 mi below Bayou Teche, where it expands to 400' through the outlet. The excavated material was used to construct guide levees extending from the West Atchafalaya Basin Protection Levee to the Gulf Intracoastal Waterway on each side of the outlet. Bridges were constructed in association with these projects.

Atchafalaya basin levees include all levees in the Atchafalaya basin, except for the Morganza Floodway. This levee system is designed to protect areas from normal high waters of the Mississippi-Red River backwater area and the Atchafalaya River, and to introduce floodwaters through the Atchafalaya River, the Morganza, West Atchafalaya, and Atchafalaya Basin floodways, to the Gulf of Mexico via the Wax Lake Outlet and the Lower Atchafalaya River. The system includes about 449 mi of levees and will contain a flood of 1,100,000 cfs. Individual levees within this project are the East Atchafalaya Basin Protection Levee, West Atchafalaya Basin Protection Levee, East Atchafalaya River Levee, West Atchafalaya River Levee, Bayou des Glaises Fuseplug Levee, Mansura Hills to Hamburg Levee, and levees west of Berwick; of all of these, only the East Atchafalaya Basin Protection Levee, West Atchafalaya Basin Protection Levee, and levees west of Berwick lie in the coastal basin. The East Atchafalaya Basin Protection Levee includes 1.3 mi of floodwall along Morgan City and about 0.4 mi of floodwall below Morgan City. The West Atchafalaya Basin Protection Levee parallels the East and West Calumet floodgates and follows eastward to Berwick through the Gulf Intracoastal Waterway. This levee connects with 1 mi of floodwall along the front of the town of Berwick. A total of 56.5 mi of intermittent levees tying into high ground are located west of Berwick. They have been designed to protect the cultivable lands along the Teche and Sale Ridges from flood backwaters from the Mississippi and Red rivers through the floodways, the Wax Lake Outlet, and the Lower Atchafalaya River.

The Charenton Drainage Canal is a subproject of the West Atchafalaya Basin Protection Levee, which extends from the Charenton Floodgate to Bayou Teche, and thence along Bayou Teche and a new land cut to West Cote Blanche Bay. The canal has a bottom width of 75', depth of -30' NGVD, and a design discharge capacity of 22,000 cfs. Atchafalaya River is the title of a project which involves dredging a 12' channel with a bottom width of 125' from the Gulf Intracoastal Waterway at Morgan City to the Mississippi River via the Atchafalaya and Old rivers. Atchafalaya River, Morgan City to Gulf of Mexico, consists of a channel which was progressively enlarged to 20' by 200' from 1939 to 1974; it will be further enlarged to 20' by 400'.

The Atchafalaya Basin floodway is about 15 mi wide and is located between protection levees from the lower limits of the Morganza and West Atchafalaya floodways to Morgan City and through the Lower Atchafalaya River and Wax Lake Outlet to the Gulf of Mexico. It includes the Atchafalaya Basin levees, Atchafalaya River improvement dredging, Atchafalaya River, Bayou Boeuf Lock, Bayou Sorrel Lock, Berwick Lock, Charenton Floodgate, East Access Channel, East

Freshwater Distribution Channel, East-West Calumet floodgates, railroad bridge at Berwick, Wax Lake Outlet, West Access Channel, West Freshwater Distribution Channel, Atchafalaya basin main channel improvement dredging, Bayou Courtableau freshwater diversion structure and channel, and the Sherbourne freshwater diversion structure and channel.

Of these subprojects, only the Bayou Boeuf Lock, Berwick Lock, the East-West Calumet floodgates, the railroad bridge at Berwick, and the Wax Lake Outlet are located exclusively in the coastal part of the basin. Bayou Boeuf lock is located in the East Atchafalaya Basin Protection Levee below Morgan City, where it crosses Bayou Boeuf and the Gulf Intracoastal Waterway. It consists of two reinforced-concrete gate bays, equipped with steel sector gates connected by an earth chamber which has a timber guide wall on both sides. The lock is 1148' long, 75' wide, and has a depth over sills of 13' at mean low Gulf level. Berwick Lock, completed in 1951, is located in the West Atchafalaya Basin Protection Levee and provides a navigation passage through the levee, up the Lower Atchafalaya River to Patterson, and to Bayou Teche. It is near the crossing of the Lower Atchafalaya River, about 2 mi north of the town of Berwick. This lock is a reinforced-concrete structure 45' wide, with sills at an elevation of -9.8' NGVD, and a length of 300'.

The east Atchafalaya basin protection levee landside drainage improvement includes two projects, one of which is in the coastal area. The Bayou Boeuf-Bayou Long drainage canal and enlargement of Bayou Chene provided for the improvement of existing streams from the Bayou Sorrel lock to the vicinity of Lake Palourde, with a land cut from Lake Palourde to Bayou Boeuf, and the enlargement of Bayou Boeuf; channel dimensions were 9' by 100'. The project was completed in 1947 and provided drainage and navigation from the Gulf Intracoastal Waterway to the levee borrow pit. The only subproject of the west Atchafalaya basin protection levee-landside drainage improvements project in the coastal area is Charenton.

Atchafalaya basin bank stabilization is being constructed from above the vicinity of Simmesport to the lower end of the main stem levee system to maintain favorable alignment for navigation and for protection of the levee system. Through 1986, 36.7 mi of revetment have been placed along the riverbanks, but in the coastal area it is only found in the vicinity of Morgan City (U.S. Army Corps of Engineers 1988).

Terrebonne Basin

The Terrebonne basin is confined between the Atchafalaya basin floodway levee system and natural levees of the Lower Atchafalaya River on the west and the west bank of Bayou Lafourche on the east (its area is described in the habitat section). It lies within the south-central section of the Mississippi River delta plain, and is developed exclusively in Holocene sediments. The surface of the Terrebonne basin comprises two transgressed delta complexes, equated with the abandoned Teche and Lafourche deltas. Abandoned distributaries of both delta complexes occupy the north-central part of the basin. Marine processes have reworked the seaward margin of the abandoned deltas. Barrier island systems at the southern edge of the basin include the Isles Dernieres, associated with the Bayou Grand Caillou delta lobe of the Teche complex, and Timbalier and East Timbalier islands, the westernmost section of the Bayou

Lafourche headland, and all of the Bayou Lafourche shoreline, developed since abandonment of the Bayou Lafourche delta complex.

The basin's coastal water bodies include Caillou Bay and Lake Pelto, both behind the Isles Dernieres; Timbalier Bay, Lake Felicity, Old Lady Lake, and Lake Raccourci, protected by the Timbalier Islands; Terrebonne Bay and Lake Barre, protected by both island chains; and Fourleague Bay, protected by Point au Fer Island. Major inland lakes, some with connection to the Gulf, include Caillou Lake, Lake Mechant, Lost Lake, Lake de Cade, Lake Theriot, and Lake Boudreaux. Major bayous include Bayou Terrebonne, Creole Bayou, Big Carencro Bayou, Bayou Sale, Bayou du Large, Bayou Grand Caillou, Bayou Petit Caillou, Grand Bayou, Bayou Blue, Bayou Penchant, Palmetto Bayou, Bayou Colyell, and Bayou Jean Le Croix. The west bank levee of Bayou Lafourche bounds this area to the east and the Atchafalaya River Basin Protection Levee and the Lower Atchafalaya River border the western portion. The Atchafalaya River greatly influences the southwestern portion of this basin, which compensates for some of the marsh loss in other parts of the basin. Sediment will no longer reach this area if the Avoca Island levee is constructed.

Soils in the Terrebonne basin are developed exclusively on delta plain or alluvial deposits. Major soils in the delta plain include 1) Medisaprists, fresh, adjacent to alluvial areas across the northern part of the basin and incorporating areas of flotant marsh; 2) Medisaprists-Hydraquents, moderately saline, on delta plain deposits across the central part of the basin; and 3) Medisaprists-Hydraquents, saline, developed on delta plain deposits across the southern part of the basin around Terrebonne and Caillou bays, on some of the Isles Dernieres, and on some broken marsh remnants in Timbalier Bay. Less extensive delta plain soils include 1) Allemands-Kenner-Larose, fresh, adjacent to and between alluvial ridges in the northern part of the basin and incorporating areas of flotant marsh; 2) Timbalier-Bellpass, saline, in the southeastern part of the basin; 3) Scatlake, saline, developed on the Bayou Lafourche headland following Bayou Lafourche to north of Leeville, along the northern edge of Timbalier Bay, on East Timbalier Island, and isolated marsh remnants in Timbalier Bay; 4) Lafitte-Clovelly, moderately saline, located in the east-central part of the basin; and 5) Udipsamments-Medisaprists, saline, occurring on some of the Isles Dernieres and Timbalier Island. Three of the alluvial soil associations are developed only along Bayou Lafourche: 1) Sharkey-Fausse, frequently flooded, developed on fine-grained sediments; 2) Barbary-Sharkey, frequently flooded, developed on fine-grained sediments; and 3) Commerce, 0-1%, developed on silty sediments. These same soils, in addition to those listed as follows, occur on the distributaries in the north-central part of the basin: 1) Mhoon-Commerce, 0-1%, developed on silty sediments; 2) Fausse, frequently flooded, developed in fine-grained sediments; and, 3) Barbary-Fausse, frequently flooded, developed on fine-grained alluvium (figure 27).

Major urban areas in or near the Terrebonne basin include Houma and Morgan City; settlement and industrialization follows the Bayou Lafourche levee ridge, Bayou Terrebonne, Bayou Grand Caillou, and Bayou Petit Caillou. Communities within the coastal basin include Dulac, Golden Meadow, Leeville, and Cocodrie. Canals and slip construction for oil and gas activities have dramatically affected the Terrebonne basin. The construction of the Houma Navigation Canal provided a path for saltwater intrusion; salinities in Bayou Terrebonne doubled since its construction. The Gulf Intracoastal Waterway, Minors Canal, Falgout Canal, and New Canal, and major roads including highway 315 through Theriot, 57

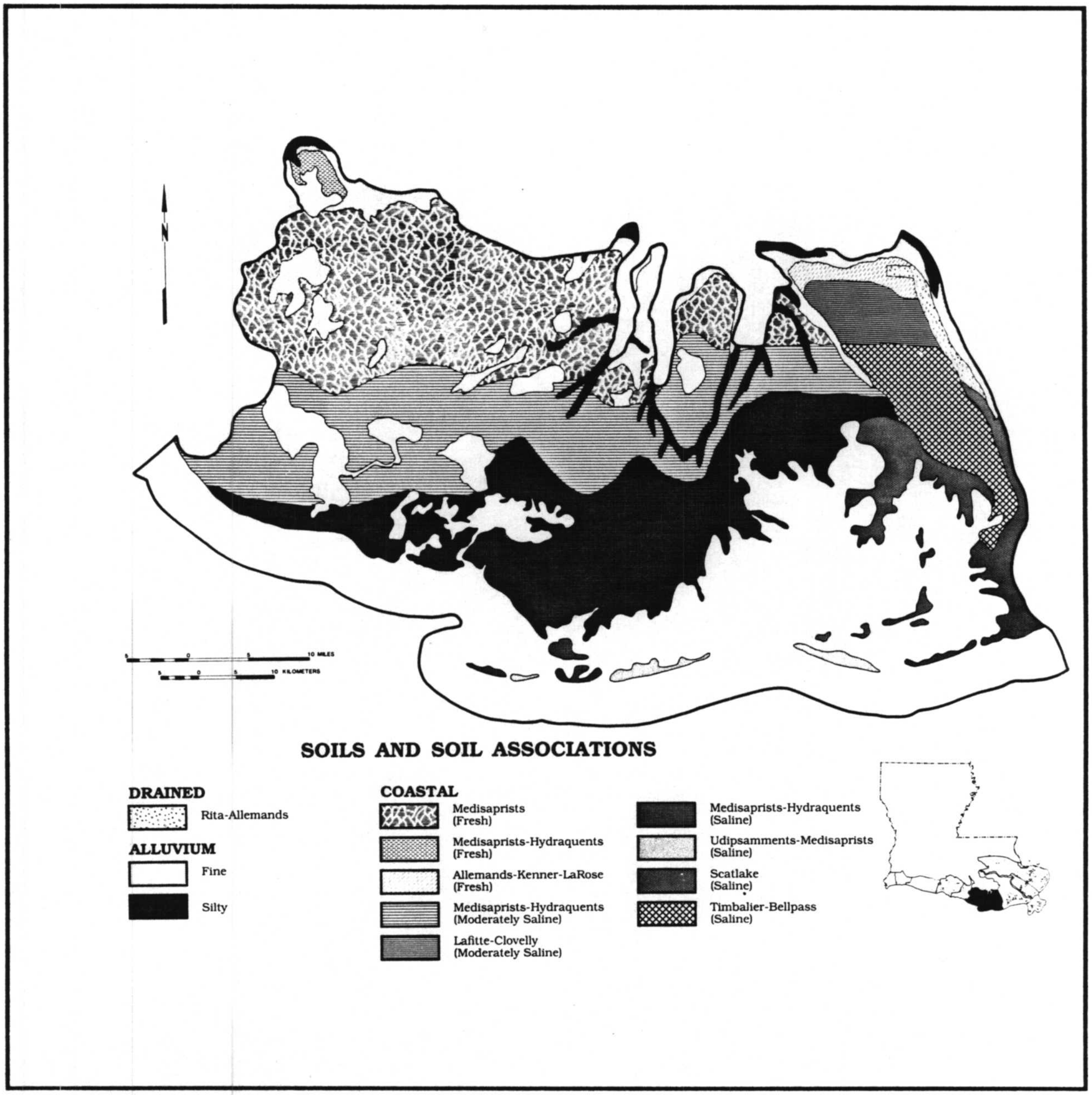


Figure 27. Major coastal soil associations of the coastal Terrebonne basin (Spicer 1981).

through Dulac, 56 to Cocodrie, and 55 through Point Barre also have affected wetland hydrology. The Pointe au Chien Wildlife Management area is located in the eastern part of the Terrebonne basin between Montegut and Cutoff.

The Terrebonne basin has four water-level stations in or near the coastal zone (figure 28). Maximum water levels for the period of record occurred in 1973 at two locations, and in 1977 and 1978 at the others. The highest water level recorded in the basin was 10.56' in 1973, at the Bayou Boeuf-Gulf Intracoastal Waterway at Bayou Boeuf Lock, West. The minimum water level recorded was -1.98', also at this station. The basin does not contain any major rivers and is dependent principally upon local rainfall for direct freshwater input. Discharge data have been collected only since 1984 on the Bayou Grand Caillou at Dulac, so trends are not shown. Data show that stream discharge is negative, or tidally influenced, much of the year. Maximum discharge is not available, but maximum gage height was 8.89' on October 28, 1985. Minimum discharge was -1,470 cfs on October 28, 1985, with the minimum height being 2.96' on February 14, 1985. The approximate reach of tidal influence is shown in figure 29.

The Houma Navigation Canal at Bayou Petit Caillou near Cocodrie is the only Department of Environmental Quality water quality station in the Terrebonne coastal basin. Dissolved oxygen levels are seasonally low, with 18 observations below 5 ppt or mg/l since 1978, but none below 3 ppt or mg/l. Turbidity ranges from 1.3 to 280 NTU, with most large values late in 1983 and early in 1984. Total suspended solids ranges from 10 to 542 ppt or mg/l. There are no obvious relationships between these variables and the hydrology (figure 30).

Some of the most critical water quality problems in the Terrebonne basin are encountered in the marshes and estuaries below Houma. Discharge of untreated domestic waste here has, on occasion, resulted in closure of large areas of water bottoms to shellfish culture. Long-term closures include Terrebonne Bay, which has been closed since 1968. The Terrebonne basin also has water quality problems due largely to agricultural runoff in Lakes Caillou and Barre. In addition, Grand Bayou suffers from pesticide pollution. The problems in these lakes include turbidity, sediment deposition, reduced photosynthesis, and low dissolved oxygen. The Houma Navigation Canal at times has high fecal coliform counts. The only water quality limited segment of the basin is the estuarine area immediately south of Lake Boudreaux.

Classification of water quality by segments has assessed the following Water quality indexs: 1) 46.7, with the major problem being dissolved oxygen for the west Terrebonne coastal area south and west of Bayou Black Ridge and Bayou du Large, including the Gulf Intracoastal Waterway from Bayou Boeuf to Houma, Lake De Cade, Lake Mechant, Bayou Junop and adjacent coastal waters; 2) 75.4, with the major problems being fecal coliform and dissolved solids for the middle Terrebonne coastal area between Bayou du Large ridge and Bayou Terrebonne ridge including Bayou Grand Caillou, Houma Navigation Canal, Bayou Petit Caillou, Bayou Terrebonne and Lake Pelto and adjacent coastal waters; and 3) 50.9, with the major problem being fecal coliform for the east Terrebonne coastal area between Bayou Blue ridge and Bayou Lafourche ridge, including Bayou Barre, Lake Barre, Bayou Jean La Croix, Lake Felicity, Bayou Blue, Lake Raccourci, Timbalier Bay, and adjacent coastal waters (Louisiana Department of Transportation and Development 1984).

Saline marshes in the Terrebonne basin extend as far as 20 mi inland, and

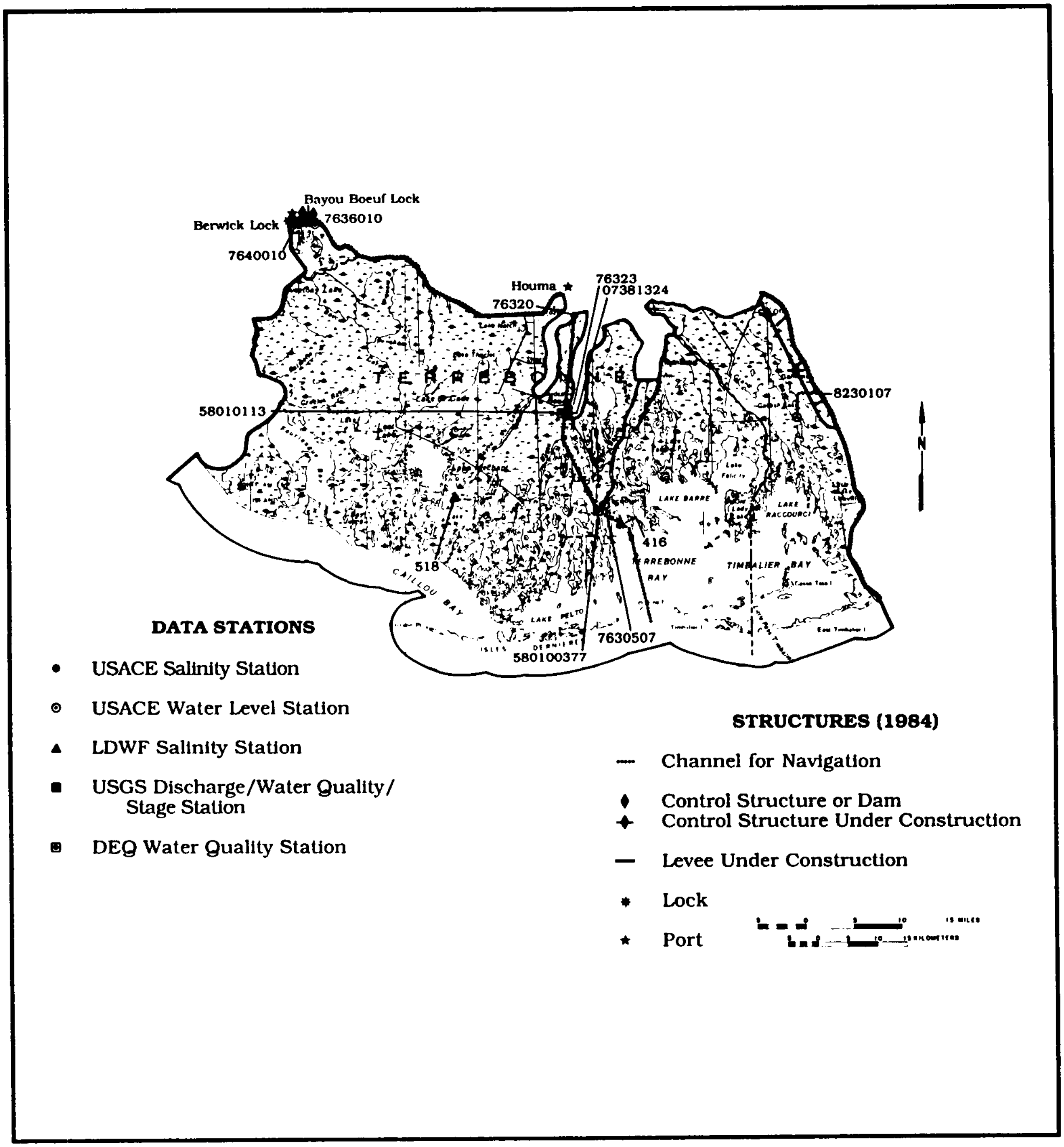


Figure 28. Data stations and major structures in the coastal Terrebonne basin (Department of Transportation and Development 1984).

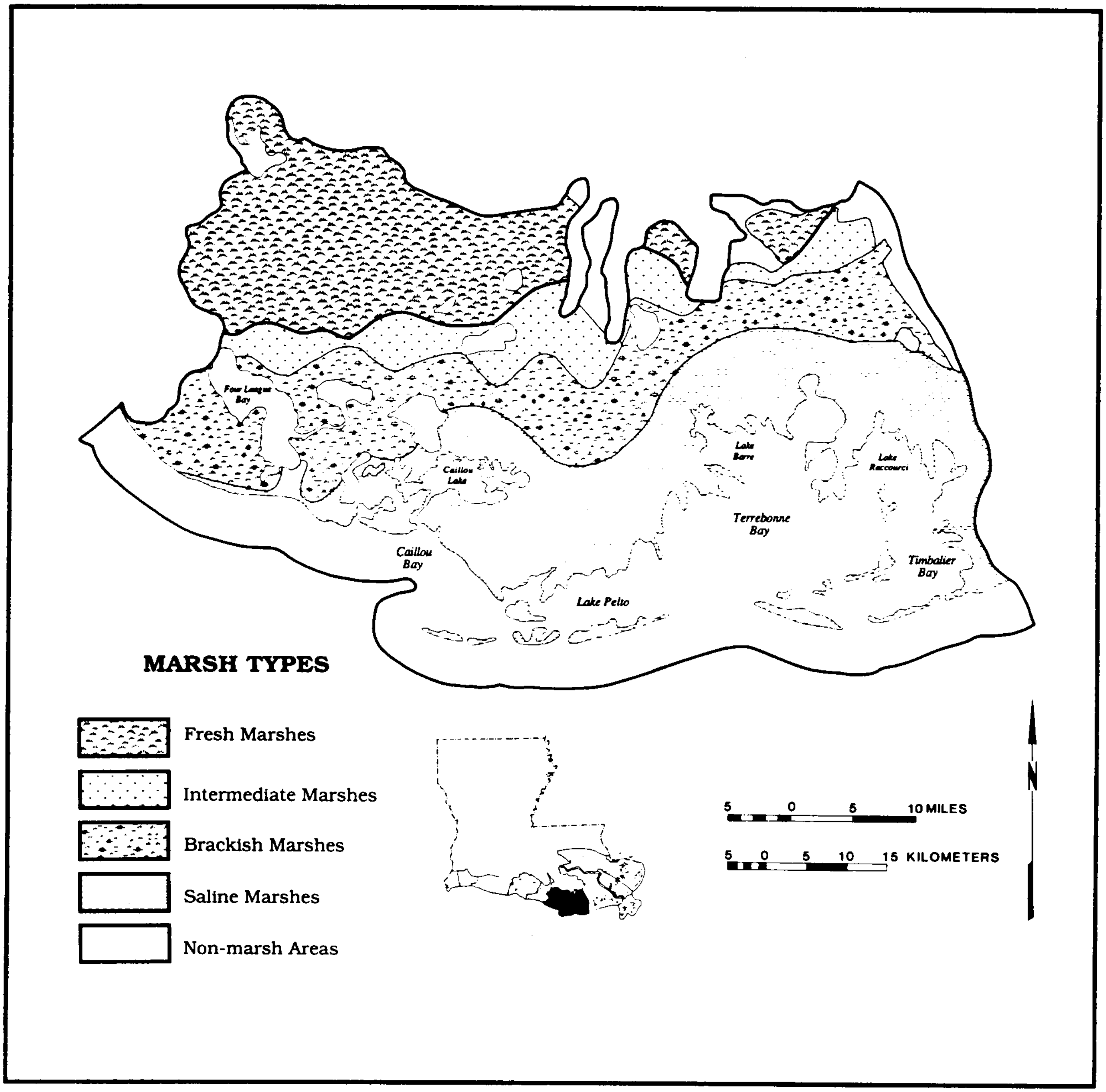
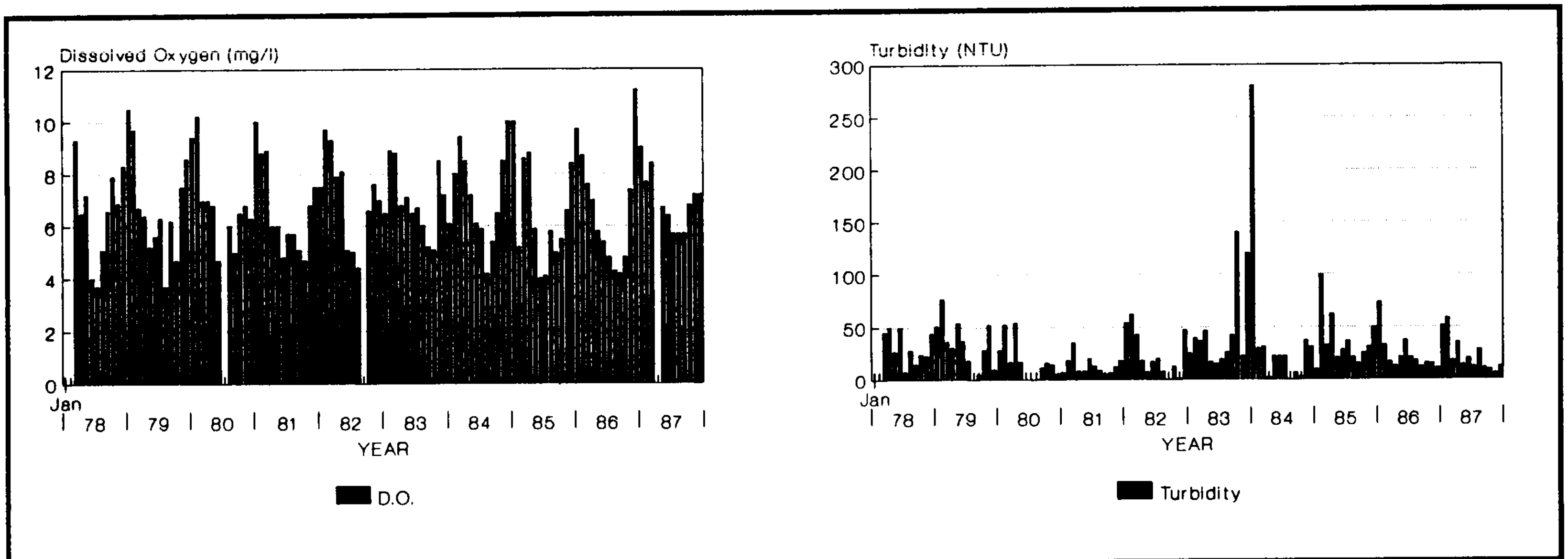


Figure 29. Marsh types in the Terrebonne basin (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.



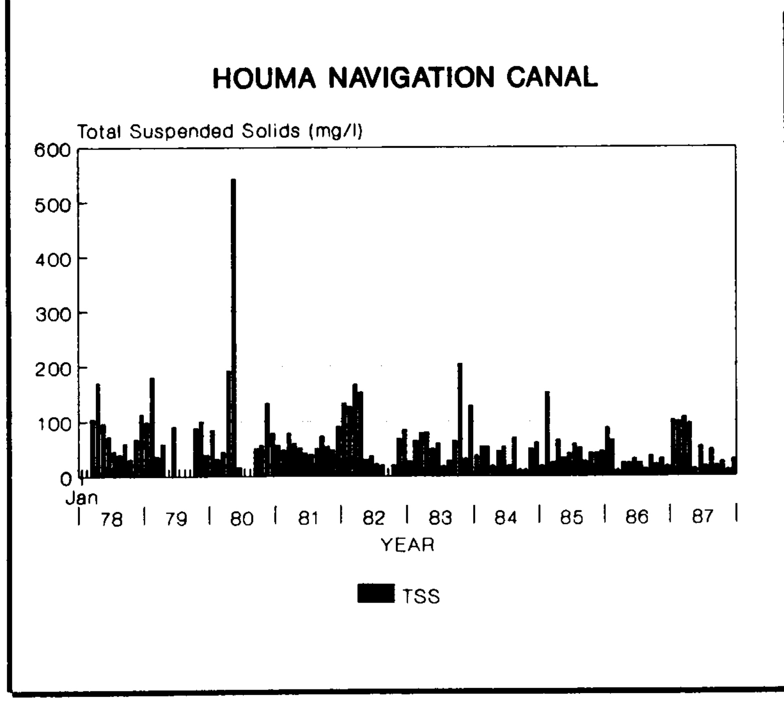


Figure 30. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Houma Navigation Canal, 1978-1987.

are approximately parallel with the coast. Salinities are recorded at four locations. Mean values in the basin are 10.76 ppt at the Caillou Lake Camp, 9.44 ppt at Cocodrie, 1.20 ppt on the Bayou Grand Caillou at Dulac, and 0.34 ppt on the Gulf Intracoastal Waterway at Houma. Assessments of relative sea level change show rates of 0.40"/yr (1.02 cm/yr) from 1976 to 1983 on Bayou Blue near Catfish Lake, and 0.30"/yr (0.75 cm/yr) from 1955 to 1983 on Bayou Boeuf at Bayou Boeuf Lock, East. Subsidence at these stations is 0.31"/yr (0.79 cm/yr) and 0.21"/yr (0.52 cm/yr).

Hydrologic modifications include the Houma Navigation Canal, 15' deep, 150' wide, and about 30 mi long, allowing navigation from the Gulf Intracoastal Waterway near Houma to the Gulf of Mexico. A waterway 5' deep and 40' wide extends from the Gulf Intracoastal Waterway at Houma, through Bayous LeCarpe, Delton, and Grand Caillou to Bayou Dulac. Other modifications include repeated dredging of a 24-mi canal 6' deep along Bayou Terrebonne, and a 20-mi channel 5' deep and 40' wide along Bayou Petit Caillou.

Barataria Basin

The Barataria basin is bounded between natural levees of Bayou Lafourche and bordered by the Terrebonne basin on the west, the artificial levee of the Mississippi River and basin on the east, and the Gulf of Mexico to the south. The basin is developed exclusively in Holocene sediments, does not contain any major rivers, and is dependent principally upon local rainfall for direct freshwater input. Some controlled diversion of Mississippi river flow through a pumping/siphon plant at Donaldsonville into Bayou Lafourche for water supply occurs, but not in appreciable quantities; the maximum capacity of the plant is 300 cfs.

The Barataria basin lies in the central portion of the Mississippi River delta plain. It is composed of the Lafourche, St. Bernard, and Modern delta complexes. Barrier islands and beaches are abundant along the southern edge of Barataria basin. These include most of the Bayou Lafourche headland, Grand Isle, the Grand Terre Islands, and Shell Island. The headlands and islands have eroded extensively in recent years, with sand bodies being reworked, causing development of larger and additional tidal passes. Bara-taria Basin contains three large lakes: Lake Salvador, Lake des Allemands, and Little Lake; surface areas are 70, 23, and 20 mi^2, respectively. In addition to these, there are several other smaller lakes in the basin, including the Lake Cataouatche, Lake Boeuf, Lake Hermitage, Roud Lake, and Lake Laurier. Bayous include Bayou Lafourche, Bayou Ferblanc, Bayou Raphael, West Fork Bayou L'Ours, Bayou Perot, Bayou Rigolets, Bayou Barataria, Bayou des Families, Bayou Segnette, Bayou des Allemands, Bayou Bechnel, Bayou Dupont, Bayou Grand Cheniere, Grand Bayou, Bayou Long, Dry Cypress Bayou, Robinsons Bayou, and Bayou Grand Liard. The larger coastal saltwater bodies include Caminada and Barataria bays.

Soils in the Barataria basin developed on delta plain and alluvial deposits. Those developed in the delta plain include 1) Medisaprists-Hydraquents, moderately saline, developed extensively along the northeastern part of the basin on marsh deposits adjacent to Mississippi River alluvial deposits; 2) Medisaprists-Hydraquents, saline, developed along the eastern part of Barataria Bay from Quatre Bayoux Pass to east of Shell Island; 3) Lafitte-Clovelly, moderately saline, large areas surrounding Little Lake; 4) Timbalier-Scatlake, saline, along the northern fringe of Barataria Bay; 5) Timbalier-Bellpass, saline, in the southwestern part of the basin; 6) Scatlake, saline, developed on the Bayou Lafourche headland following Bayou Lafourche to north of Leeville, along the northern edge of Caminada Bay, on the Grand Terre Islands and on isolated marsh remnants in Caminada and Barataria bays; 7) Felicity, moderately saline, developed on sandy sediments of Grand Isle; 8) Rita-Allemands, drained, parallel to natural levees of Bayou Lafourche and near alluvial ridges in the northern part of the basin; 9) Westwego-Harahan, drained, developed on very fine-grained alluvial sediments adjacent to the Mississippi River; 10) Allemands-Kenner-Larose, fresh, adjacent to and between alluvial ridges in the northwestern part of the basin and incorporating areas of flotant marsh; 11) Kenner-Allemands, fresh; 12) Hydraquents-Medisaprists, fresh; and 13) Allemands-Carlin, fresh, incorporating areas of flotant marsh. Alluvial soils are: 1) Commerce-Sharkey, 0-1%, developed on silty natural levees along the Mississippi River and abandoned distributaries; 2) Fluvaquents, drained, principally adjacent to the levees of the Mississippi River; 3) Barbary-Fausse, frequently flooded, developed on fine-grained alluvium of the Mississippi River; 4) Sharkey, 0-1%, on fine-grained deposits of Bayou Lafourche north of Leeville; 5) Commerce-Sharkey, 0-1%, on silty alluvium of the Mississippi River and Bayou Lafourche; 7) Commerce, 0-1%, developed on silty alluvium of Bayou Lafourche; and 8) Barbary, frequently flooded, developed on fine-grained alluvium of the Mississippi River (figure 31).

Distributaries, along with canals and spoil banks, and roads, affect wetland hydrology. The major roads include Louisiana highways 308 and 1 to Grand Isle, 45 to Lafitte, 90 through des Allemands, 20 near Vacherie, 70 near Lauderdale, and 18, 327, 478, 406, and 23 following the west bank of the Mississippi River. Canals include the Freeport Sulphur Canal, SW Louisiana Canal, Dupre Cut, Bayou Segnette Waterway, Canal Tismond Foret, Godchaux Canal, Wilkinson Canal, Company Canal, Baker Canal North and South, Providence Canal, Eighty Arpent Canal, and several others. Although the Bayou Lafourche distributary was abandoned about 300 years ago, it provided fresh water to the basin until the waterway was closed off from the Mississippi by levees in 1904. Nearly all the fresh water entering the basin is from precipitation. The Gulf Intracoastal Waterway provides an avenue for minor lateral exchange of water between basins, and occasionally southeast winds will drive riverine-influenced waters into the basin by way of tidal passes. Sediment input into this area is derived from the marine processes of erosion and redeposition.

Urban, industrial, and agricultural activities are concentrated along the natural and artificial levees, which are located at the boundaries of the basin. The Mississippi River from Donaldsonville to Belle Chasse is a major area of industrial and urban development; Bayou Lafourche and the Mississippi River from Belle Chase to Venice include residential and commercial development. Along the coastline, developed areas include Grand Isle, with residential and industrial activities, and Port Fourchon, with port and industrial activities. Industries, including food processors and fertilizer manu- facturers, are scattered throughout the basin. The major urban areas in this part of the coastal basin include many of the New Orleans suburbs, such as Harahan, Westwego, Gretna, and Algiers, and other areas such as Thibodaux, Raceland, Cutoff, and Grand Isle. This basin is greatly affected by oil and gas activities, with intense dredging of canals and slips in the Venice, Lafitte, and Leeville oil fields. The Louisiana Offshore Oil Port pipeline corridor runs from the offshore receiving platform approximately 30 mi south-southeast of Fourchon to the Clovelly salt

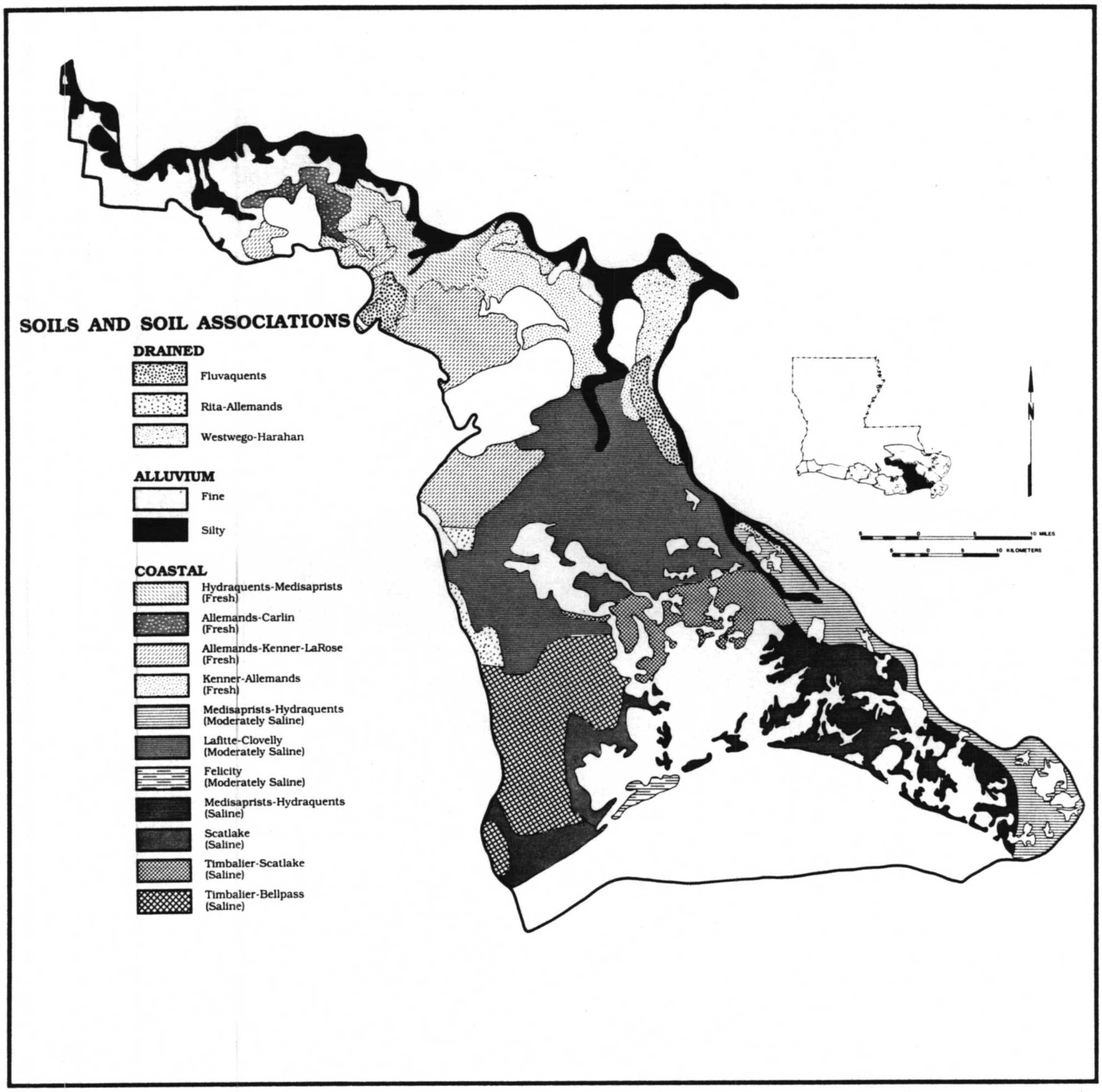


Figure 31. Major coastal soil associations of the coastal Barataria basin (Spicer 1981).

dome storage site near Galliano. The Salvador Wildlife Management area lies in the northern part of Barataria basin on the northwest shore of Lake Salvador. The Wisner Wildlife Management area is located west of Caminada Bay.

The Barataria basin has eight water-level stations in coastal Louisiana (figure 32; table 3). Maximum water levels for the period of record in the basin occurred at Grand Isle during Hurricane Betsy on September 9, 1965, with an elevation of 10.60′. Minimum water level was -1.64′ on September 9, 1965, on the Gulf Intracoastal Waterway at Algiers Lock. Discharge data have been collected on Bayou Lafourche at Donaldsonville just outside the coastal basin from 1961 to 1985, and since 1984 on Bayou Lafourche at Thibodaux. Trends are only shown for Donaldsonville because of the longer period of record. Maximum daily discharge recorded was 642 cfs on April 13, 1980. No flow, the minimum value, was recorded on several occasions. With the much shorter period of record, maximum discharge at Thibodaux was 1,210 cfs on October 28, 1985. Minimum discharge was 40 cfs on November 8, 1985 (figure 33). The approximate reach of tidal influence is shown in figure 34.

There are four water quality stations in the coastal Barataria basin monitored by Department of Environmental Quality: Bayou Lafourche at Cutoff and Larose, Bayou Chevreuil near Chegby, and Little Lake at Temple. On the Bayou Lafourche at Cutoff, dissolved oxygen has been low on several occasions since data collection began in 1978. On 39 occasions, values were 5 ppt or less, and six of these measurements were 3 ppt or less. Turbidity ranged from 5 to 320 NTU, and total suspended solids from 10 to 360 ppt. Since 1972, Bayou Lafourche at Larose has shown 49 dissolved oxygen values below or equal to 5 ppt, and 19 of these below or equal to 3 ppt. Turbidity ranges from 5.1 to 302 NTU, and total suspended solids from 0 to 524 ppt. Dissolved oxygen levels have also been extremely low on Bayou Chevreuil near Chegby; 107 observations since 1978 have been below or equal to 5 ppt, and 80 of these have been below or equal to 3 ppt. These are among the lowest values for all of the coastal basins. Turbidity has ranged from 8 to 372 NTU, and total suspended solids from 4 to 350 mg/l, with no apparent trends. Little Lake at Temple shows the best dissolved oxygen levels in the Barataria Basin. Only seven observations of dissolved oxygen since 1978 were below or equal to 5 ppt, and none was below or equal to 3 ppt. Turbidity ranged from 1.5 to 259 NTU, and total suspended solids from 2 to 410 ppt or mg/l, with no apparent trends (figures 35, 36, 37, and 38).

Most of the water bodies are affected by saline water from the Gulf of Mexico; this can present problems if sufficiently high concentrations of chloride enter municipal and industrial water supplies. Bayou Lafourche at times has high fecal coliform counts as does Bayou Barataria. Concerns related to water quality include saltwater intrusion from the Gulf, pollution from oil production activity, and contamination from untreated or poorly treated sewage.

Overall, the basin's water is considered to be moderately to severely polluted. The principal problems are fecal coliforms and low dissolved oxygen. Bayou Lafourche from Donaldsonville to Larose has a Water quality index of 50.8, with problems including turbidity and fecal coliform. Chronically high bacterial counts originate from the discharges of unsewered camps in the marsh areas and overflow or bypass from municipal sewage systems. Oxygen depletions from seasonally operated industries such as menhaden processing and shrimp packing also have caused problems. Most of the water bodies adjacent to the west bank of the Mississippi River also have water quality problems. Bayou Segnette, Harvey Canal, and the Algiers cutoff all have low dissolved oxygen levels. Municipal

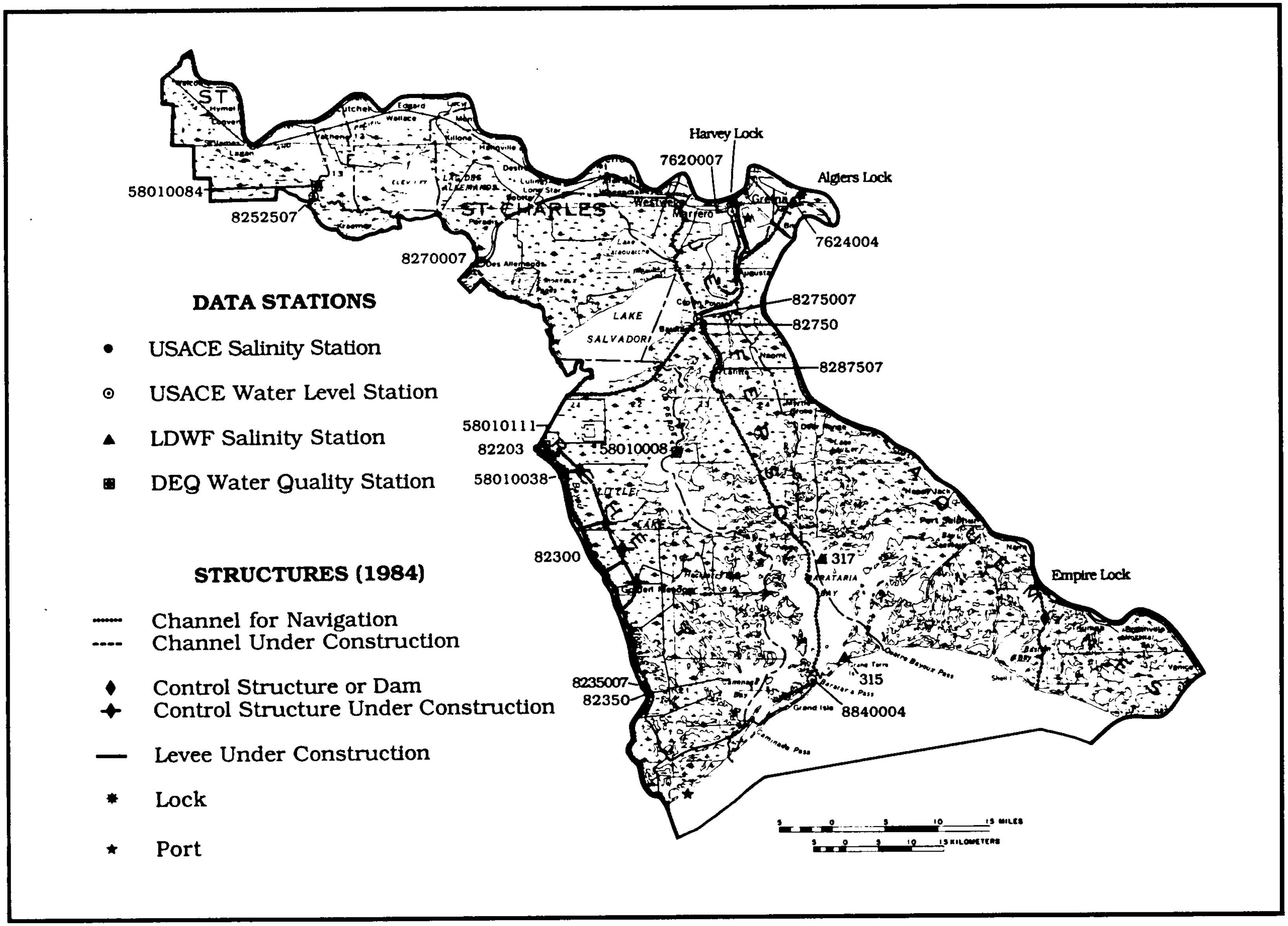


Figure 32. Data stations and major structures in the coastal Barataria basin (Department of Transportation Development 1984).

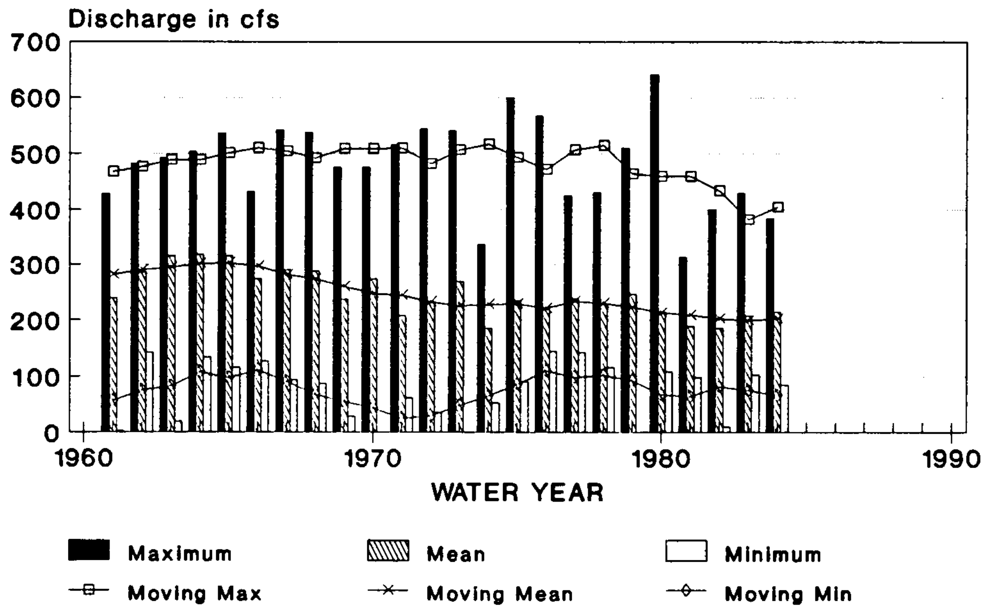


Figure 33. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Bayou Lafourche at Donaldsonville, 1961-1984.

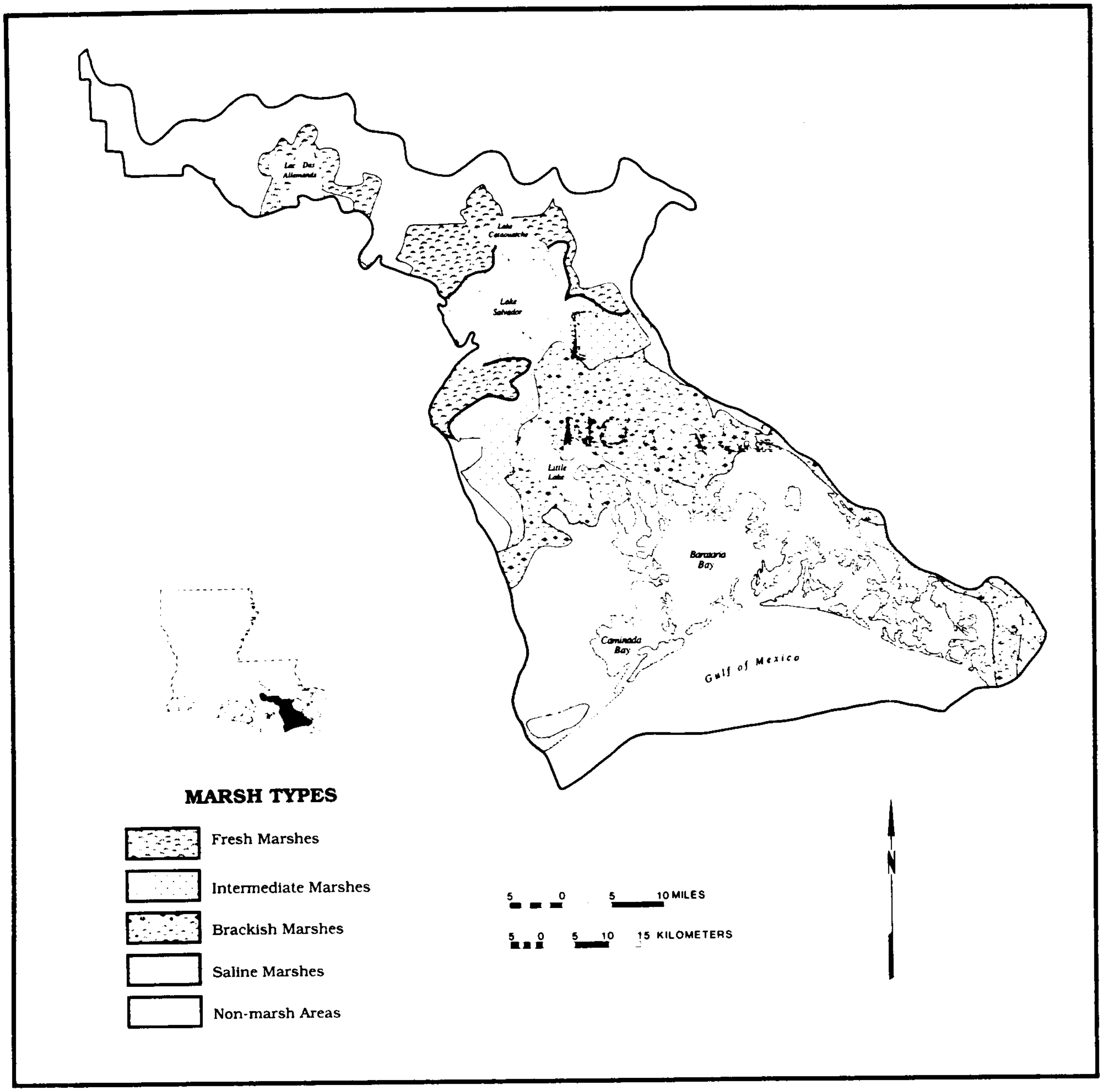
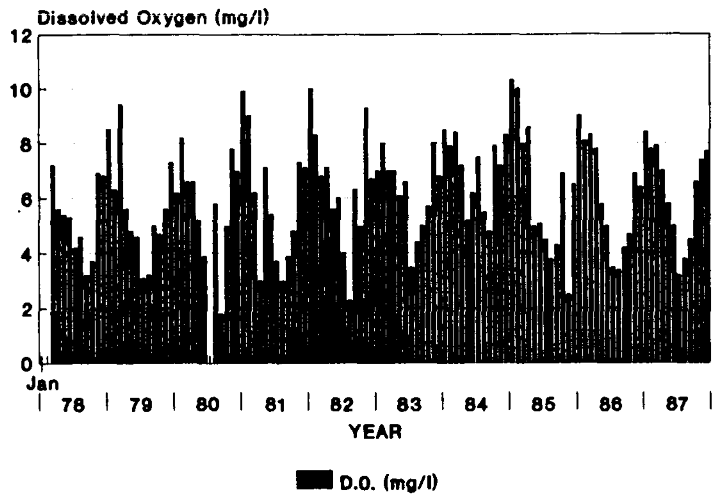
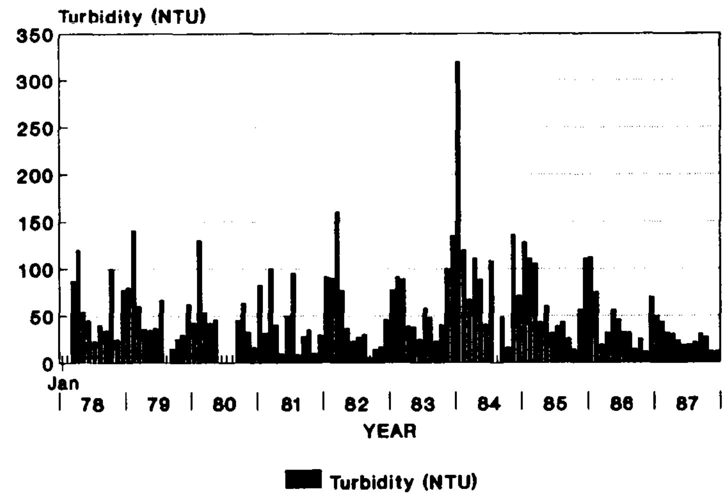


Figure 34. Marsh types in Barataria basin (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.





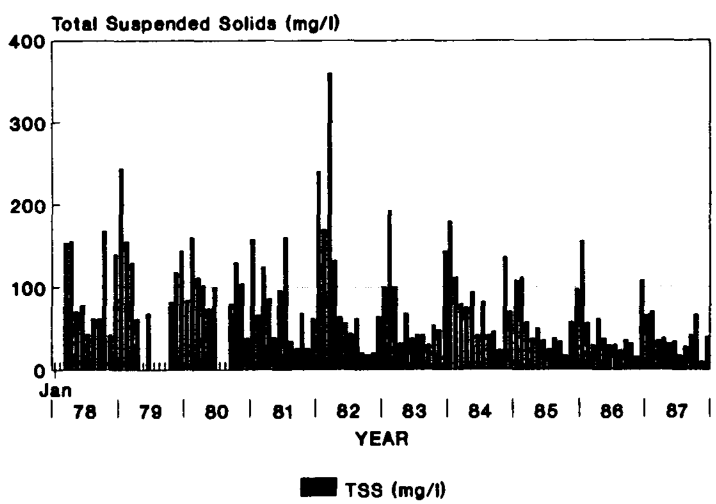


Figure 35. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Bayou Lafourche at Cutoff, 1978-1987.

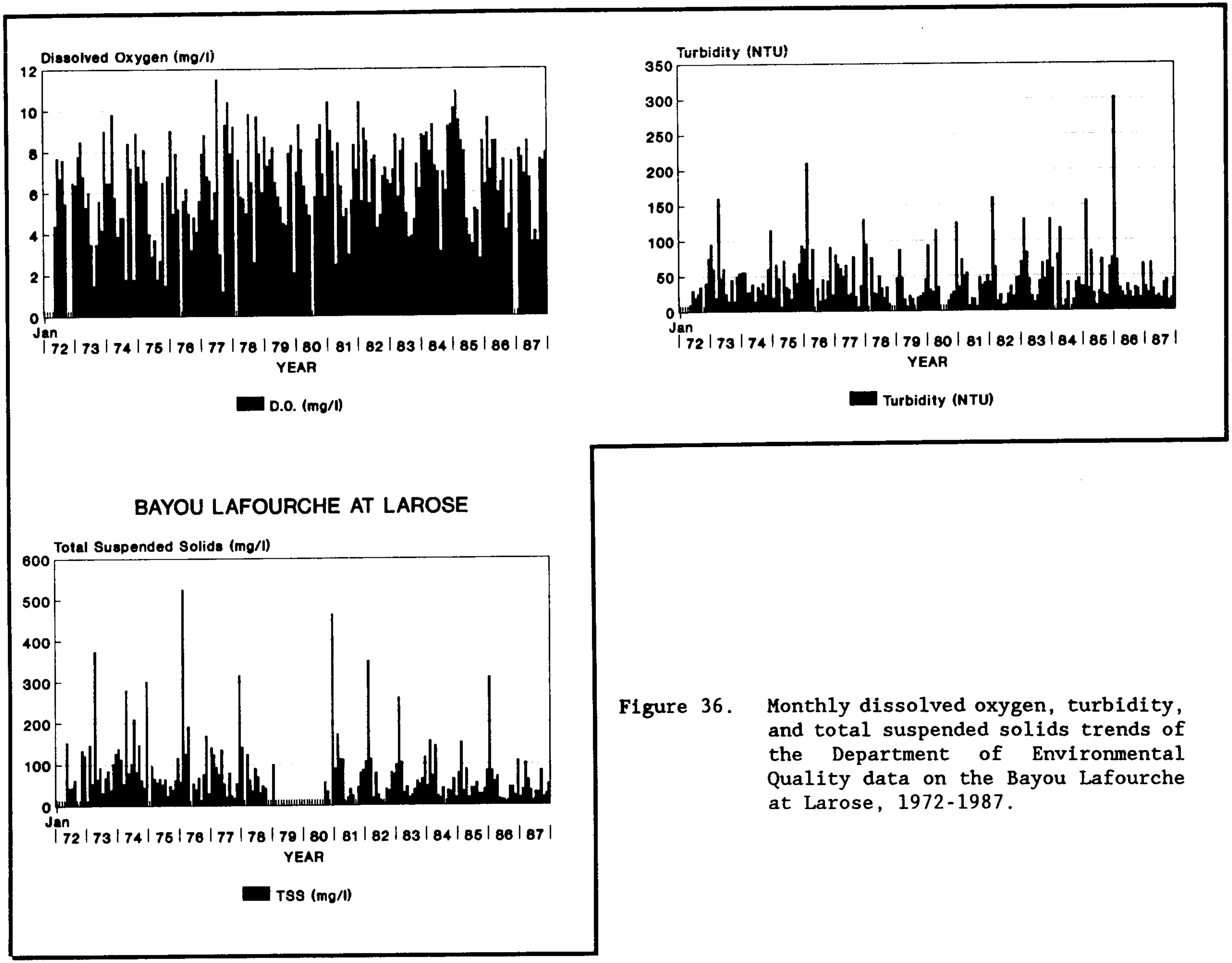


Figure 36. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Bayou Lafourche at Larose, 1972-1987.

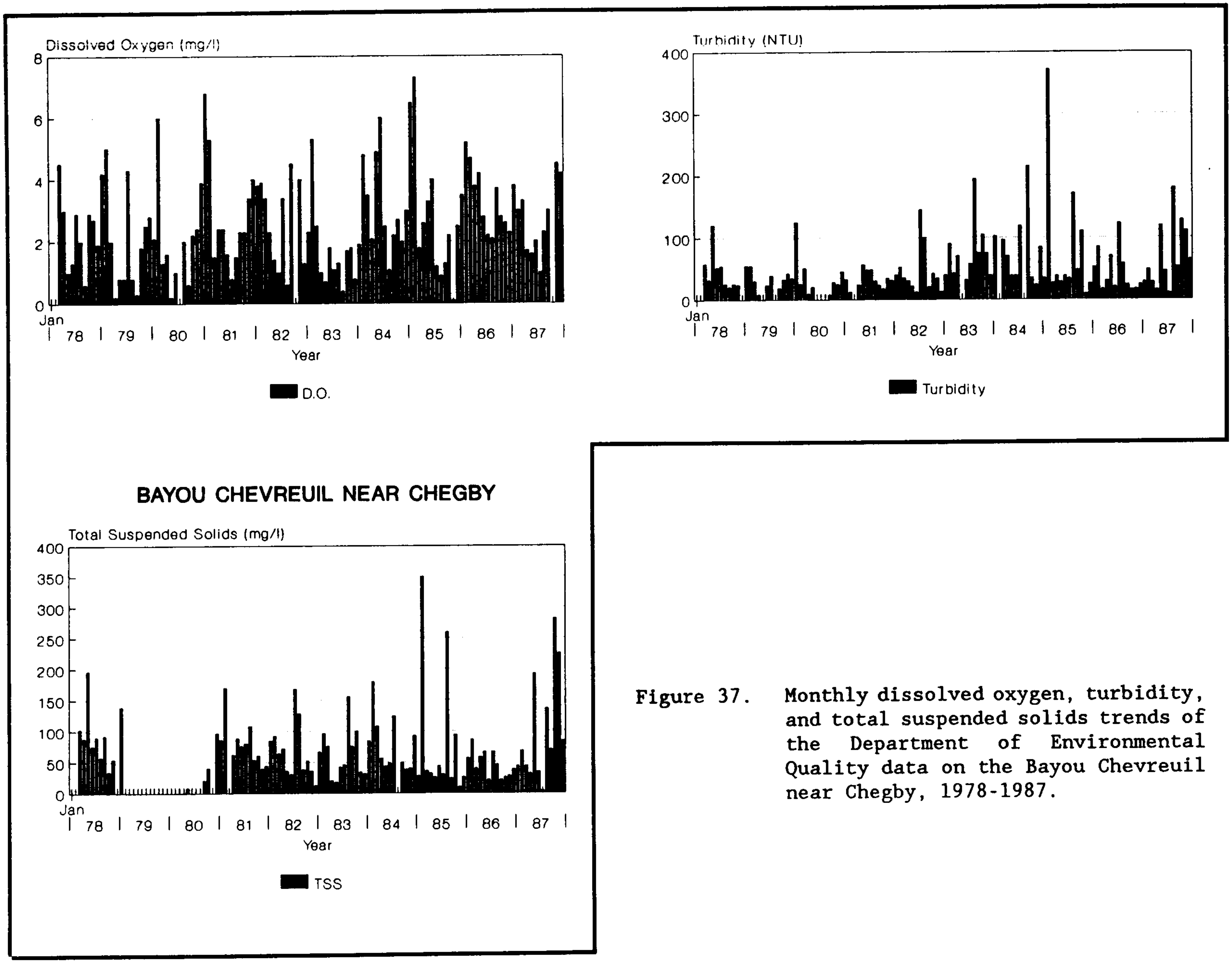
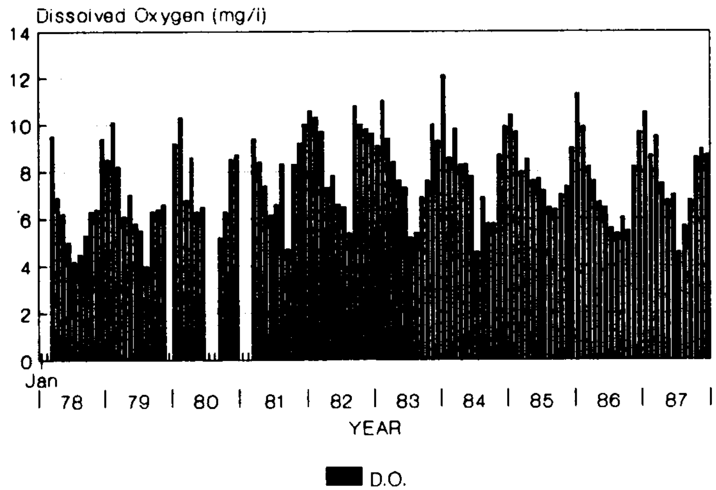
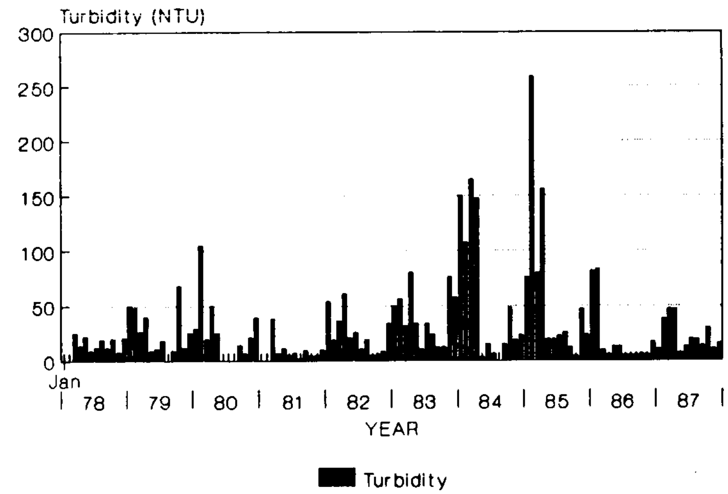


Figure 37. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Bayou Chevreuil near Chegby, 1978-1987.





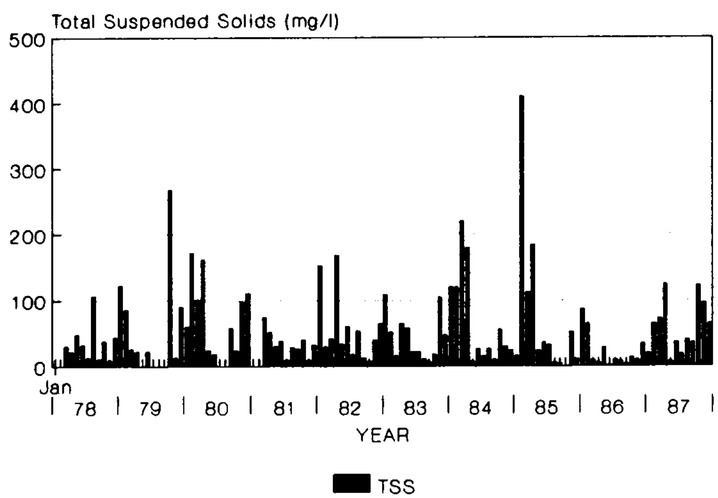


Figure 38. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Little Lake at Temple, 1978-1987.

discharges and urban nonpoint sources seem to be the causes of these problems. Seasonal closures of oyster beds in the Sandy Point Bay area occur during spring floods. The northwest portion of the Barataria basin lying between the Mississippi River to the north and Bayou Lafourche to the west and south, including Bayou Verret, Bayou Citamon, Grand Bayou, Bayou Chevreuil, Bayou Boeuf, and Lake Boeuf has a Water quality index of 74.4, with the major problem being dissolved oxygen. The portion of the Barataria basin lying south of the Gulf Intracoastal Waterway, including Little Lake, Bayou Rigolettes, Barataria Waterway, and Barataria Bay, was assessed a water quality index of 58.7, with the major problem being dissolved solids.

Water quality problems in this basin are intensified by limited drainage from upper basin streams, extensive residential and camp development, and tidally influenced water level fluctuation. Problems in the lakes include turbidity, sediment deposition, reduced photosynthesis, and low dissolved oxygen. Some of the lakes, including Verret, also have pesticide pollution, probably originating from drainage of sugar cane fields. Because the main flow of Bayou Lafourche is pumped from the Mississippi at Donaldsonville, many of the water quality problems associated with the Mississippi may be found in the bayou. These problems include coliforms, mercury, pesticides, carcinogens, taste, and odor. Urban runoff from land adjacent to the bayou causes additional pollutant loads. Other problems include low dissolved oxygen in downstream reaches, and eutrophication which decreases in severity from Lake Cataouatche to the estuarine areas.

Salinities decrease away from the Gulf, with brackish and saline marshes dominant over fresh and intermediate marshes. Measurements were acquired at six locations in the basin with the highest means of 20.90 ppt at the Marine Lab at Grand Terre, 15.50 ppt on Bayou Lafourche at Leeville, and 12.90 ppt at St. Mary's Point. Low values were 0.56 ppt on Bayou Lafourche at Larose, 1.72 ppt on Bayou Lafourche at Galliano, and 1.93 ppt on Bayou Barataria at Barataria. Relative sea level rise was measured at six locations in the basin, and ranges from 0.07"/yr (0.17 cm/yr) on Bayou Chevreuil near Chegby (1952-1983) to 0.36"/yr (0.92 cm/yr) on Bayou Rigaud at Grand Isle. Subsidence, computed by subtracting eustatic change rates for the Gulf of Mexico, therefore ranges from -0.02"/yr (-0.06 cm/yr) at Chegby which shows an increase in water surface elevation, to 0.27"/yr (0.69 cm/yr) at Grand Isle. Such increases may be a function of the period of record or changes on the water bottom, because tide gages measure changes in a water body and not on the land.

Navigation projects in the Barataria basin include the Bayou Lafourche and Lafourche Jump Waterway, Bayou Segnette Waterway and Bayou Segnette, the Barataria Bay Waterway, and the waterway from Empire to the Gulf of Mexico. The Bayou Lafourche and Lafourche Jump Waterway includes permanent closure of the head of Bayou Lafourche without a lock, a channel 9' deep by 100' wide from Golden Meadow to Leeville, a channel 12' deep by 125' wide from Leeville to the Gulf of Mexico, a jettied entrance at Belle Pass, and the closure of Pass Fourchon.

The Barataria Bay Waterway extends about 37 mi, from the Gulf Intracoastal Waterway to Grand Isle; it is 12' deep and 125' wide at mean low Gulf. The channel between mile -1.26 and the 12' contour through Barataria Pass in the Gulf of Mexico was enlarged to 250' wide, and enlarged again to 15' deep from mile 0 to the 15' contour. The waterway from Empire to the Gulf of Mexico consists of a 9'-by-80' channel; jetties extend to the 6' contour at the Gulf outlet.

The Bayou Segnette project consisted of reestablishing a usable navigation channel 6' deep and 40' wide between Bayou Bardeaux and the westward end of the Westwego Canal, a distance of about 6 mi. Further channel enlargement provided an 8'-by-50' channel between miles 1.5 and 5.5. The Bayou Segnette Waterway is 12.2 mi long and begins at the southern end of Company Canal at Westwego and follows the existing channel of Bayou Segnette (including its cutoffs), a land cut to the east of Lake Salvador, and end at the head of the Barataria Bay Waterway. The channel is about 8' deep and 80' wide.

Flood control and protection projects in the Barataria basin include the Larose to Golden Meadow Hurricane Protection Project, the Harvey Canal-Bayou Barataria Levee, and the Grand Isle Beach Erosion Project. The Harvey Canal-Bayou Barataria Levee project consists of construction of a levee along part of the Gulf Intracoastal Waterway in Jefferson Parish, enlargement of a previously existing levee from Cousins Canal to mile 6, and a new levee from mile 6 to Louisiana state highway 45, near Crown Point. The Larose to Golden Meadow Hurricane Protection Project includes enlargement of 3 mi of existing levees, construction of 43 mi of new levees, 8 mi of low interior levees, two major floodgates in Bayou Lafourche, and several drainage pumping stations. The project was still under construction in 1984 and has progressed appreciably since then. The Grand Isle project provides for hurricane protection and reduction of beach erosion on the island; it includes construction of a sand-filled berm and a vegetated and sand-filled dune extending the length of Grand Isle's Gulf shore, and a jetty to stabilize the western end of the island at Caminada Pass. The artificial dune was constructed to an elevation of 11' NGVD.

Mississippi River Basin

The Mississippi River is the largest river on the North American continent, draining approximately 1.24 million mi^2. The Mississippi River basin is bounded by the Barataria basin to the west, the Pontchartrain basin to the northeast, the Breton Sound Basin to the southeast, the coastal zone boundary to the north, and the Gulf of Mexico to the south. The basin is located in the eastern portion of the Mississippi River delta plain. In addition to the Mississippi River, major channels in the basin include distributaries at Grand and Tiger Pass, Southwest Pass, South Pass, Southeast and Northeast passes, Pass a Loutre, Raphael Pass, North Pass, and Main Pass. Major coastal water bodies in the proximity of the birdfoot delta include West Bay, East Bay, Garden Island Bay, and Blind Bay.

The Mississippi River basin includes alluvial and deltaic deposits associated with the modern Mississippi River. The predominant soils of the Mississippi River and delta basin include, in order of dominance, 1) Commerce-Sharkey, 0-1%, developed on silty sediments along the Mississippi River and abandoned distributaries; 2) Sharkey-Commerce, frequently flooded, developed along the natural levees of the Mississippi River in alluvial and deltaic areas, particularly on the downstream end of the channel; and 3) Convent-Commerce-Sharkey, 0-1%, developed on silty sediments along the Mississippi River upstream of New Orleans. Minor soils developed on Mississippi River alluvium in the northern part of the coastal basin are: 1) Sharkey, 0-1%, developed on fine-grained alluvium; and 2) Commerce, 0-1%, developed on silty alluvium. Soils developed in the delta plain deposits include 1) Medisaprists-Hydraquents, moderately saline, developed on the outer edges of the modern deltaic area of the Mississippi River on marsh deposits; and 2) Medisaprists, fresh, developed in the inland section near the distributaries of the modern deltaic area of the Mississippi River. Both soil associations have approximately the same areal extent (figure 39).

Roads are nonexistent in the basin, except for access roads along and across artificial levees that are the basin boundaries. The only canals within the basin proper are small features in the vicinity of the Mississippi delta. Human activities in the basin include industrial activities on the batture, water use by municipalities adjacent to the river, sand and silt extraction from borrow pits, cattle grazing, and extensive barge and ship traffic.

The hydrology of the Mississippi River system has been greatly modified to reduce flooding. Numerous reservoirs and flood control structures lie upstream along the channel and its tributaries. In the study area, flow is diverted into the Atchafalaya basin at the Old River Control and Auxiliary structures (mile 313), which were completed in 1963 and 1987, respectively; into the Morganza Floodway at the Morganza Spillway (mile 278), which was completed in the early 1950s; and also into the Pontchartrain basin through the Bonnet Carre Spillway (mile 128), which was built in the mid-1930s. The combined diversion through these three structures during the flood of 1973 amounted to about 40% of the total flow at Vicksburg, Mississippi (mile 436) (Chin et al. 1975). Uncontrolled diversions of flow, where breaches are cut in natural levees, have been implemented at Pass a Loutre and are proposed elsewhere in the delta region to reduce land loss and salinity in wetlands adjacent to the Mississippi River. The Delta National Wildlife Refuge and Pass a Loutre Wildlife Management area are located in the coastal Mississippi basin.

There are 18 water-level stations in the Mississippi basin (figure 40). In general, moving upstream the stations show progressively higher stages due to the channel gradient. The maximum water levels across the basin occurred as a result of the following events: the 1927 flood at three locations; Hurricane Camille in 1969 at three locations; Hurricane Betsy in 1965 at two locations; and the 1973 flood at two locations. The maximum stages recorded at these stations are partly dependent on the length and period of record. The minimum water level recorded was -1.87' on South Pass at Port Eads in 1939. Continuous discharge measurements are not collected within the coastal Mississippi basin, but farther upstream at Tarbert Landing. Maximum and minimum daily discharges at Tarbert Landing during the period of record were 1,977,000 cfs in February 1937, and 85,000 cfs on November 4, 1939; however, discharges have not been determined for the record high and low stages at this location. Mean discharge for 1973-1982 is 514,000 cfs. Maximum, mean, and minimum discharges in the Mississippi River have shown appreciable variations during the 20th century (figure 41). Before the Old River Control Structures were completed in 1963, maximum discharges exceeded 1,500,000 cfs on at least nine occasions. Maximum discharge has not exceeded 1,500,000 cfs then. Mean discharge shows a similar relationship, having exceeded 500,000 cfs more often before completion of the Old River Control project (figure 41). Periodic discharge measurements are collected at Belle Chasse, but are not described because of the short period and discontinuity of the record. Discharge is markedly seasonal, with low flow occurring in the summer and fall, and high flow during the winter and spring. The effect of tides increases downstream and is notable as far upstream as 35

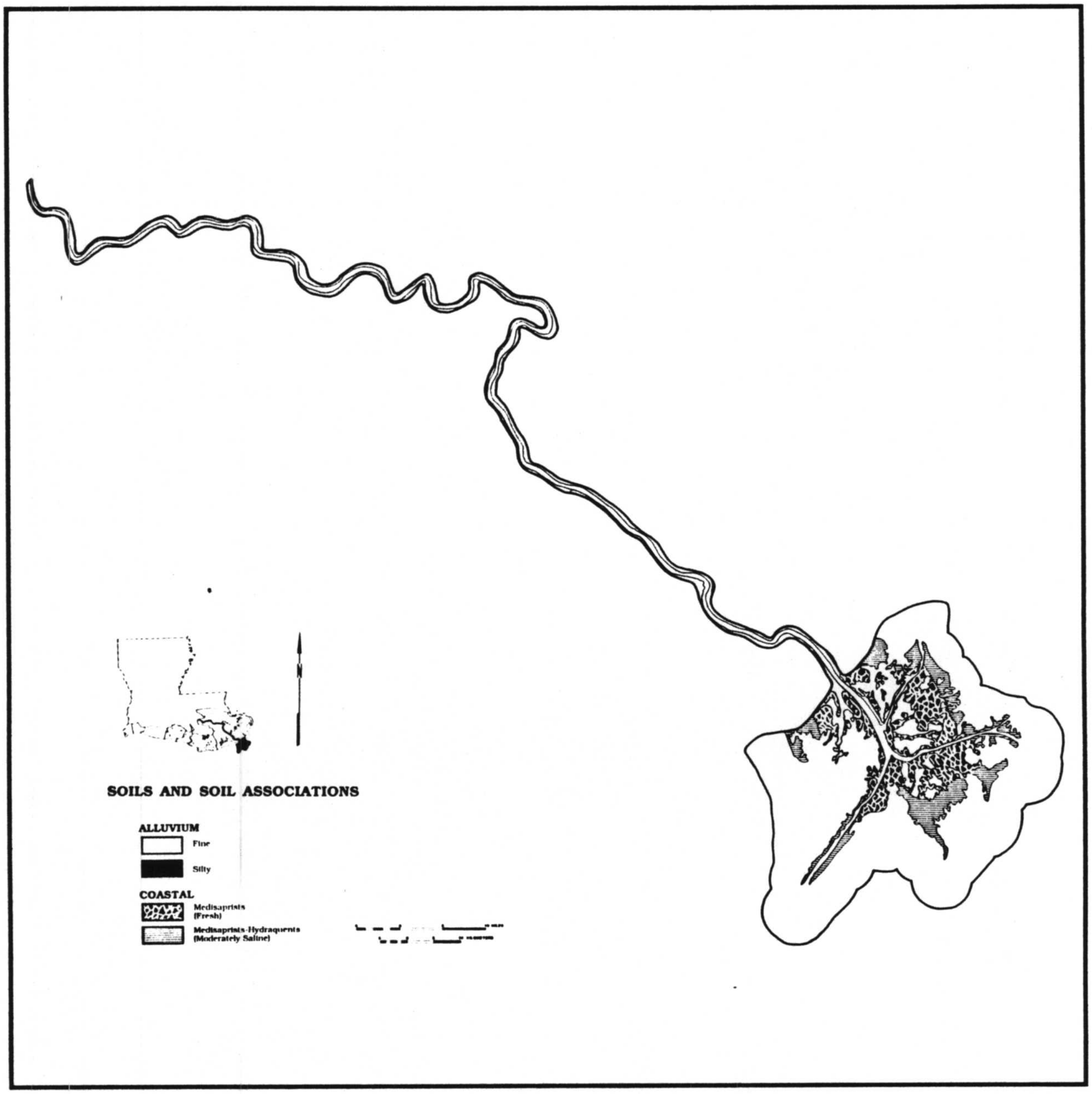


Figure 39. Major coastal soil associations of the coastal Mississippi basin (Spicer 1981).

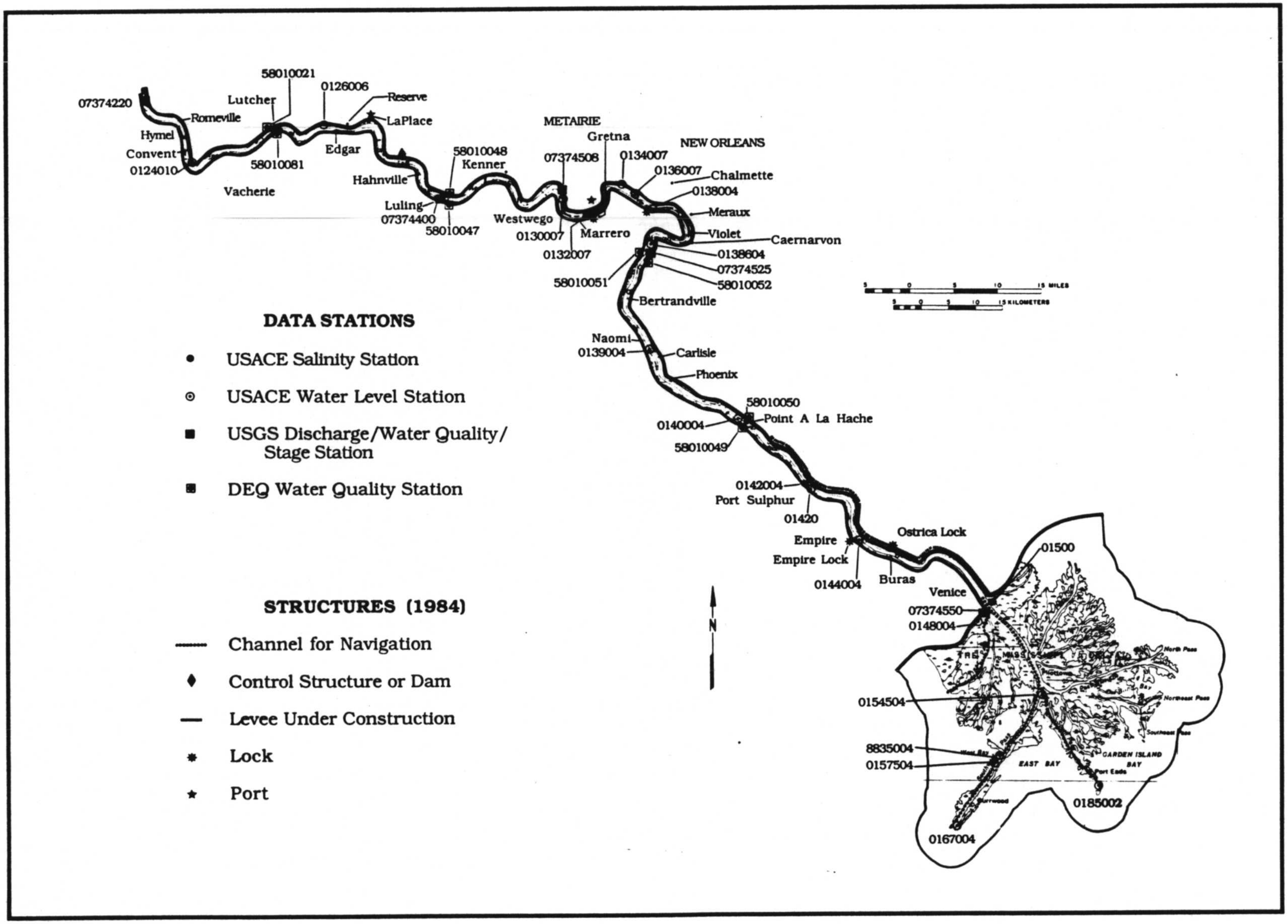


Figure 40. Data stations and major structures in the coastal Mississippi basin (Department of Transportation and Development 1984).

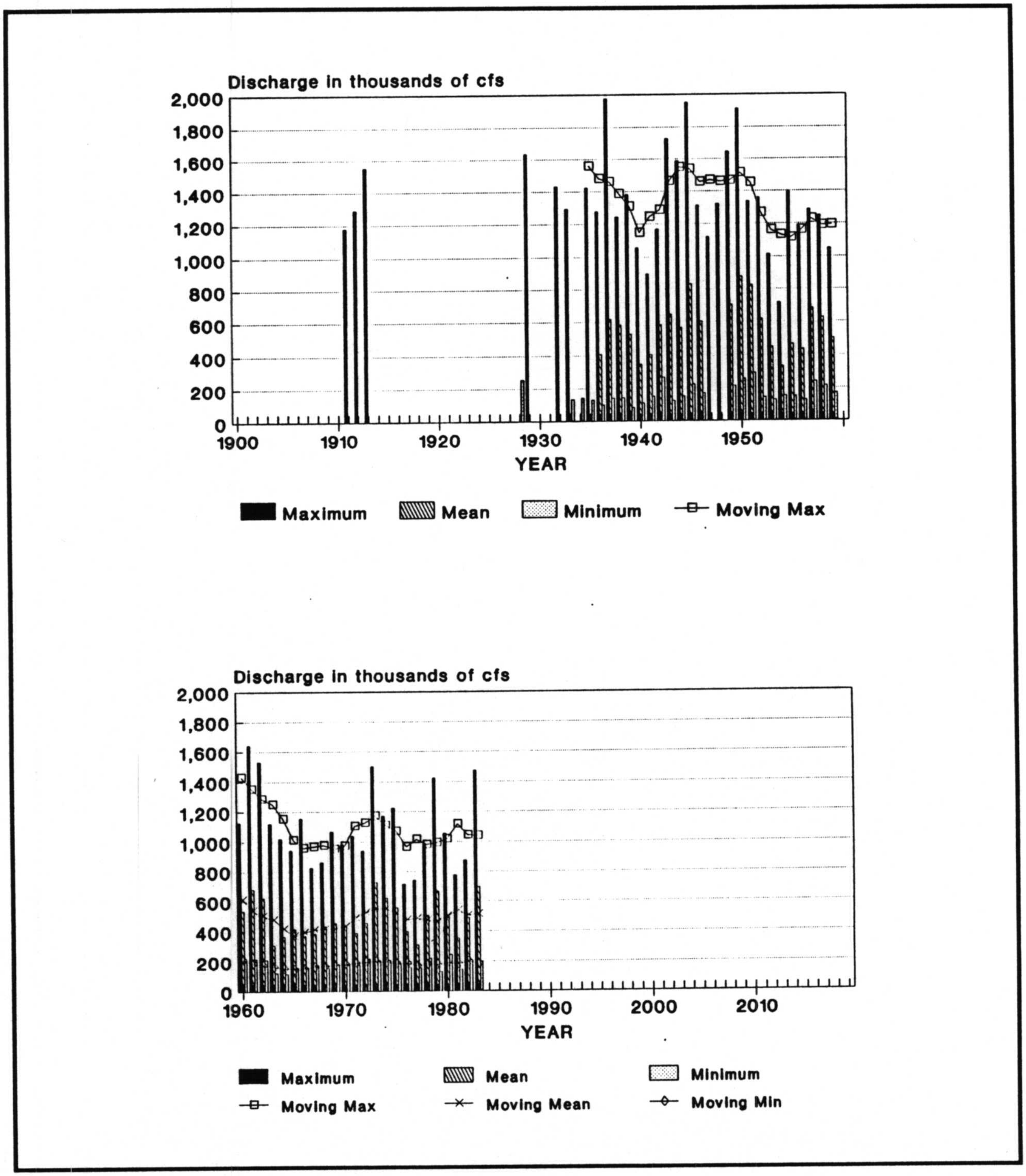


Figure 41. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for Mississippi River at Tarbert Landing, 1937-1959, and 1960-1984.

mi above Baton Rouge during extreme low water (Kolb 1962). The approximate reach of tidal influence in the basin as reflected by vegetation is shown in figure 42.

Water quality is examined by the Department of Environmental Quality at eight locations in the coastal Mississippi basin, with east and west bank sampling on the ferry landings at Lutcher, Luling, Belle Chasse, and Pointe a la Hache. Dissolved oxygen measurements since 1966 were at or below 5 ppm at Lutcher, east bank, on two occasions, and Lutcher, west bank, on three occasions, with no values below 3 ppt at either location. Turbidity ranged from 4 to 500 NTU and 3.5 to 510 NTU, and total suspended solids from 0 to 702 ppm and 0 to 450 ppm. Since 1966, Luling, east bank, has had six dissolved oxygen measurements below 5 ppm, and Luling, west bank, eight measurements below 5 ppm and one of these below 3 ppm. Turbidity ranged from 3.3 to 525 NTU and 1.8 to 550 NTU, and total suspended solids from 0 to 636 ppm and 2 to 636 ppm. Since 1966, Belle Chasse, east bank, has had 16 dissolved oxygen measurements below 5 ppt, and Belle Chasse, west bank, 13 measurements below 5 ppt and one of these below 3 ppt. Turbidity ranged from 3.3 to 525 NTU and 1.8 to 550 NTU, and total suspended solids from 0 to 636 ppt and 2 to 636 ppt. Since 1971, Pointe a la Hache, east bank, has had 13 dissolved oxygen measurements below 5 ppt; one of these was below 3 ppt, and Pointe a la Hache, west bank, had six measurements below 5 ppt. Turbidity ranged from 1.3 to 280 NTU and 1.4 to 250 NTU, and total suspended solids from 1 to 464 ppt and 0 to 560 ppt (figures 43, 44, 45, 46, 47, 48, 49, 50).

Water quality is examined by the U.S. Geological Survey at five locations in the coastal Mississippi basin: Union, Luling, New Orleans, Belle Chasse, and Venice. At Union and Luling, since 1973 no dissolved oxygen measurements have been below 5 ppt. Turbidity ranged from 2 to 210 NTU and 2 to 230 NTU, and total suspended solids from 7 to 646 ppt and 1 to 605 ppt. At New Orleans, there were no dissolved oxygen measurements below 5 ppt; since 1970, turbidity ranged from 1.5 to 160 NTU and total suspended solids from 44 to 130 mg/l. At Belle Chasse and Venice, there was one dissolved oxygen measurement below 5 ppt, since 1978 and 1973, respectively. Turbidity ranged from 1 to 230 NTU and 0.5 to 200 NTU. Readings on total suspended solids were not taken at Belle Chasse, but ranged from 1 to 762 mg/l at Venice. Suspended sediment ranged from 7 to 746 mg/l at Belle Chasse. Only six suspended sediment samples were collected at Venice (figures 51, 52, 53, 54, 55).

Concerns relating to surface water resources include high water levels in the Mississippi River that cause flooding within leveed areas and possible levee breakage, waste spills from industrial and shipping activity, and contamination from untreated or poorly treated sewage. The major effect on water quality is from the municipal/industrial corridor, which begins just above Baton Rouge and continues below New Orleans. There are over 100 industrial and over 10 municipal discharges along the river. Additional problems have been attributed to heavy barge and ship traffic from New Orleans to the Gulf of Mexico. Fecal coliform is a major problem on the Mississippi River. This bacterial contamination has led to closures of oyster grounds of the Mississippi delta since 1973. Phenols and DDT violations also occur below New Orleans. The lower segment of the basin is subject to saltwater intrusion at times of low flow, which results in chloride violations.

The water quality in the segment of the river from the upper basin boundary to New Orleans (mile 106) is considered to be moderately polluted with a water

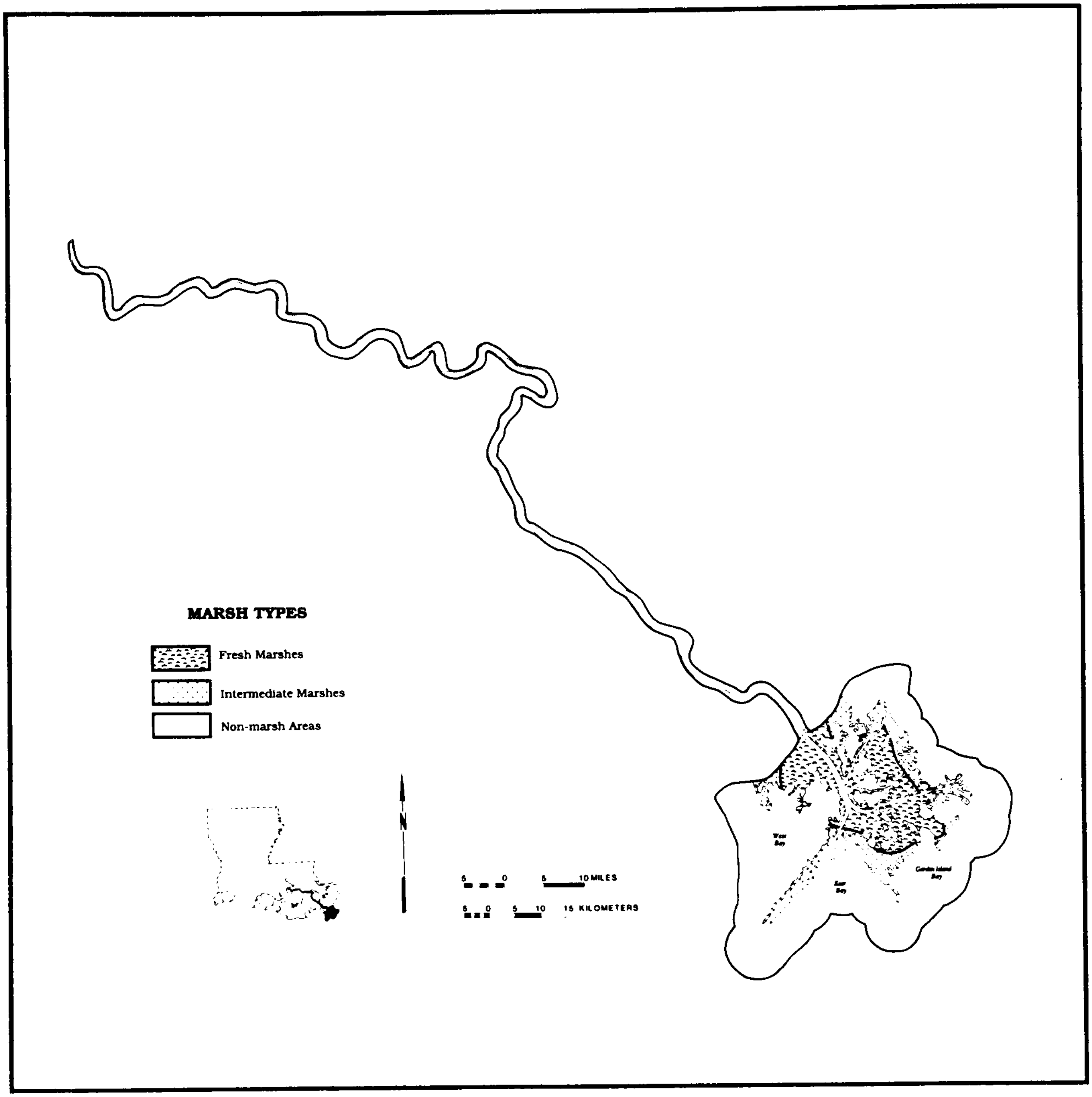
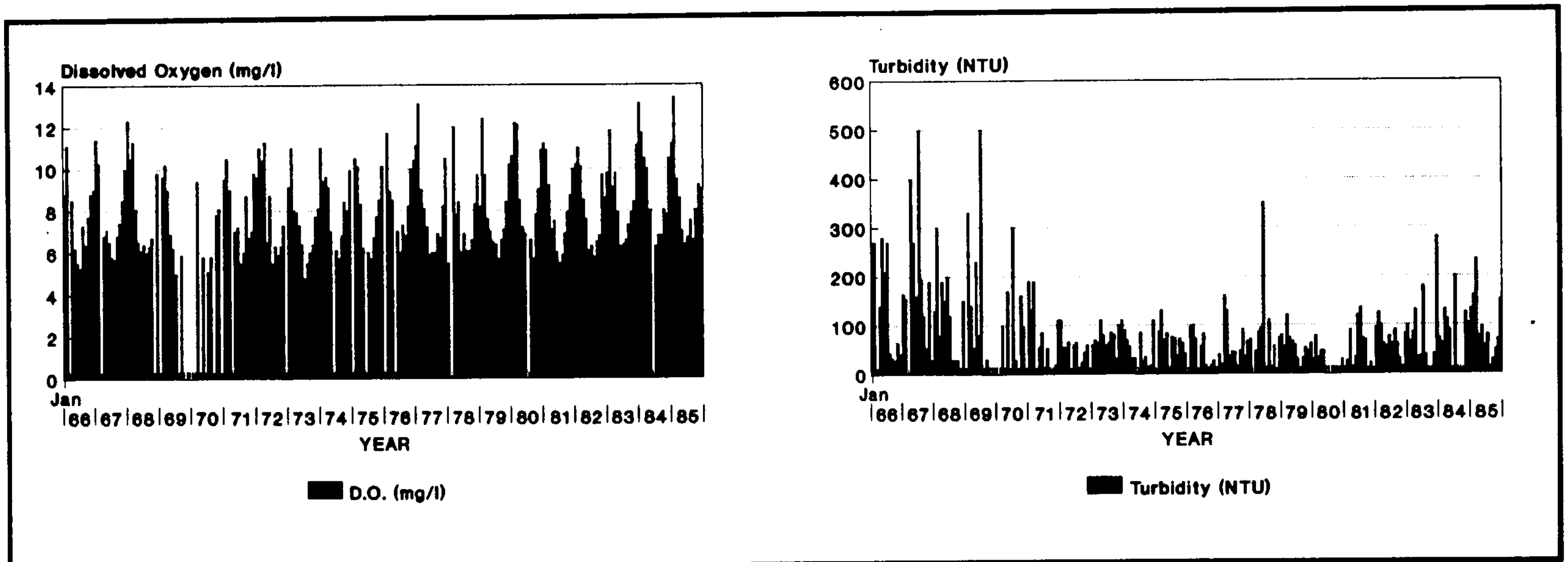


Figure 42. Marsh types in the Mississippi basin (Chabreck 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.



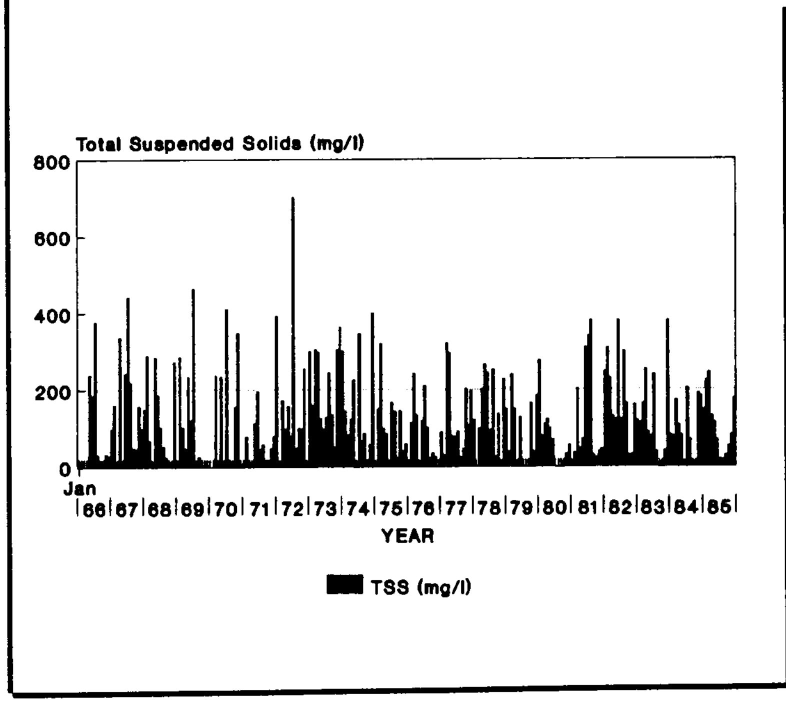
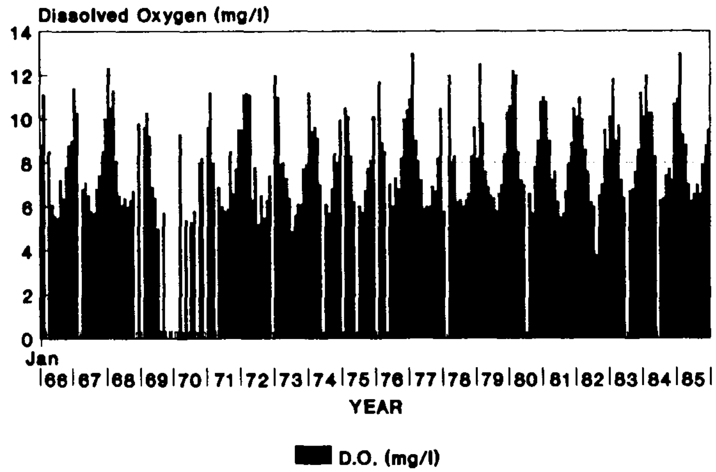
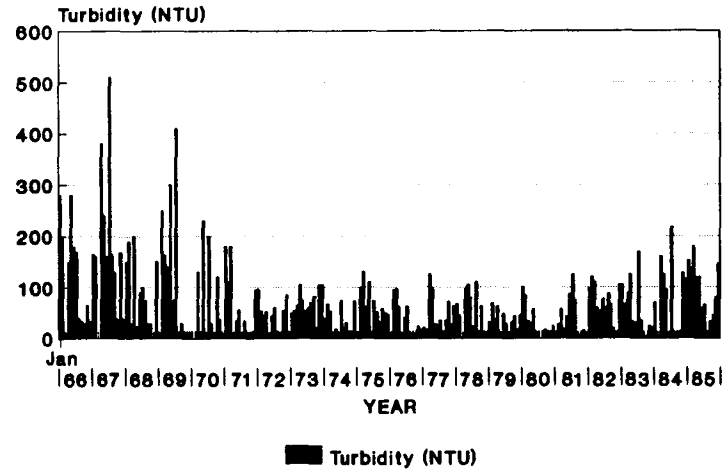


Figure 43. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Lutcher, East Bank at Ferry Landing, 1966-1985.





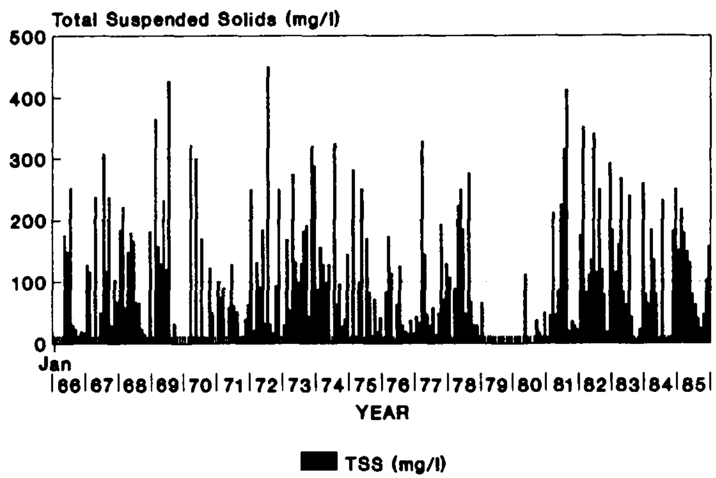


Figure 44. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Lutcher, West Bank at Ferry Landing, 1966-1985.

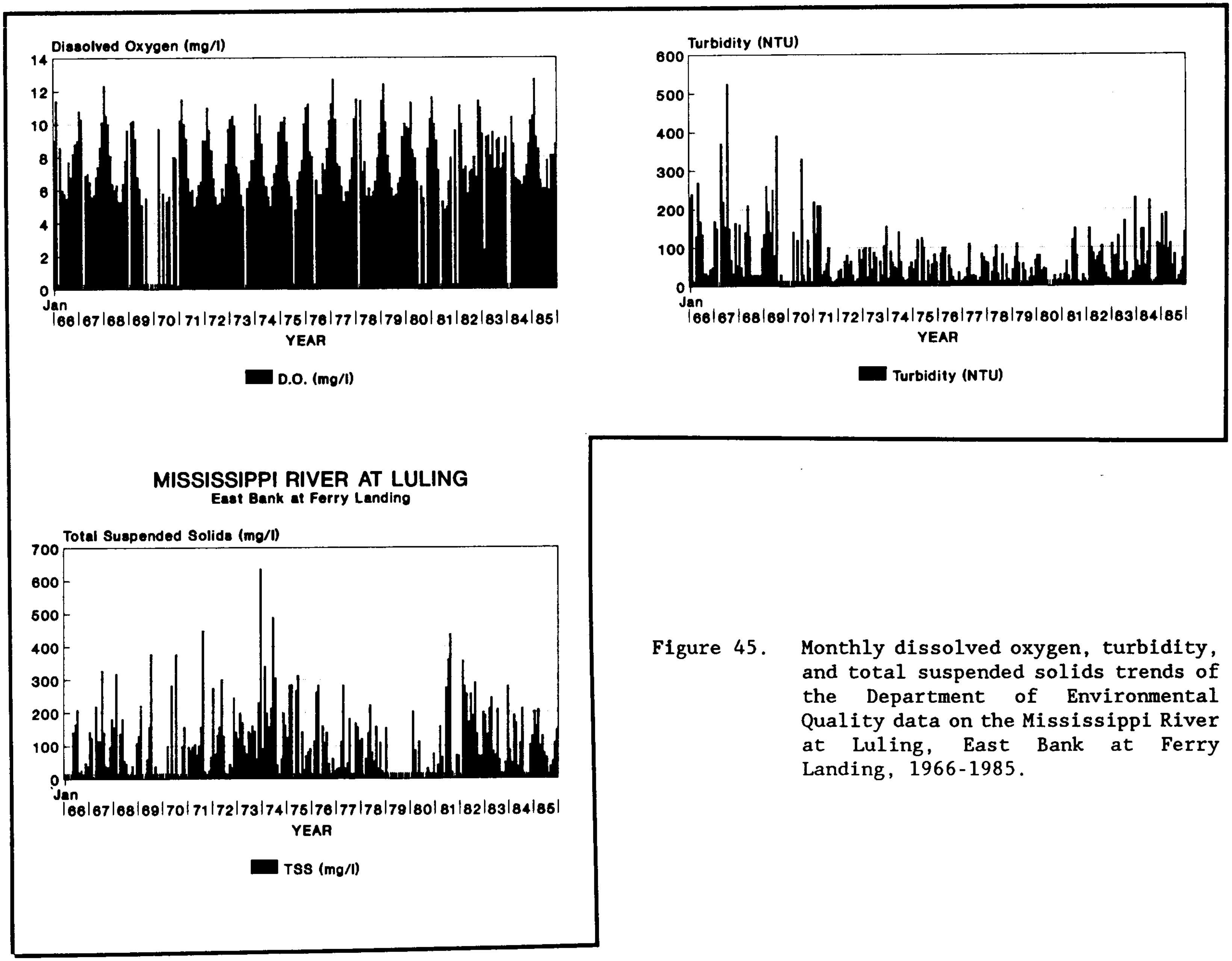


Figure 45. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Luling, East Bank at Ferry Landing, 1966-1985.

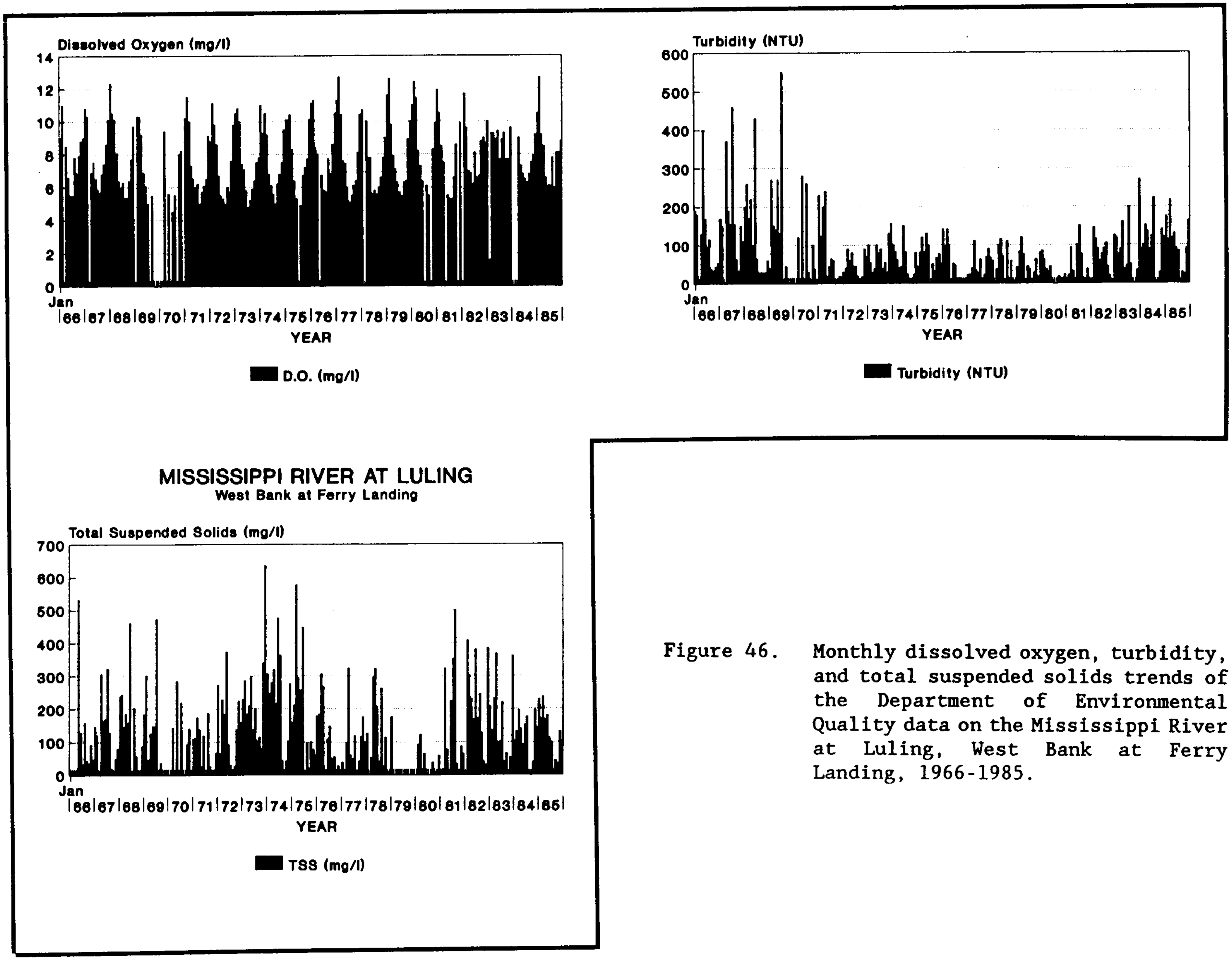
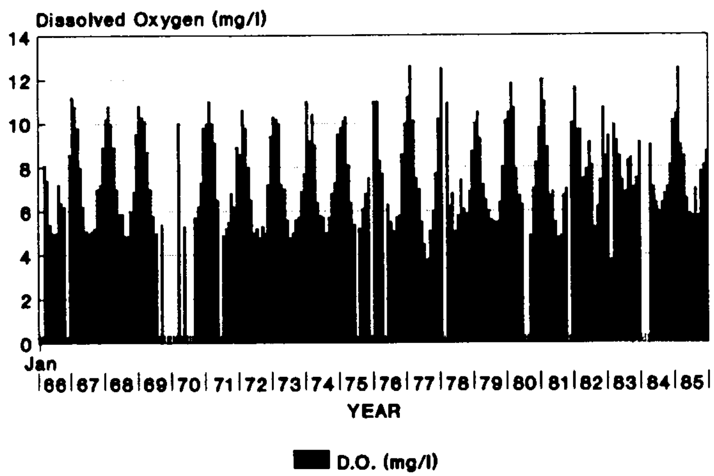
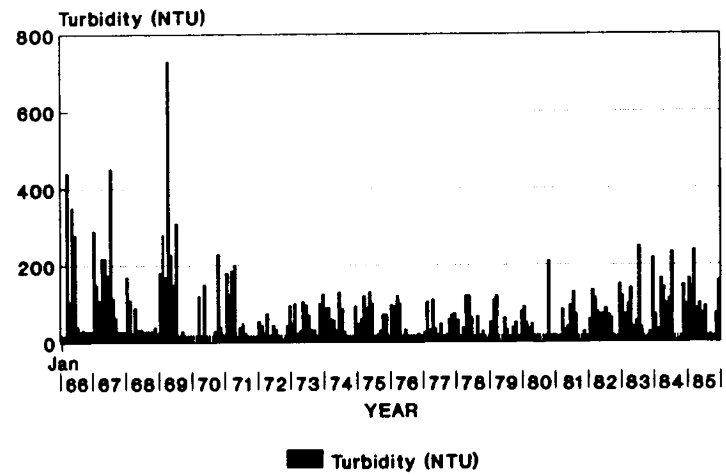


Figure 46. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Luling, West Bank at Ferry Landing, 1966-1985.





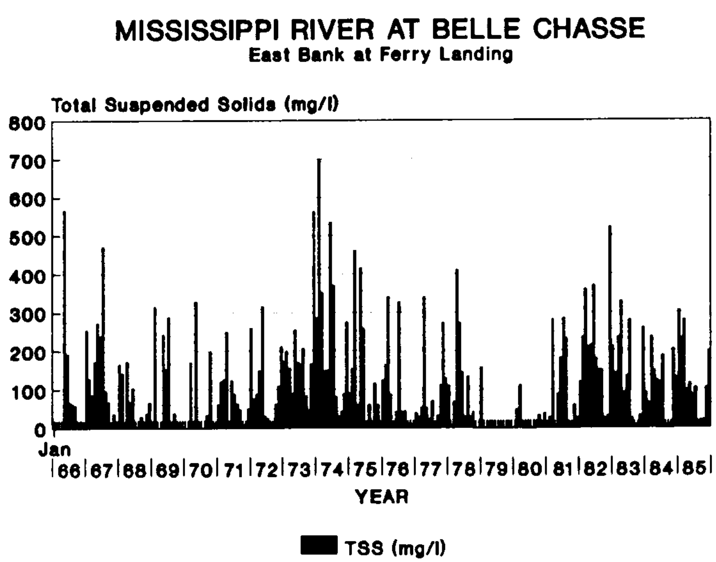
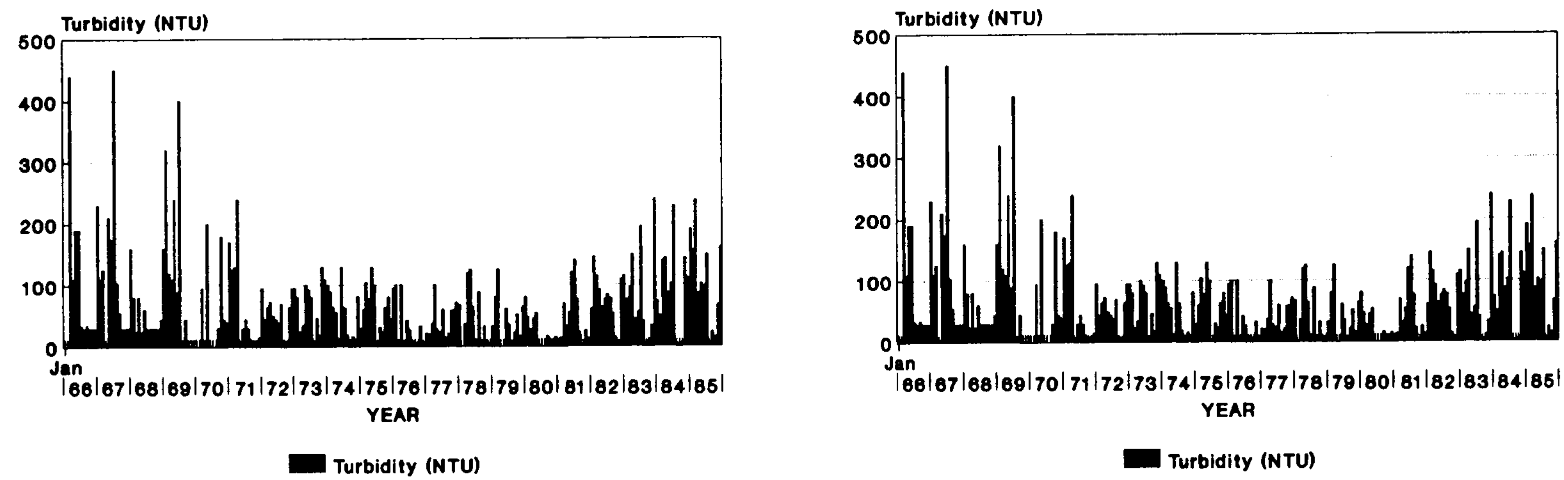


Figure 47. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Belle Chasse, East Bank at Ferry Landing, 1966-1985.



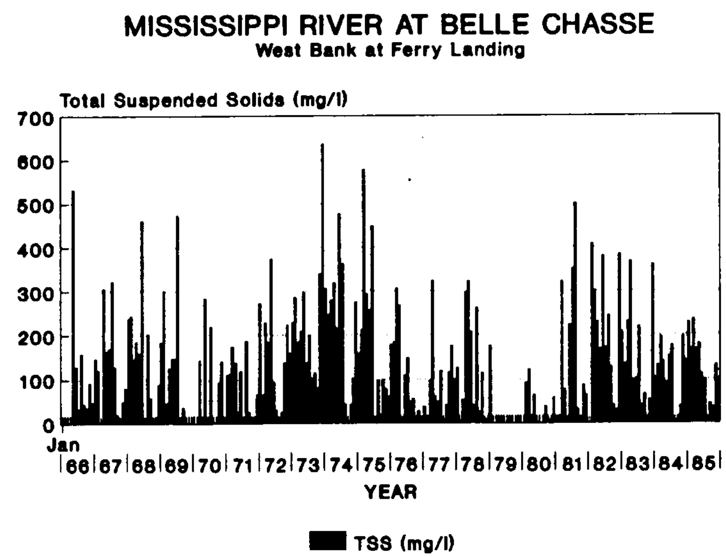
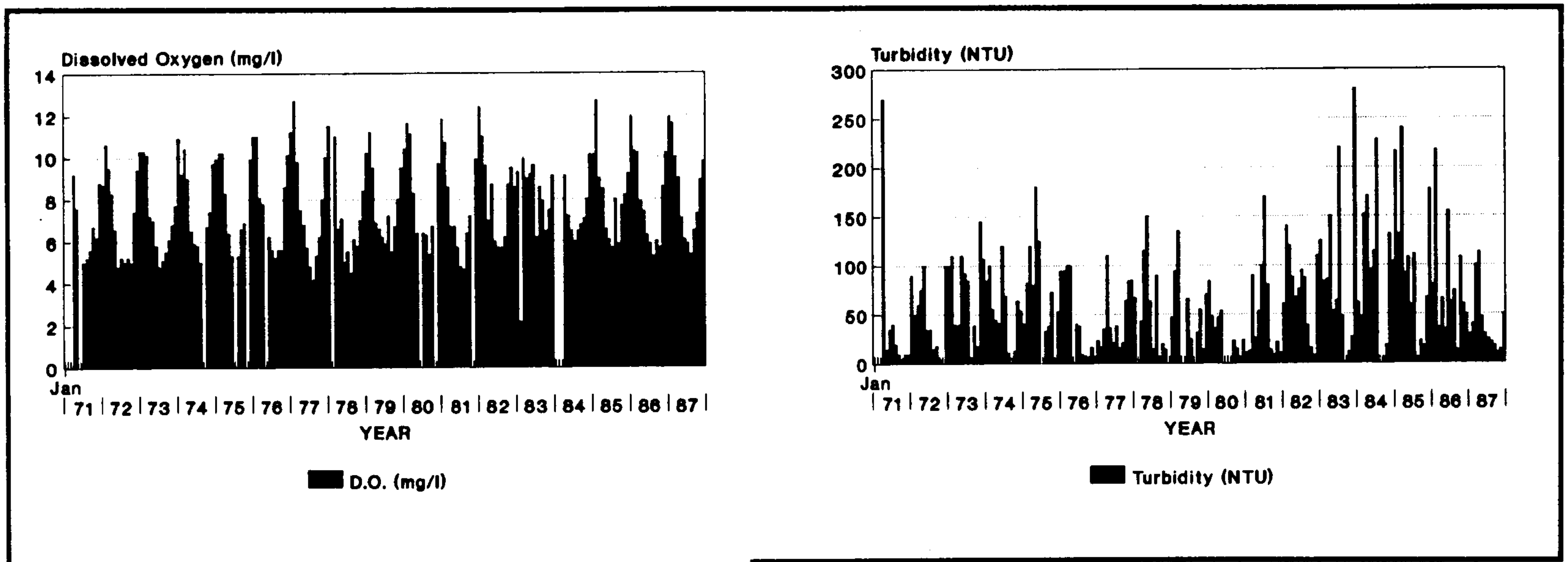


Figure 48. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Belle Chasse, West Bank at Ferry Landing, 1966-1985.



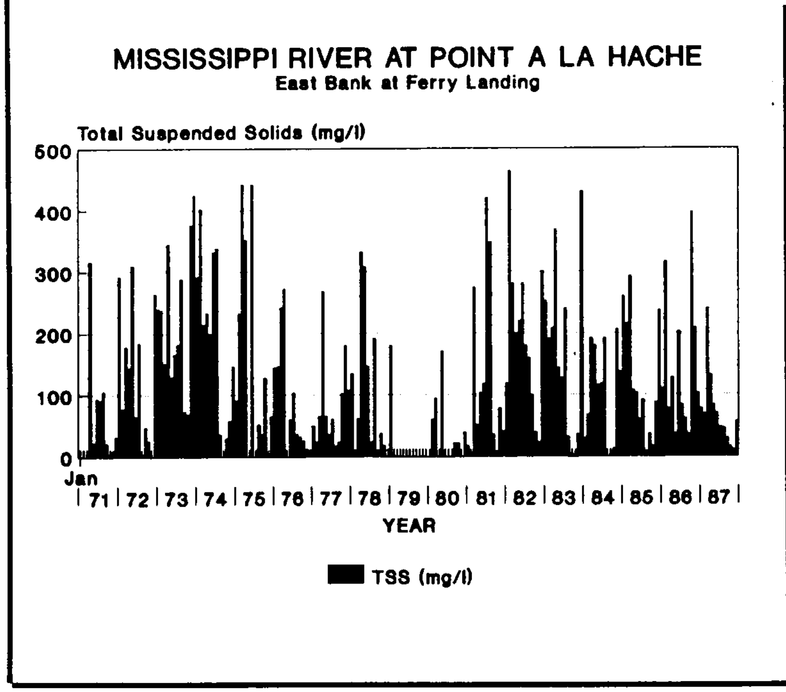
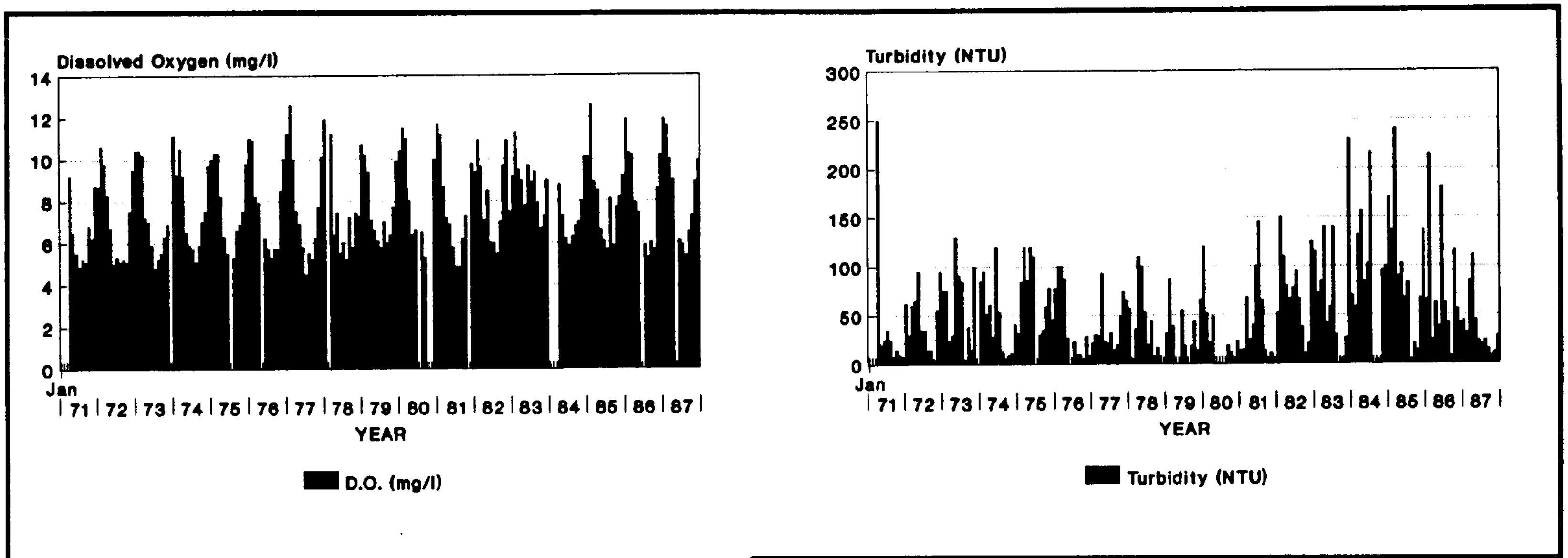


Figure 49. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Point a la Hache, East Bank at Ferry Landing, 1971-1987.



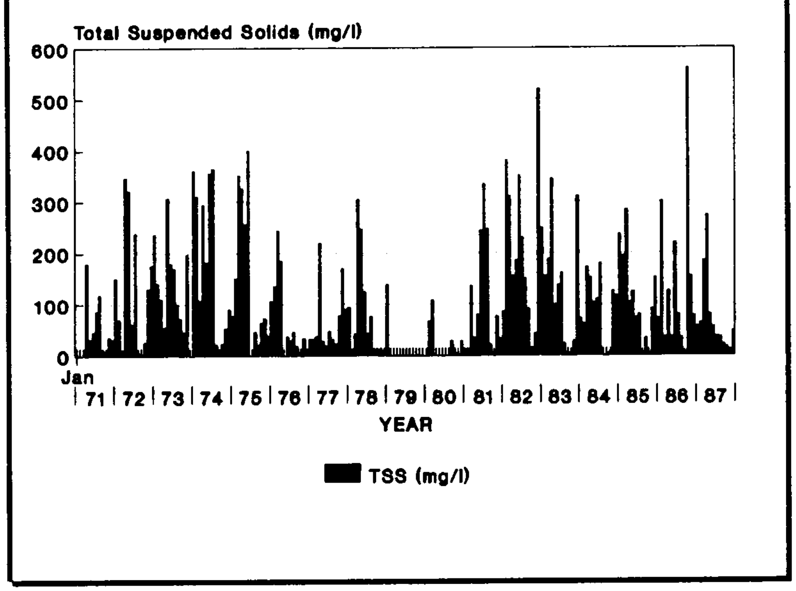


Figure 50. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Mississippi River at Point a la Hache, West Bank at Ferry Landing, 1971-1987.

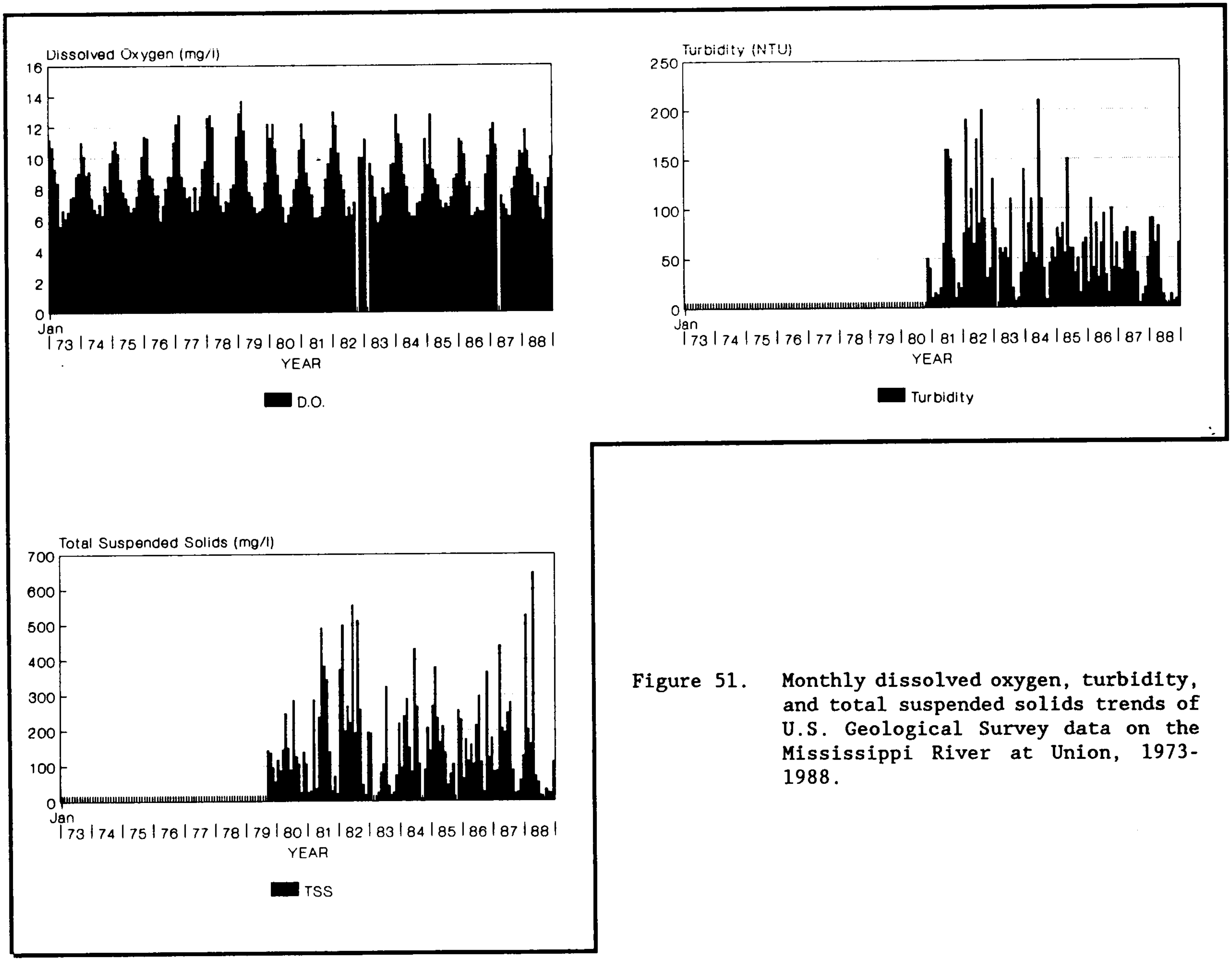


Figure 51. Monthly dissolved oxygen, turbidity, and total suspended solids trends of U.S. Geological Survey data on the Mississippi River at Union, 1973-1988.

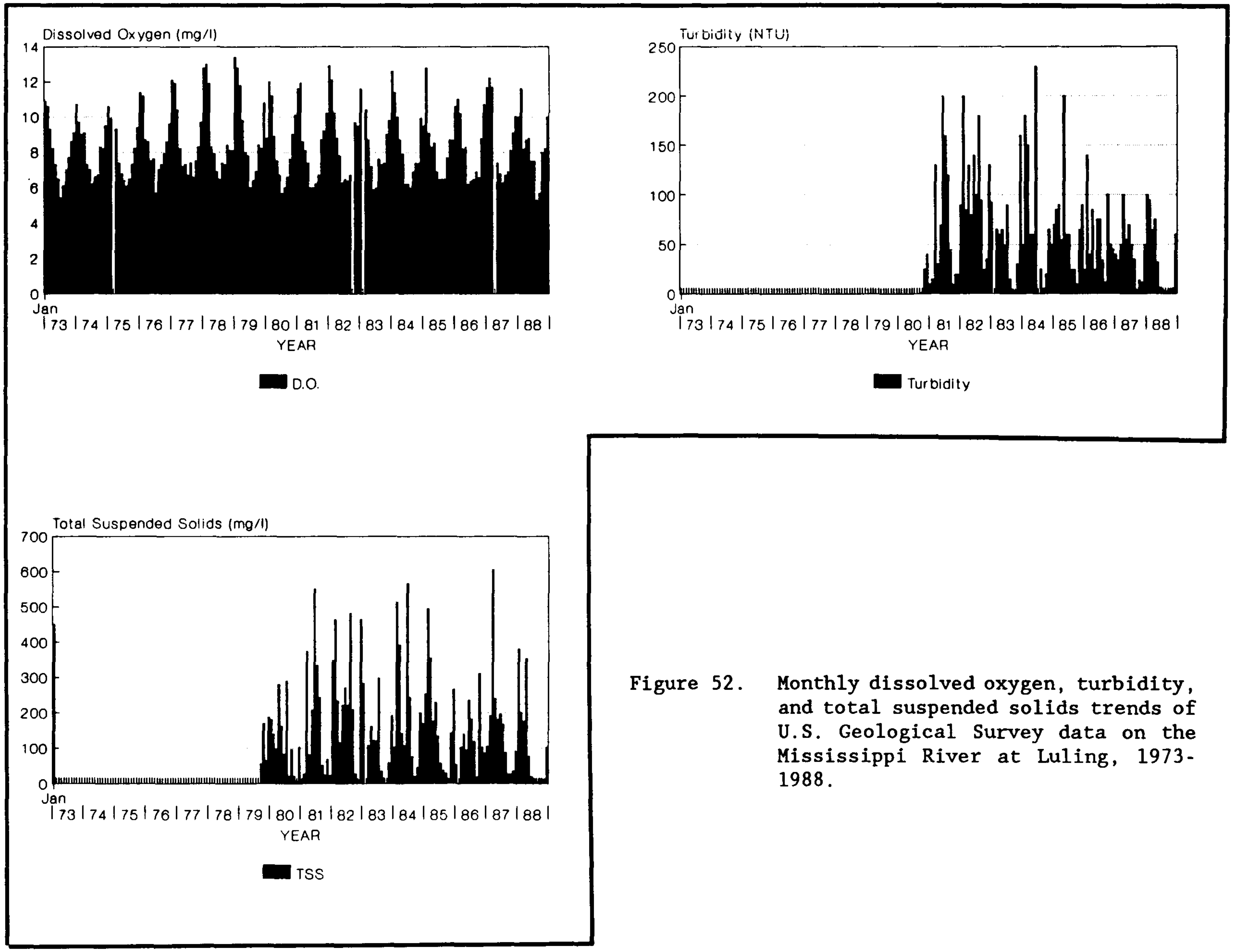
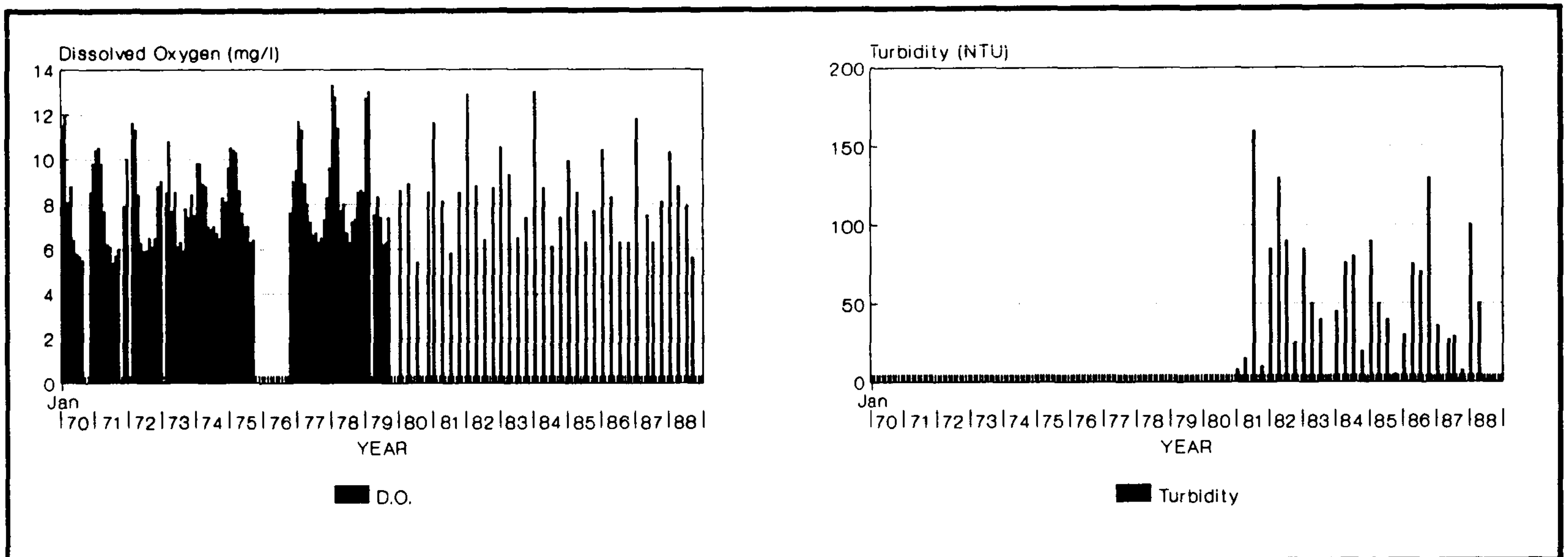


Figure 52. Monthly dissolved oxygen, turbidity, and total suspended solids trends of U.S. Geological Survey data on the Mississippi River at Luling, 1973-1988.



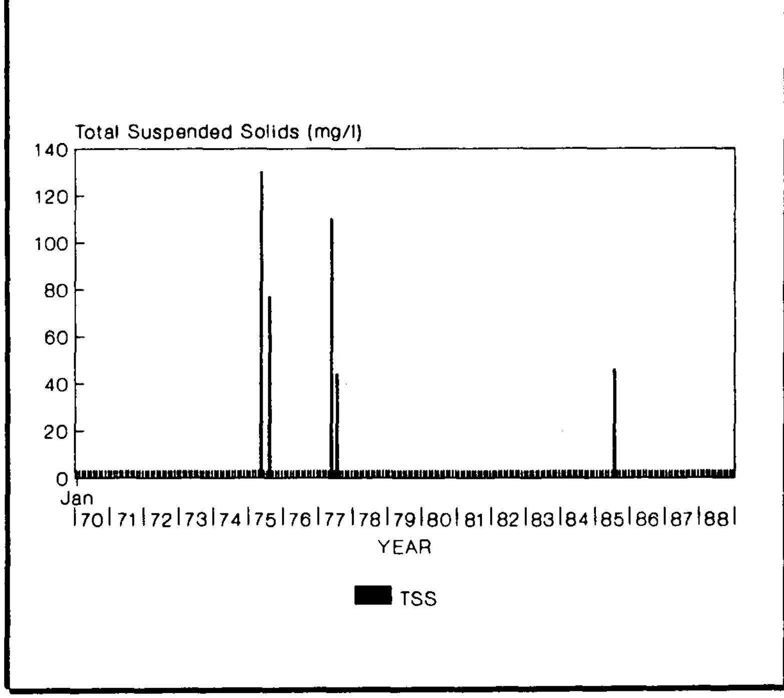


Figure 53. **Monthly dissolved oxygen, turbidity, and total suspended solids trends of U.S. Geological Survey data on the Mississippi River at New Orleans, 1970-1988.**

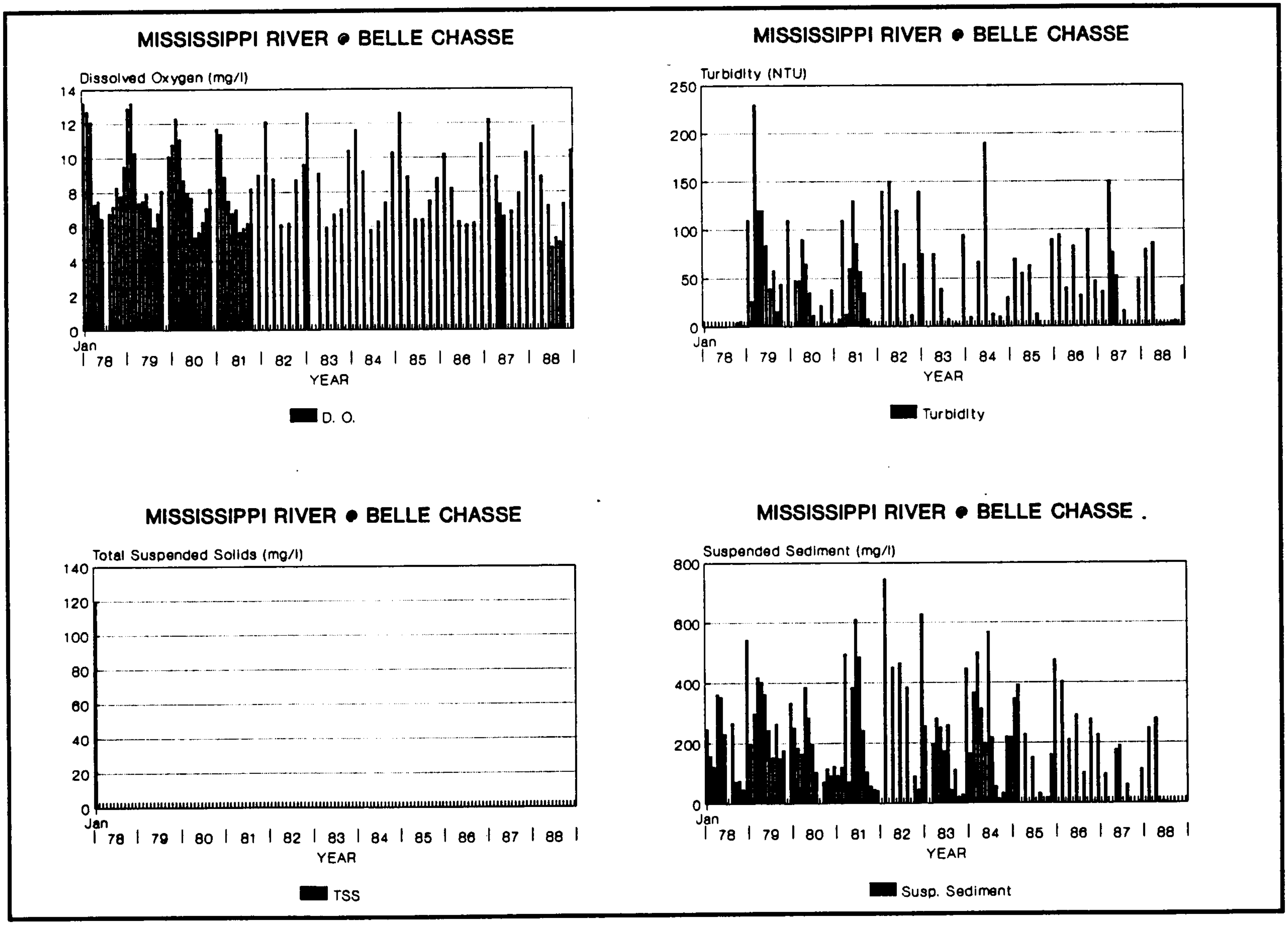


Figure 54. Monthly dissolved oxygen, turbidity, and suspended sediment trends of U.S. Geological Survey data on the Mississippi River at Belle Chasse, 1978-1988.

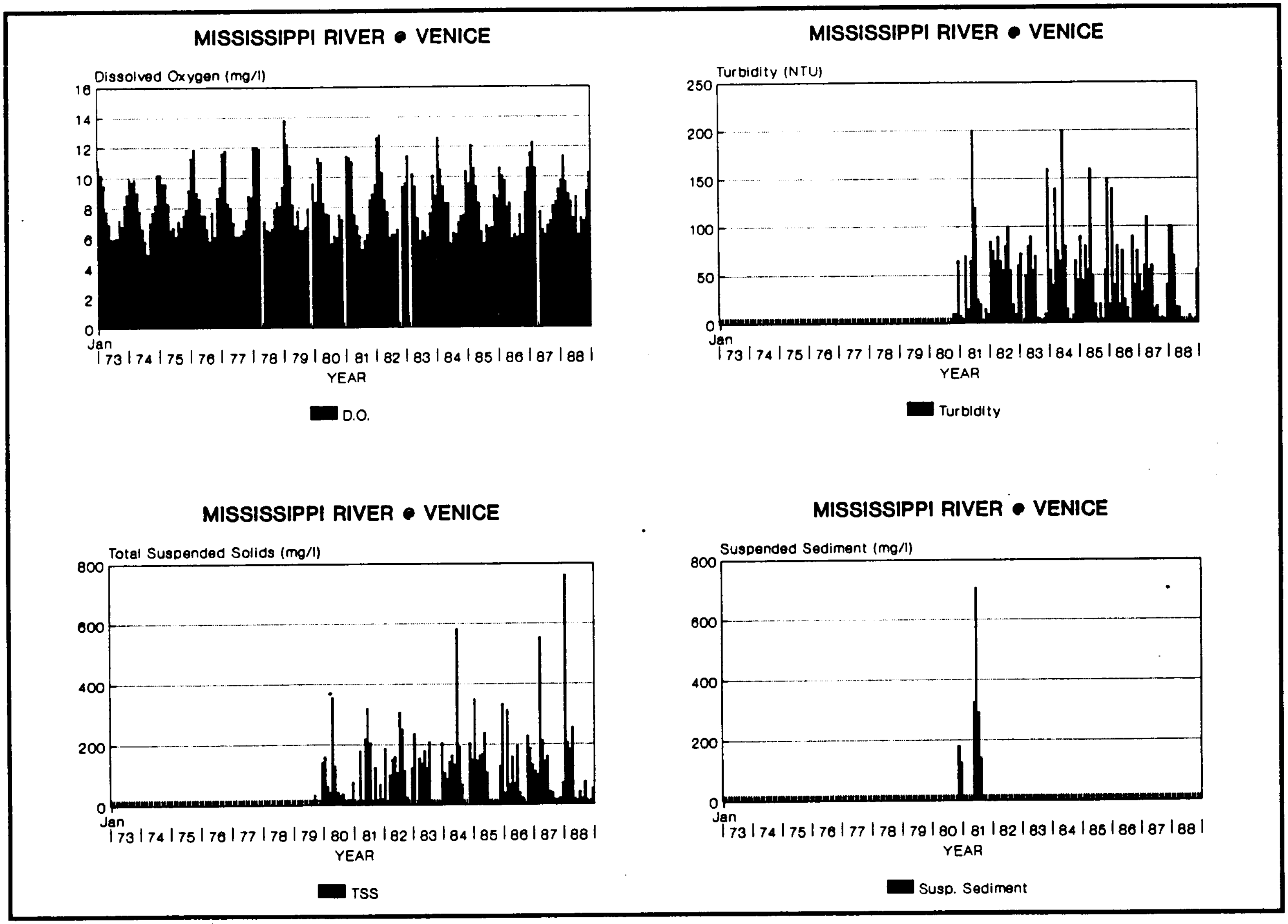


Figure 55. Monthly dissolved oxygen, turbidity, total suspended solids, and suspended sediment trends of U.S. Geological Survey data on the Mississippi River at Venice, 1973-1988.

quality index of 54.3 (an average of readings from seven water quality stations) (Louisiana Department of Transportation and Development 1984). Water quality indexs of these stations range from 48.9 to 57.9; the major problems are turbidity and fecal coliforms. This segment of the Mississippi is considered water quality limited because of taste and odor problems. Low levels of phenols and DDT have been identified, and there is concern over the possibility of a major spill of toxic or hazardous materials from industrial and shipping activities which could contaminate river water. The Mississippi River is the primary source of drinking water for most of the river parishes from Ascension to the Gulf of Mexico. The portion of the Mississippi River from New Orleans (mile 106) to the Head of Passes (mile 0) has a Water quality index of 83.0, with the major problem being fecal coliform. Saltwater intrusion in the Mississippi River depends on discharge, flow duration, winds, and tides. In 1939-1940, salt water was recorded as far upstream as Luling. Chloride concentrations may on occasion exceed the recommended limits for public supplies. Existing saltwater intrusion would become worse if navigation depths were increased as planned. Proposed protection measures for water supply include the periodic establishment of a saltwater barrier, moving water intakes or treatment plants upstream of this barrier, and the development of storage reservoirs.

In the delta region, the basin is dominated by freshwater deltaic deposits, which increase in salinity away from the river and its distributaries near the Head of Passes. Salinity is measured at two stations in the coastal Mississippi basin. The Mississippi River at Port Sulphur has a mean salinity of 0.17 ppt, and the Mississippi River at the Jump near Venice has a mean salinity of 0.42 ppt. Assessments of relative sea level rise were conducted for 10 stations in the coastal basin. The maximum rate of rise was 1.54"/yr or 3.93 cm/yr (1975-1983) at West Bay near Burrwood. The maximum rate of rise for a long-term station was 0.36"/yr or 0.91 cm/yr (1944-1988) for South Pass at Port Eads. Most other stations show much slower rates of relative sea level rise. The minimum rate was at the Mississippi River at Donaldsonville, with a change in relative sea level of -0.05"/yr or -0.12 cm/yr. Water surface changes based on relative sea level rise estimates in the Gulf of Mexico therefore range from a rise of 0.14"/yr (0.35 cm/yr) to subsidence of 1.45"/yr (3.70 cm/yr).

Navigation projects in the coastal Mississippi River basin include the Mississippi River, Baton Rouge to the Gulf of Mexico, and the Mississippi River outlets at Venice. Authorized dimensions for the Mississippi River, Baton Rouge to Gulf of Mexico are as follows: between Baton Rouge and New Orleans, 40' deep by 500' wide; New Orleans to Head of Passes, 40' deep by 1,000' wide; Southwest Pass, 40' deep by 800' wide; Southwest Pass bar channel, 40' deep by 600' wide; South Pass, 30' deep by 450' wide; and South Pass bar channel, 30' deep by 600' wide. Bank restoration works were required along the Mississippi River below Venice and in Southwest Pass because of high water in 1973. Additional bank restoration, including building rock foreshore dikes and bank nourishment, and repair of the east and west jetties at the mouth of Southwest Pass, has been authorized. At present, an average of 20 million yd^3 is dredged annually.

The Mississippi River ship channel, Gulf to Baton Rouge project, will entail dredging of the Mississippi River up to 55' deep. The first increment of this work began with dredging of the 45' channel from the Gulf to Donaldsonville, at mile 181 above the Head of Passes. Dredge material from construction and maintenance of this project will be used for bank nourishment and marsh creation.

The Mississippi River outlets, Venice project, provides for enlargement of existing outlets of Baptiste Collette Bayou and Grand Tigre Passes. The channel dimensions are 14' deep by a bottom width of 150', except for entrance channels, which are 16' by 250'. Jetties were constructed to the -6' contour to reduce the cost of maintenance dredging.

Flood control projects include the Atchafalaya Basin Floodway, the Bonnet Carre Spillway and Floodway, the Morganza Floodway and components, the West Atchafalaya Floodway and components, and the Old River project and components. The Atchafalaya Basin Floodway project is located between protection levees approximately 15 mi apart, extending from the lower limits of Morganza and West Atchafalaya floodways at the latitude of Krotz Springs to Morgan City and through the Lower Atchafalaya River and Wax Lake Outlet to the Gulf of Mexico.

The Bonnet Carre Spillway, located between the east bank of the Mississippi River and Lake Pontchartrain about 33 river miles above downtown New Orleans, is capable of passing a flow of 250,000 cfs into Lake Pontchartrain and thence to the Gulf. It prevents overtopping of the levees at and below New Orleans. The project consists of a reinforced-concrete control structure located in the riverbank, and guide levees extending about 5.7 mi from the river to the lake. The levees average 19' high and form a floodway flaring from 7,700' in width at the river end to 12,400' wide 3.5 mi from the river to the lake. The structure consists of 350 bays, each 20' wide and equipped with movable timbers. About half the bays are elevation 15.35' NGVD and the remaining about 2' higher. The spillway was completed in 1936 and has served its intended function on seven occasions: 1937, 1945, 1950, 1973, 1975, 1979, and 1983.

The Morganza Floodway consists of the Morganza Combined Control Structure, Morganza Floodway Levees, the Point Coupee Drainage Structure and Bayou Latenache, and three bridge improvements. The Morganza Combined Control Structure consists of about 19,340' of levee and a reinforced-concrete structure consisting of 125 gate openings, each about 28' wide, separated by 3' wide piers. Each opening is equipped with a steel vertical lift-gate operated by a gantry crane. The Morganza Floodway Levees consist of upper and lower guide levees which, with the East Atchafalaya River levee, form a floodway about 5 mi wide. Both the upper and lower guide levees trend southwesterward from the Combined Control Structure; the upper levee extends about 9 mi to the East Atchafalaya River levee near Melville and the lower about 19.4 mi to the East Atchafalaya Basin levee near Krotz Springs.

The west Atchafalaya floodway is designed to carry floodwaters in excess of the combined capacities of the Atchafalaya and Mississippi rivers, and the Morganza floodway. The floodwaters will enter the floodway by overtopping the levee at its head, and along the south bank of Bayou des Glaises. The floodway is about 6 mi wide, and lies between the West Atchafalaya River levee and the West Atchafalaya basin protection levee, for a distance of about 32 mi. It has not been operated to date.

The Old River Project includes the Low-Sill Control Structure, the Overbank Control Structure, the Old River Navigation Lock, the levee from Black Hawk to Torras, and the Auxiliary Structure. This project was designed to maintain the balance of flows from the Mississippi into the Atchafalaya River and basin by control structures on the right descending bank of the Mississippi River. The Old River Low-Sill Control structure is a reinforced-concrete structure consisting of 11 gate bays, with 44' between piers, and 566' between abutments. The three center bays have a weir crest of -5.0' for passing low flows and the other bays have a weir crest of 10' NGVD. The overbank control structure is a reinforced-concrete structure consisting of 73 gate bays, with 44' between piers. The weir crest is 52' NGVD and the total length is 3,356' between abutments. The structure was completed in 1959, and was operated in 1973, 1974, 1975, 1979, 1983, 1984, and 1985. The Auxiliary Control Structure is a reinforced-concrete structure consisting of six gate bays, each having a 62' clear width between piers. The weir crest is -5.0' NGVD, with 442' between abutments. The Old River Navigation Lock, completed in 1962, provides for continued navigation between the Atchafalaya, Ouachita-Black, and Red rivers, and the Mississippi River through Old River. It has a width of 75', a usable length of 1,190', and sills at -11.8'. About 16 mi of levee join the right bank main-line levee at Black Hawk with the control structures and lock, and bank stabilization works have been completed as required to control the meandering of channels. Rehabilitation work has also been conducted, particularly to repair damages sustained during the 1973 flood.

The Mississippi delta region project was designed to increase wetlands productivity. The feature consists of four gated water- or salinity-control structures on the banks of the Mississippi River, with connecting channels and levees that will introduce fresh water from the Mississippi River to the adjoining Barataria and Breton Sound basins. Controlled diversions of flow involve cutting breaches through artificial levees and building flow regulation structures and retention ponds. These are authorized on the east bank of the river at Bohemia and Caernarvon, and on the west bank at Davis Pond and Homeplace. Construction has begun at Caernarvon and is expected to be completed in 1990.

As a result of the drought of 1988, which caused record low water flows and saltwater intrusion into the Mississippi River up to New Orleans, the Mississippi River saltwater barrier was authorized and completed. Channel deepening has increased the frequency and duration of saltwater intrusion, but before 1988 river discharges did not decline enough to make a test viable. The project consists of a submerged sand sill located at river mile 63, with a crest elevation of -45' NGVD to permit navigation, a length of 1,670', and average height of 25' (Soileau et al. 1989). Dredging began on July 1, 1988, and was completed on August 1, 1988. The remaining part of the drought mitigation plan included barging uncontaminated water to those downstream of the sill at mile 49 and 18.6 mi above Head of Passes.

Breton Sound Basin

The Breton Sound basin is confined to coastal Louisiana, being bounded by the left descending bank of the Mississippi River to the west, the west bank of the Mississippi River Gulf Outlet to the east at the Pontchartrain basin, and the Gulf of Mexico to the south. Major landforms in the basin include natural levee ridges of Bayou Terre Aux Boeufs and River Aux Chenes. Other channels include Bayou Bienvenue, Bayou Villere, Bayou la Chape, Middle Bayou, Bayou Bernard, Bayou Ducros, Bayou Pisana, and Bayou Chaperon. Breton Island is the major barrier island in the basin. Coastal water bodies are numerous because the basin contains large expanses of broken marsh at its seaward end. The major coastal water body is Breton Sound, with smaller coastal water bodies including Grand Bay, Quarentine Bay, California Bay, Long Bay, American Bay, Bay Crabe, Bay Gardene, Black Bay, Lake La Fortuna, and Lake Machais amongst others. Major lakes include Lake Lery, Big Mar, Grand Lake, Lake Petit, Spanish Lake, Lake Batola, Hopedale Lagoon, Lake Amenee, and Lake Cuatro Caballo, as well as several water bodies called lakes that have major openings to the Breton Sound.

The Breton Sound basin is composed of deltaic and alluvial deposits of the abandoned St. Bernard delta, with some influence from the Mississippi River, particularly along its western boundary. Predominant soils in the Breton Sound basin include, in order of dominance: 1) Medisaprists-Hydraquents, moderately saline, developed extensively across the central part of the basin on marsh deposits; 2) Medisaprists-Hydraquents, saline, developed along the northern edge of Breton and Chandeleur sounds in areas of broken marsh islands; 3) Commerce-Sharkey, 0-1%, developed on predominantly silty sediments along the Mississippi River and abandoned distributaries; 4) Sharkey-Commerce, frequently flooded, developed on fine-grained sediments adjacent to the natural levees of the Mississippi River, particularly on the downstream end of the channel; 5) Barbary-Sharkey, frequently flooded, developed on clayey alluvium along the Mississippi River and abandoned distributaries; and 6) Udipsamments-Medisaprists, saline, developed on the Chandeleur Islands barrier shoreline (figure 56).

Major roads and canals affect wetland hydrology. Roads include Louisiana highways 46 and 39, which follow the east bank of the Mississippi River with highway 46 continuing to Alluvial City, highway 47 near Chalmette, highway 300 to Delacroix, and highway 624 to the Mississippi River Gulf Outlet past Hopedale. Canals include the Lake Borgne Canal, Back Levee Ditch, New Canal, Forty Arpent Canal, Delacroix Canal, Reggio Canal, and others.

Development is concentrated along the artificial and natural levees of the Mississippi River; urban and industrial activities predominate between New Orleans and Belle Chasse and agricultural, residential, and industrial activities are concentrated between Belle Chasse and Venice. Development also occurs along the upper portion of the natural levee ridges along Bayou Terre aux Boeufs. The Bohemia National Wildlife Management area borders the east bank of the Mississippi River and the Breton Sound National Wildlife Refuge is located on and around the southwestern Chandeleur Islands.

There are five water level stations in the Breton Sound basin (figure 57). The maximum water level for the period of record was 11.06' during Hurricane Camille in September 1969 on the Mississippi River Gulf Outlet at Shell Beach. The highest water levels at other stations occurred in 1979, 1980, and 1983. The lowest water level during the period of record was -2.7' in 1965 on the Mississippi River Gulf Outlet at Shell Beach. There are no U.S. Geological Survey stage or discharge stations in the Breton Sound basin. The approximate reach of tidal influence is shown in figure 58.

There are two water quality stations monitored by the Department of Environmental Quality; one is in Bay Gardene near Bayou Lost, east of Pointe a la Hache and the other is on the west shore of Lake Petit, south of Delacroix. Bay Gardene had only one dissolved oxygen measurement below 5 ppt. Turbidity ranged from 1.8 to 152 NTU, and total suspended solids from 2 to 264 ppt. Lake Petit has experienced dissolved oxygen levels below 5 ppt or mg/l on eight occasions, with no values below 3 ppt. Turbidity ranged from 1.4 to 83 NTU, and total suspended solids from 0 to 74 ppt. The levels of turbidity and total suspended solids at Lake Petit are lower than those of most of the other basins in coastal Louisiana (figures 59, 60).

The Breton Sound basin has areas assessed as effluent limited and water quality limited. The area between the Mississippi River and Bayou Terre aux Boeufs and the Gulf has a Water quality index of 72.8, with the major problem being dissolved solids. The Mississippi River Gulf Outlet from Gulf Intracoastal

Waterway to Breton Sound is classified as water quality limited, with no Water

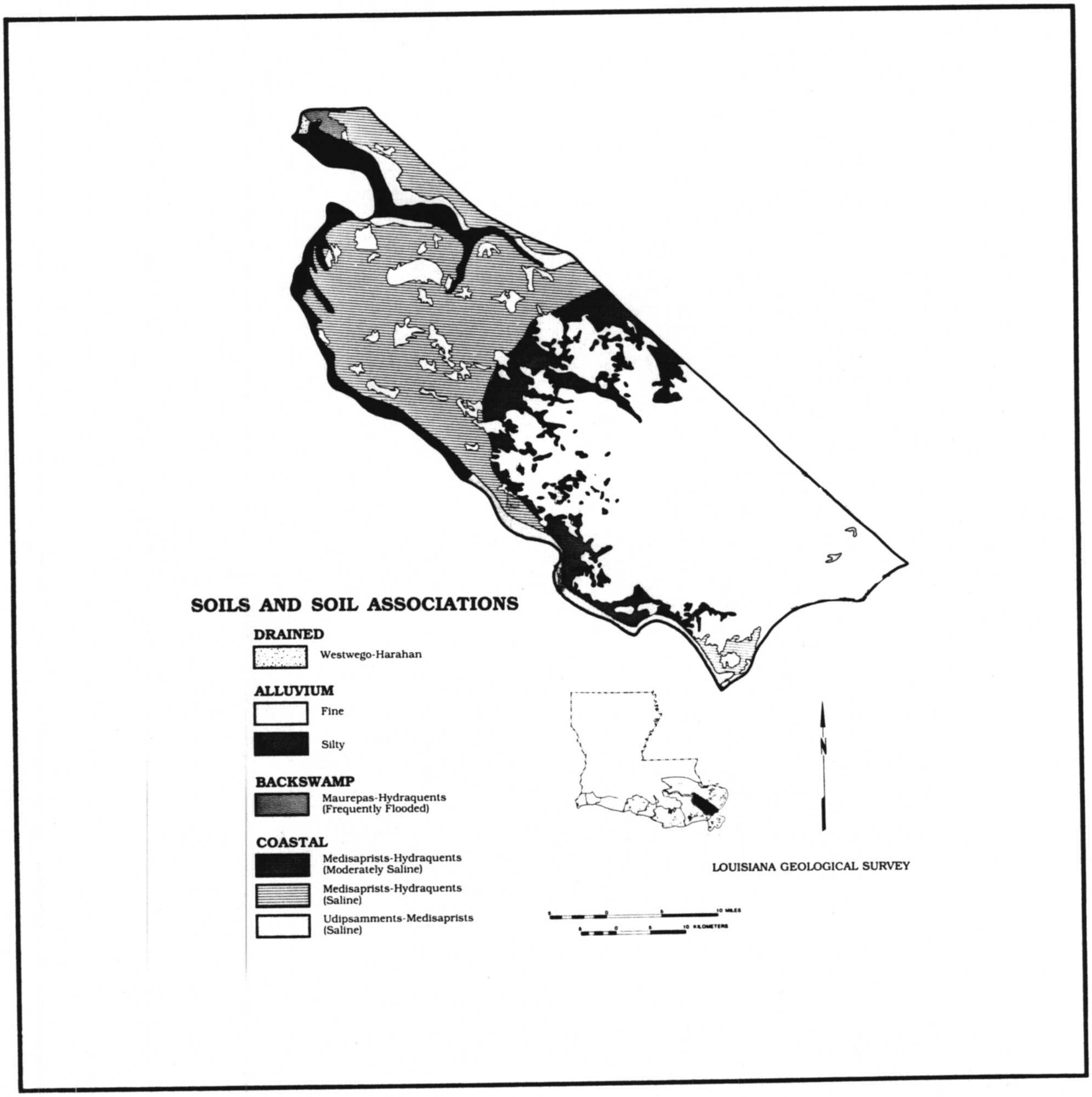


Figure 56. Major coastal soil associations of the coastal Breton Sound basin (Spicer 1981).

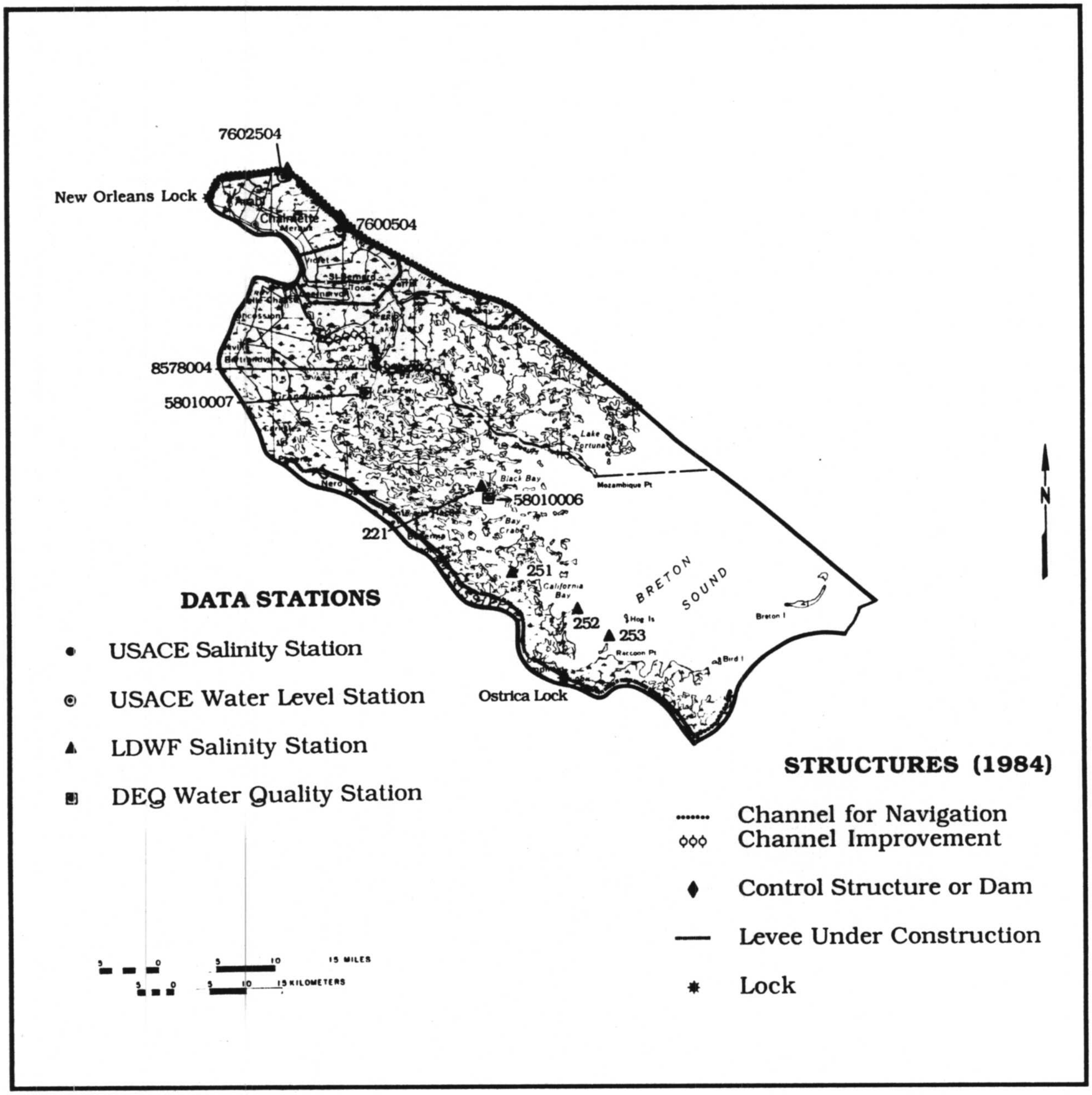


Figure 57. Data stations and major structures in the coastal Breton Sound basin (Department of Transportation and Development 1984).

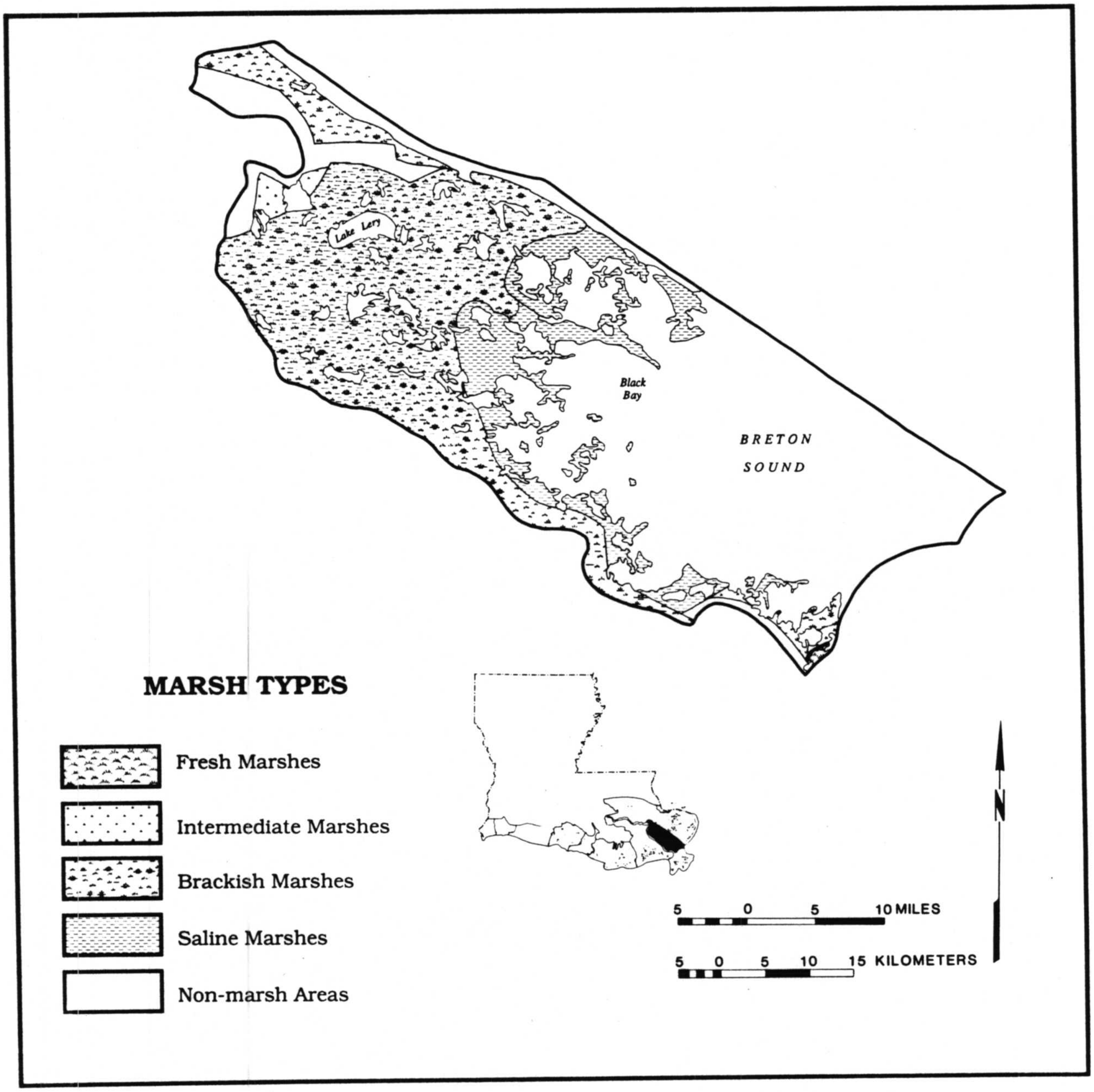


Figure 58. Marsh types of Breton Sound basin (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.

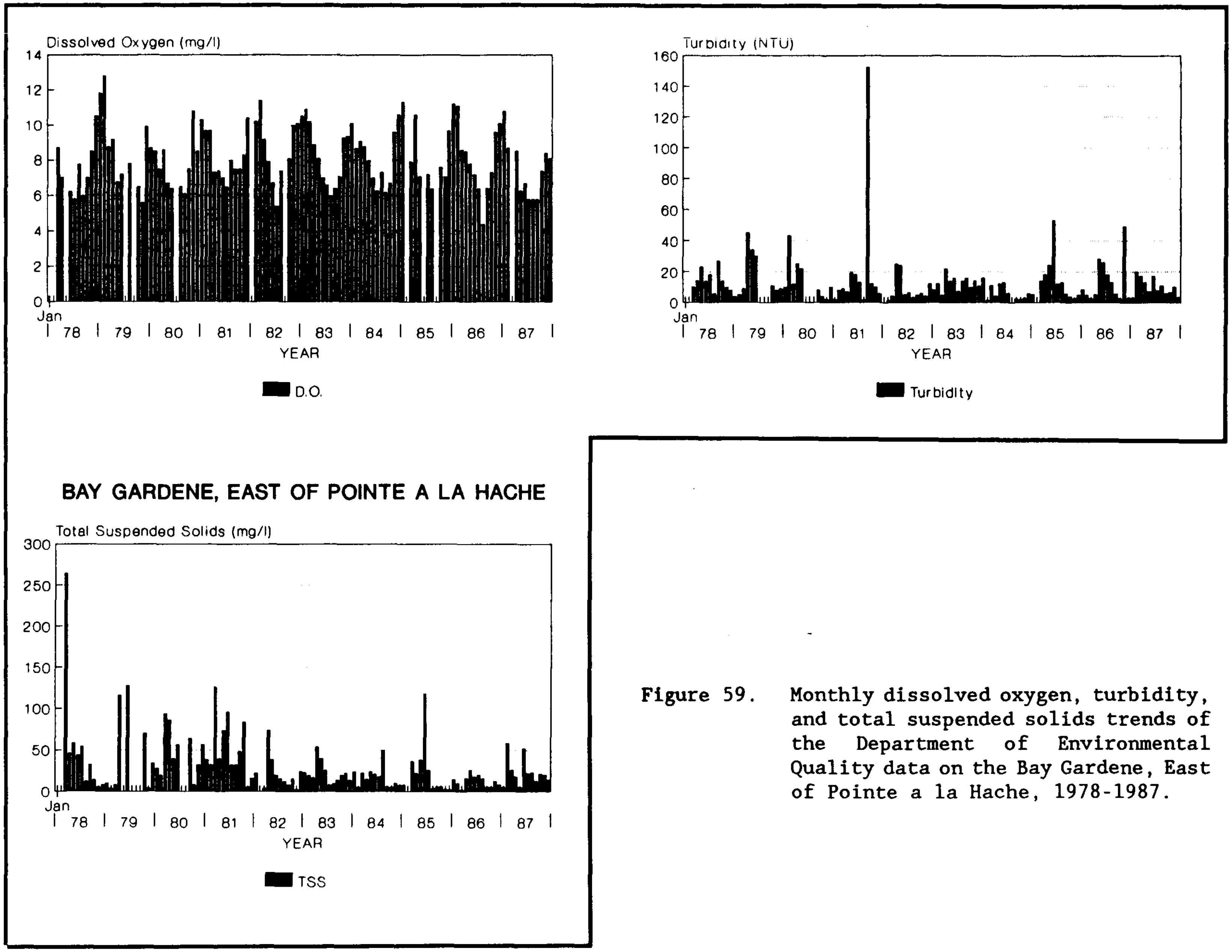
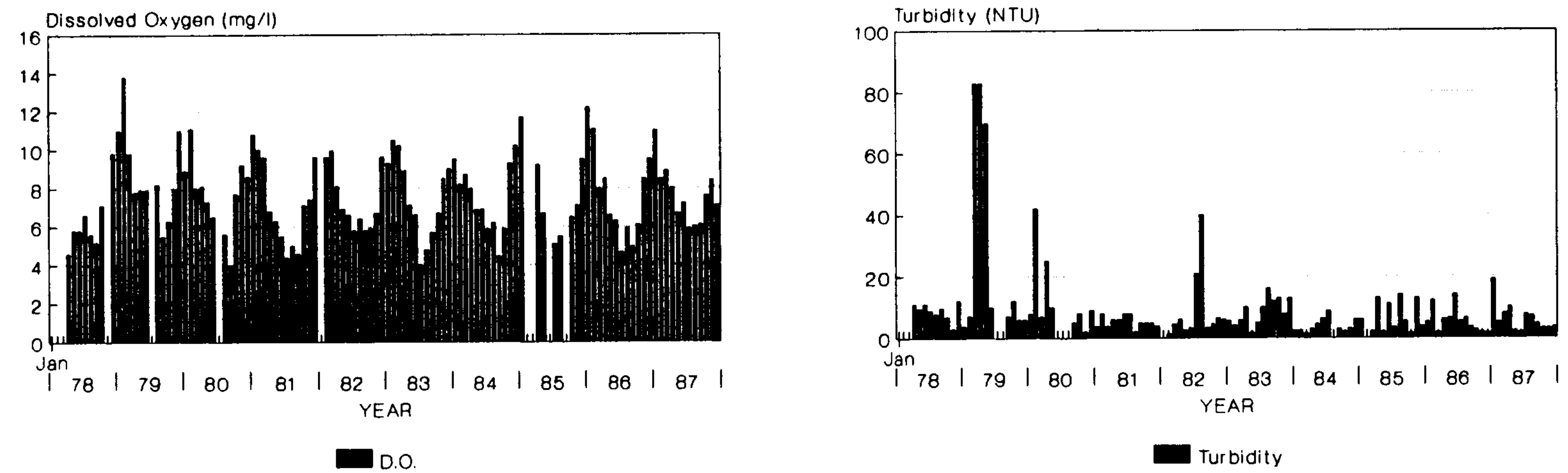


Figure 59. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Bay Gardene, East of Pointe a la Hache, 1978-1987.



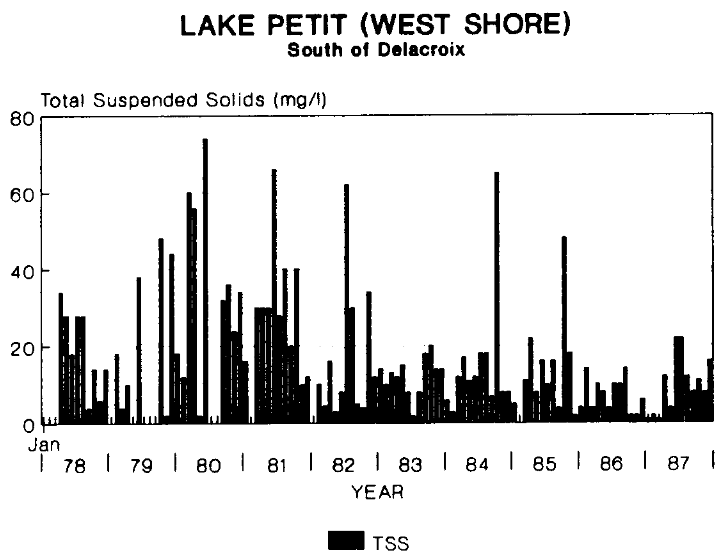


Figure 60. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Lake Petit (West Shore), South of Delacroix, 1978-1987.

quality index given.

The Breton Sound basin contains fresh and intermediate marshes in only a small area of the basin near Caernarvon. Most of the basin consists of brackish and saline marshes. Salinities are high at all four stations in the Breton Sound basin. Mean values include 11.29 ppt at Long Bay, 13.61 ppt at Bay Gardene, 17.14 ppt at California Bay, and 19.29 ppt at Sable Island.

Analysis of tide gage data showed both sea level rise and fall at various stations in the Breton Sound basin. The maximum rate of rise was 0.20"/yr (0.51 cm/yr) on Bayou Terre Aux Boeufs at Delacroix, and the maximum rate of fall was -0.37"/yr (-0.93 cm/yr) on Bayou Dupre at Floodgate, East. The analysis for both of these stations only incorporated a short period from 1975 to 1983. The station with the longest period of record, the Mississippi River Gulf Outlet at Shell Beach, showed a very slight sea level fall of -0.01"/yr (-0.02 cm/yr) from 1961 to 1983. Non-eustatic changes range from 0.11"/yr (0.28 cm/yr) to -0.46"/yr (-1.16 cm/yr) according to tide gage computations.

Hydrologic modifications include a 7.3-mi-long, 6'-deep channel from Violet to deep areas of Lake Borgne along Bayou Dupre, with widths of 80'. Other associated structures include a 100'-wide, 200'-long turning basin at Violet, and a privately owned lock at Violet which was closed in 1950. Bayou Terre aux Boeufs was snagged and cleared between miles 10.5 and 18.25, and was excavated, snagged, and cleared between miles 18.25 and 19.5. A number of levees have been constructed for flood and hurricane protection of developed areas between New Orleans and Venice, particularly along the Mississippi River. Constructing back levees, increasing levee heights and widths, modifying existing drainage facilities, and building a floodgate at Empire were part of the project.

The Mississippi River Gulf Outlet affords an outlet to the Gulf that is about 37 mi shorter than the Mississippi River route. The channel is 36' deep and 500' wide, extending from the junction of the Inner Harbor Navigation Canal and the Gulf Intracoastal Waterway in New Orleans to the -38' contour in the Gulf. Construction began in 1958, a 36'-by-250' channel was opened in 1963, and the project specifics were completed in 1968. Associated features include a turning basin near the intersection of the Mississippi River Gulf Outlet and the Inner Harbor Navigation Canal, a high-level 4-lane bridge, and jetties to the 6' contour. Foreshore protection has been emplaced to reduce bank degradation along the south bank of the Mississippi River Gulf Outlet from Industrial Canal to the end of the Chalmette hurricane protection levee.

Pontchartrain Basin

The coastal Pontchartrain basin, as delineated by the U.S. Army Corps of Engineers and this study, does not drain solely into Lake Pontchartrain, but principally into Lake Borgne and Chandeleur Sound leading to the Gulf of Mexico. It is bounded to the west-southwest by the Breton Sound basin, on its eastern boundary by the spoil bank on the western side of the Mississippi River Gulf Outlet, and to the east by the Pearl River basin. The Mississippi River Gulf Outlet is a 36'-deep, 500'-wide ship channel that runs from the Inner Harbor Navigation Canal for 76 mi southeastward to the Gulf of Mexico in St. Bernard Parish. About 43 mi of the Mississippi River Gulf Outlet were built through the marsh, which has greatly affected the hydrology of this area (Howard et al. 1984). Three major lakes included in the Pontchartrain basin are Lakes Maurepas, Pontchartrain, and Borgne, progressively more saline and closer to the Mississippi and Chandeleur sounds. Tidal exchange occurs between the sounds and the lakes, although barriers between Lakes Borgne and Pontchartrain and Lakes Pontchartrain and Maurepas restrict marine input. Lake Borgne is open to the Gulf, Pontchartrain has a surface area of 621 mi^2, and Maurepas a surface area of 91 mi^2. Smaller semi-enclosed lakes include Lake St. Catherine between Lakes Pontchartrain and Borgne, and Lake Eugenie. Coastal water bodies in addition to these lakes include the Chandeleur Sound, Bay Boudreau, Eloi Bay, Lake Athanasio, Lake Eloi, Treasure Bay, Morgan Harbor, Drum Bay, Live Oak Bay, Indian Mound Bay, Shell Island Lake, Lawson Bay, and Fishing Smack Bay.

Five major streams of the Pontchartrain basin flow southward into Lakes Maurepas and Pontchartrain. They drain portions of southwestern Mississippi and the Florida Parishes of southeastern Louisiana. The Amite, the Tickfaw, and the Tangipahoa begin in southwestern Mississippi, while the Natalbany and Tchefuncte rivers originate in Louisiana. Other rivers and channels, several of which are tributaries to these rivers, include Bayou Manchac, Dutch Bayou, Mississippi Bayou, New River, Bayou Conway, Bayou Francois, Bayou Braud, Black Bayou, Petite Amite River, Henderson Bayou, Blind River, Bayou Chene Blanc, Clay Cut Bayou, Bayou Fountain, Dawson Creek, Ward Creek, Jones Creek, Grays Creek, West Colyell Creek, Middle Colyell Creek, Colyell Creek, Little Colyell Creek, Bayou Barbary, Hog Branch, Big Branch, Lizard Creek, Blood River, Yellow Water River, Pontchatoula Creek, Bedico and East Bedico creeks, Bogue Falaya, Abita River, Pontchitolawa Creek, Bayou Chinchuba, Bayou la Branche, Bayou Bienvenue, Bayou Maxent, Bayou la Loutre, Bayou Dupre, Bayou Savage, Bayou Trepagnier, Bayou Traverse, Bayou Black, Bayou Chinchilla, Bayou Castine, Cane Bayou, Bayou Lacombe, Big Branch Bayou, Little Branch Bayou, Bayou Liberty, Bayou Bonfouca, and Salt Bayou. The basin also receives fresh water from the Mississippi River through the Bonnet Carre Spillway during high flow years. Passes include Pass Manchac, between lakes Maurepas and Pontchartrain, and the Rigolets, between Lakes Pontchartrain and Borgne.

The southern Pontchartrain basin up until a few thousand years ago was occupied by the Gulf of Mexico, with water depths of 30′ to 150′. About 3,000 years ago, this area began to be influenced by the development of the St. Bernard delta (Frazier 1967). Initially, prodelta clays were deposited in this area, bringing the level of the gulf bottom upward. As deposition continued, fine sands and silts were deposited in the landward reaches of the basin near New Orleans until they built to or slightly above sea level. The entire depositional system advanced rapidly gulfward through a complex series of abandonment of newly formed distributaries. Several of these distributaries, such as Bayou La Loutre, Bayou Terre aux Boeufs, and Bayou Yscloskey, occur above general marsh level with soils built on natural levee deposits.

Construction of the St. Bernard delta lasted for about 1,000 yr, until about 2,000 yr ago, when the Mississippi River began to occupy Bayou Lafourche farther to the west, dramatically reducing the flow in the St. Bernard delta (Frazier 1967). Its areal extent was at that time beyond the present location of the Chandeleur Island chain. As flow and sediment supply was reduced, and the area subsided, the southern Pontchartrain basin began to deteriorate. Marine processes including waves and tides dominated at the seaward edge of the lobe. Less than half of the original land surface remains, of which most has been replaced by the Chandeleur Sound.

Several hydrologic changes have occurred since construction of the

Mississippi River Gulf Outlet in 1961 (Howard et al. 1984). Saline waters from Breton Sound are transported by tides into fresh and brackish parts of the basin, across natural levees that formerly restricted flow. Tidal amplitudes increased, and precipitation that falls in the basin has been captured by the channel.

Soils in the coastal Pontchartrain basin are developed on delta plain sediments, on alluvium, or on the late Pleistocene Prairie Terraces. Those developed in delta plain sediments are 1) Medisaprists-Hydraquents, moderately saline; 2) Udipsamments-Medisaprists, saline, developed on the Chandeleur Islands barrier shoreline; and 3) Medisaprists-Hydraquents, saline, developed along the northern edge of Chandeleur and Breton sounds in areas of broken marsh islands. Those developed on Pleistocene sediments are 1) Myatt-Stough, 0-3%, developed on late Pleistocene deposits in the northwestern part of the coastal basin; 2) Calhoun-Stough, 0-3%, in the north-central part of the basin; 3) Calhoun-Providence, 0-5%, in the north-central part of the basin; 4) Olivier-Providence, 0-5%, in sediments with appreciable quantities of loess influence in the northeastern part of the basin; and 5) Deerford-Verdun-Frost, in the northeastern part of the basin on a loess-capped inlier. Alluvial soils include 1) Commerce-Sharkey, 0-1%, developed along the Mississippi River and abandoned distributaries; 2) Kenner-Allemands, drained, along the southern shoreline of Lake Pontchartrain; 3) Maurepas-Hydraquents, frequently flooded; 5) Barbary-Sharkey, frequently flooded, developed on clayey alluvium along the Mississippi River and abandoned distributaries; 6) Barbary-Fausse, frequently flooded; 7) Dystrochrepts, frequently flooded, in alluvial valleys draining Lakes Maurepas and Pontchartrain including the Natalbany and Tickfaw rivers; and 8) Haplaquepts-Dystrochrepts, frequently flooded, in alluvial valleys draining into Lake Pontchartrain, particularly the Tchefuncte-Bogue Falaya system (figure 61).

The major urban areas of this basin include New Orleans suburbs, Baton Rouge, Denham Springs, Pontchatoula, and Slidell. The lands that drain into Lake Pontchartrain are predominantly a mixture of urban, pastureland, and forests. There is also a considerable amount of sand and gravel mining in streams that drain into the coastal area, and a small amount of crop agriculture. The north and south shores of Lake Pontchartrain have also been subject to increased urban development. Wildlife management areas include the Biloxi Wildlife Management area bordering the southeast shore of Lake Borgne, the Breton National Wildlife Refuge comprising most of the Chandeleur Islands, the Joyce Wildlife Management area north of Pass Manchac, and the Manchac Wildlife Management area south of Pass Manchac.

Roads in the Pontchartrain basin include Interstate 12, which forms much of the upper boundary; Interstate 10 is located about midway between the Mississippi River levee and the lakes. Interstate 55 and Louisiana highway 51 traverse the Pontchartrain basin between lakes Maurepas and Pontchartrain. State highways following the Mississippi River's east bank include 327, 75, 942, 44, 30, 70, 3125, 48, and parts of 61 and 90. Several roads cross the lakes including the Lake Pontchartrain Causeway, Southern Causeway, Interstate 10, highway 11, and Alabama Southern Great Railroad. Canals include the Gulf Intracoastal Waterway, Inner Harbor Navigation Canal, Amite River Diversion Canal, Hope Canal, New Canal, Panama Canal, Hackett Canal, Engineers Canal, Dwyer Canal, Walker Canal, St. Rose Canal, and Lakeshore Canal.

The coastal Pontchartrain basin has 21 water-level stations (figure 62; table 3). Maximum water levels across the basin were recorded in 1965 at six locations due to Hurricane Betsy, in 1969 at six locations due to Hurricane

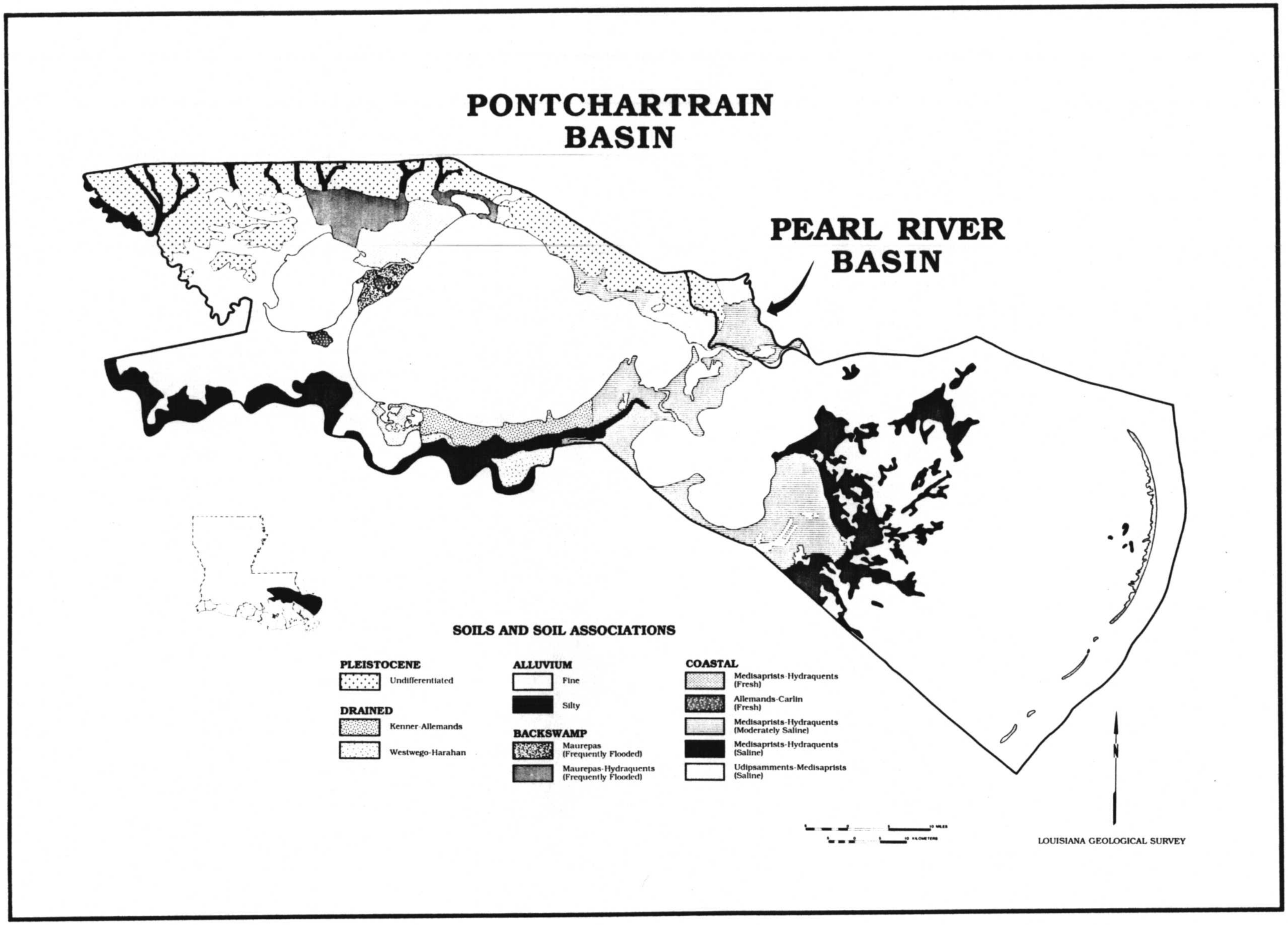


Figure 61. Major coastal soil associations of the coastal Pontchartrain and Pearl basins (Spicer 1981).

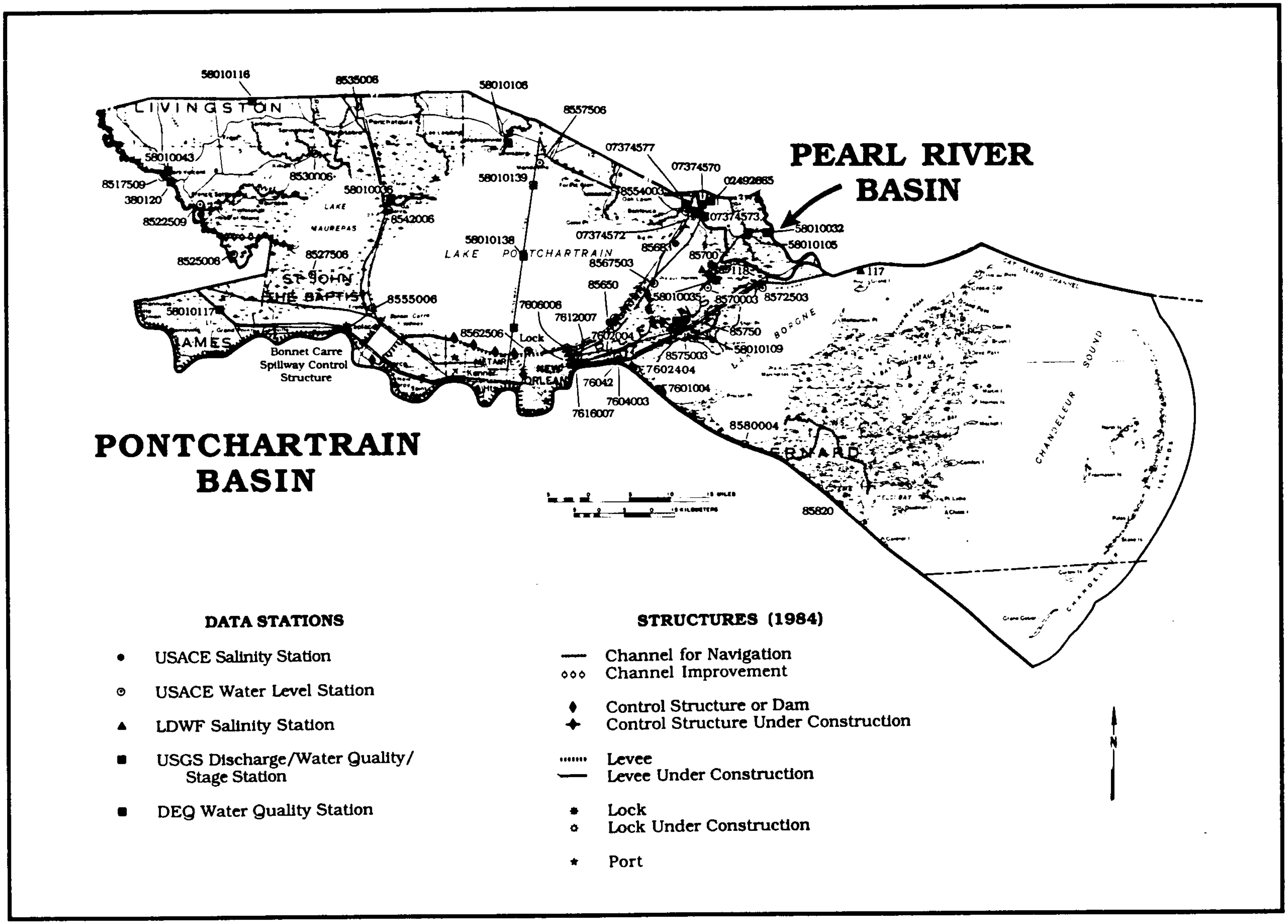


Figure 62. Data stations and major structures in the coastal Pontchartrain and Pearl basins (Department of Transportation and Development 1984).

Camille, and in 1983 at three locations due to flooding from excessive precipitation in early April. The maximum water level due to the 1965 storm was 12.09' on Lake Pontchartrain at Frenier. The maximum water level due to the 1969 storm was 12.25' on Lake Borgne at Rigolets. The 1983 flood caused water level elevations of 14.59' on the Amite River at Port Vincent. The minimum water level recorded was -2.25' in 1938 on Lake Pontchartrain at Mandeville.

There are no U.S. Geological Survey discharge stations in the coastal Pontchartrain basin, although measurements are acquired on several rivers that drain into this basin. Trends are shown for three of these that drain into Lake Maurepas, the Amite River, the Tickfaw River, and the Natalbany River, and for the Tangipahoa River, which drains into Lake Pontchartrain. Maximum and minimum daily discharges on the Amite River near Denham Springs were 105,000 cfs on April 8, 1983, and 271 cfs on October 17 and 18, 1956; the mean discharge over 49 yr (1938-1987) is 2,033 cfs. Maximum and minimum daily discharges on the Tickfaw River at Holden were 19,200 cfs on April 7, 1983 and 65 cfs on October 1 to 4, 1969; the mean discharge over 47 yr 1940-1987) is 372 cfs. Maximum and minimum daily discharges on the Natalbany River near Baptist were 9,700 cfs on April 7, 1983, and 1.8 cfs on November 2 to 5, 1963; the mean discharge over 44 yr of record (1943-1987) is 116 cfs. On the Tangipahoa River at Robert, maximum and minimum daily discharges over 49 yr of record (1938-1987) were 78,500 cfs on April 7, 1983, and 245 cfs from October 30 to November 3, 1968; the mean discharge is 1,538 cfs (figures 63, 64). The approximate reach of tidal influence is shown in figure 65.

The coastal Pontchartrain basin has five water quality stations monitored regularly by the Department of Environmental Quality. These include the Amite River at Port Vincent, Blind River near Gramercy, Pass Manchac at Manchac, Chef Menteur Pass at Chef Menteur, and Pass Rigolets, southeast of Slidell. The Amite River at Port Vincent had 25 observations of dissolved oxygen fall at or below 5 ppt, with none below 3 ppt. Turbidity ranged from 7.5 to 450 nephelometric turbidity units, and total suspended solids from 2 to 452 mg/l. The Blind River near Gramercy has the lowest dissolved oxygen values in the basin and amongst the lowest in coastal Louisiana. Since 1978, there were 97 observations below 5 ppt, and 61 of these were below 3 ppt. Turbidity ranged from 2.2 to 480 nephelometric turbidity units, and total suspended solids from 8 to 290 ppt. Pass Manchac at Manchac had measurements of dissolved oxygen at or below 5 ppt on only four occasions. Turbidity ranged from 2.2 to 280 nephelometric turbidity units and total suspended solids from 0 to 204 ppt. Dissolved oxygen at Chef Menteur Pass at Chef Menteur has only gone below 5 ppt on two occasions. Minima to maxima of turbidity and total suspended solids are 1.3 to 216 nephelometric turbidity units and 1 to 280 ppt. Pass Rigolets only has one dissolved oxygen measurement below 5 ppt. Ranges of turbidity and total suspended solids are 1.6 to 264 nephelometric turbidity units and 0 to 336 ppt (figures 66, 67, 68, 69, 70).

The potential for problems with surface water quality stem from contamination, agricultural runoff, shell dredging, sand and gravel mining, and saltwater intrusion into streams. Bayou Manchac, the Amite, Tickfaw, and Tangipahoa rivers, Lake Maurepas, and tributaries are all considered effluent limited. The water quality index of these rivers and lakes ranges from 40.3 to 68.7. The major problem of the Amite, Tickfaw, and Tangipahoa rivers is excessive fecal coliform; causes include excessive stormwater runoff, domestic wastewater discharges, and agricultural runoff. The lower Amite River from Head of Island to

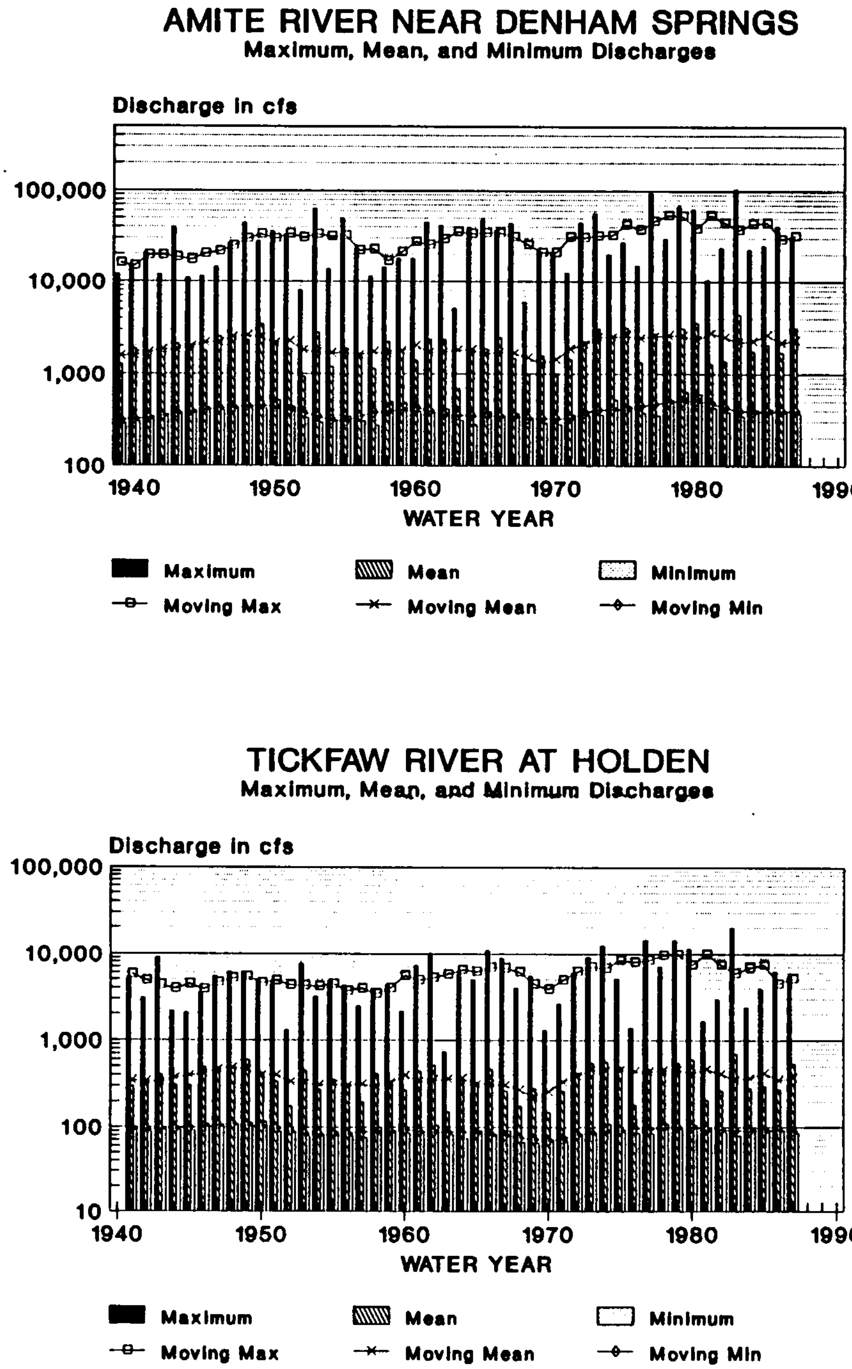
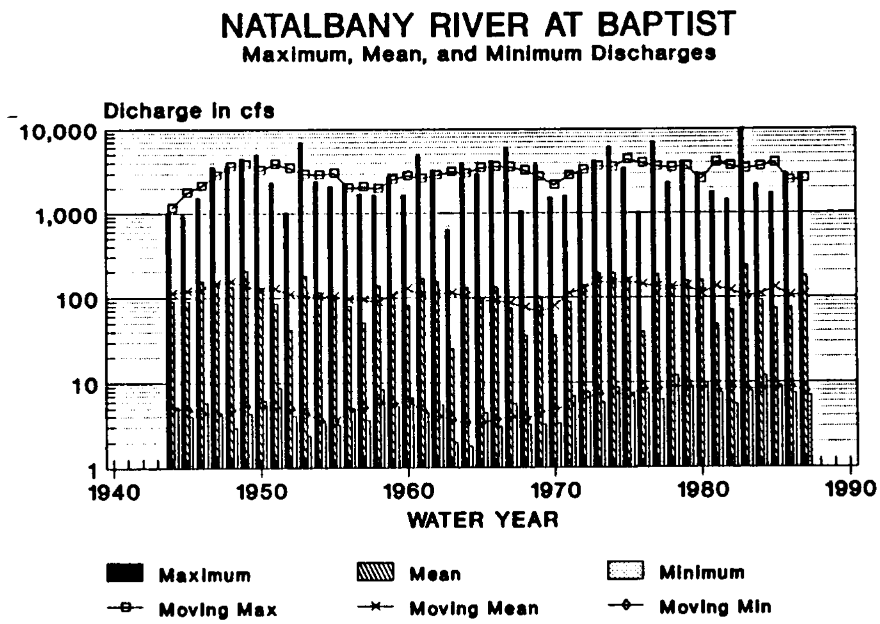


Figure 63. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for the Amite River near Denham Springs, 1939-1987, and for the Tickfaw River at Holden, 1941-1987.



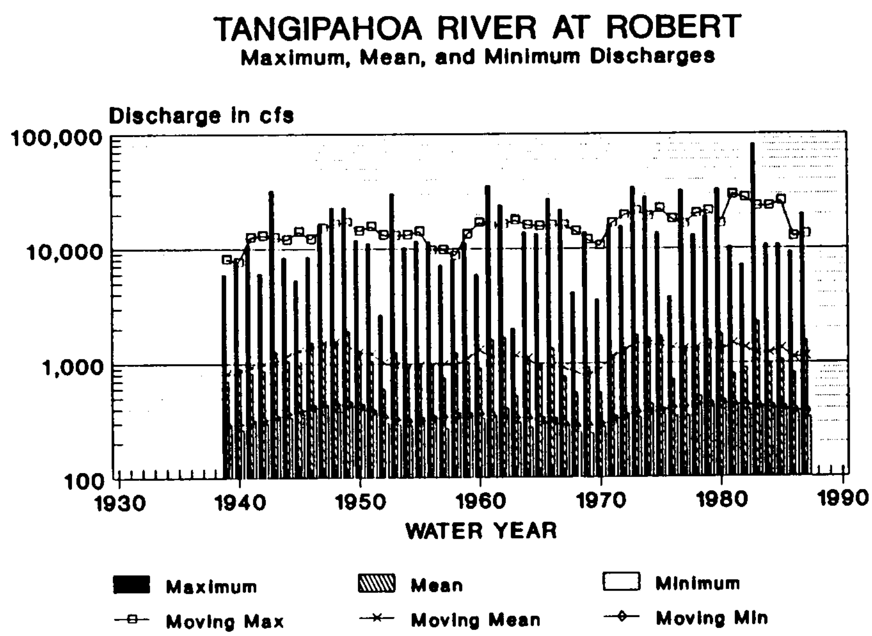


Figure 64. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for the Natalbany River at Baptist, 1944-1987, and for the Tangipahoa River at Robert, 1939-1987.

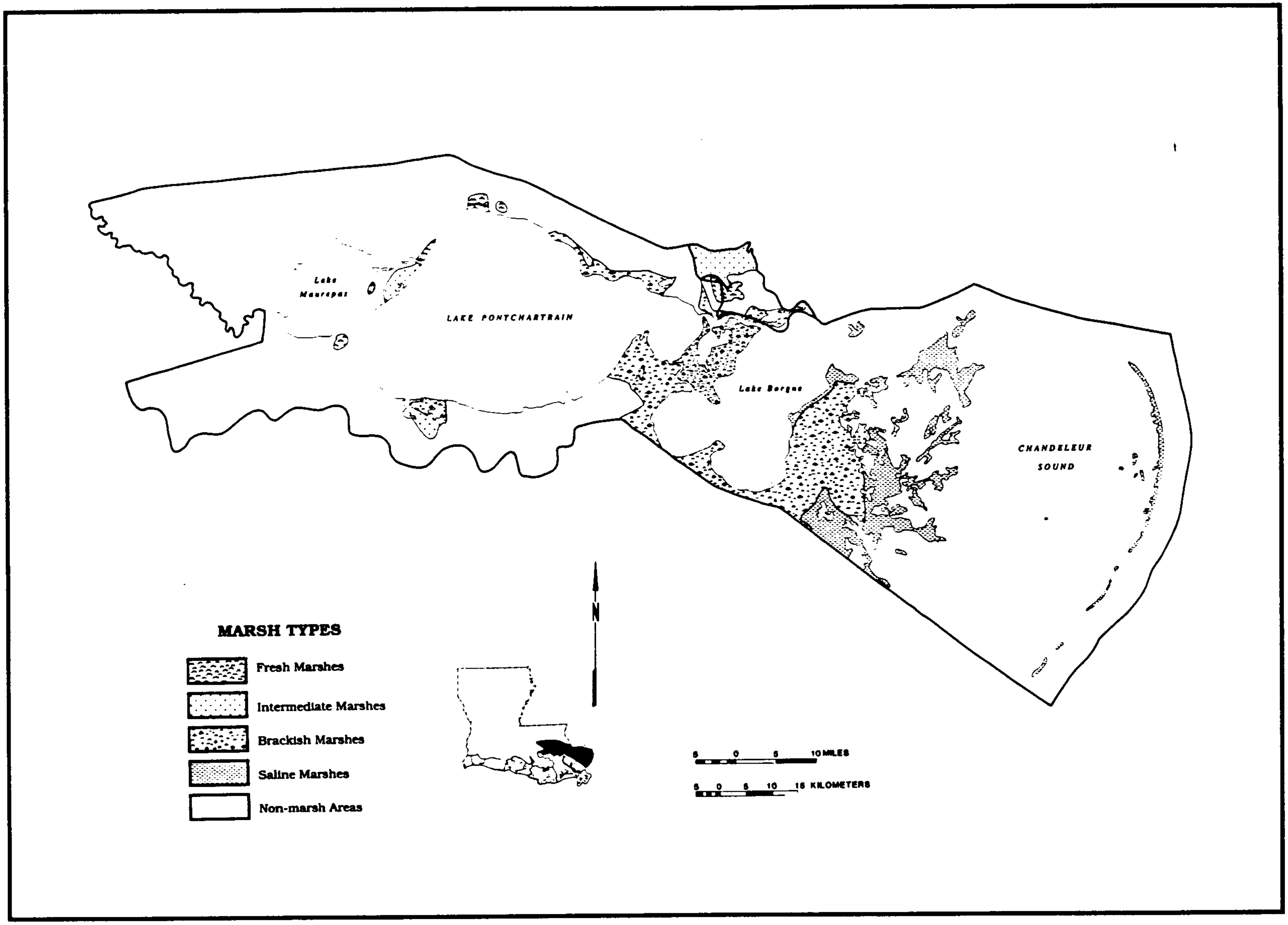
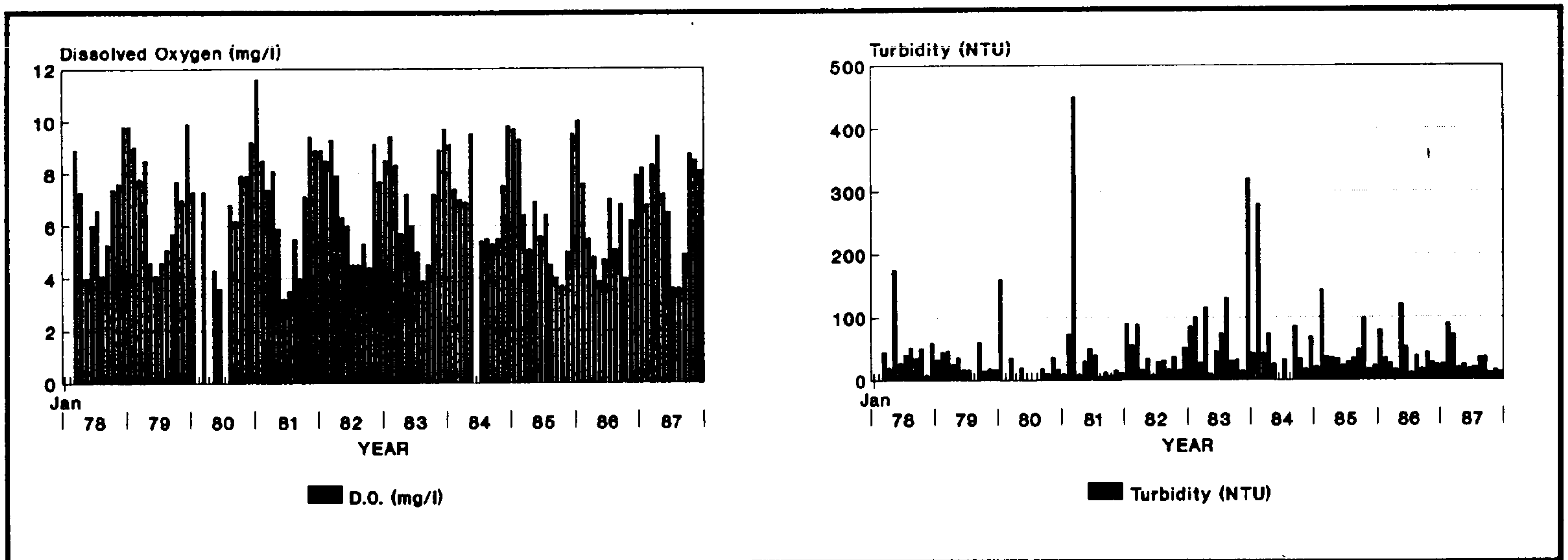


Figure 65. Marsh types in the Pontchartrain and Pearl basins (Chabreck and Linscombe 1978). Line dividing fresh from intermediate marshes represents a conservative estimate of the reach of tidal influence.



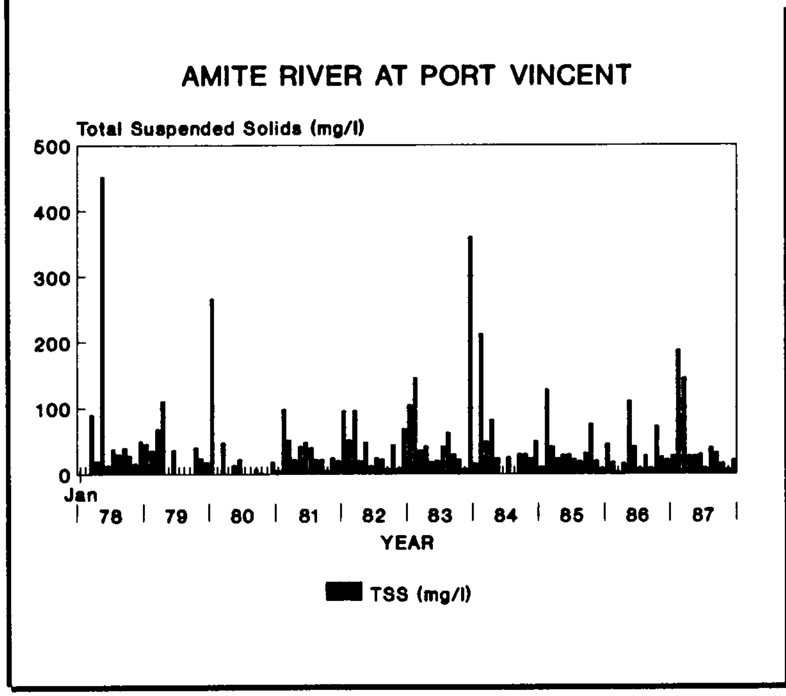


Figure 66. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Amite River at Port Vincent, 1978-1987.

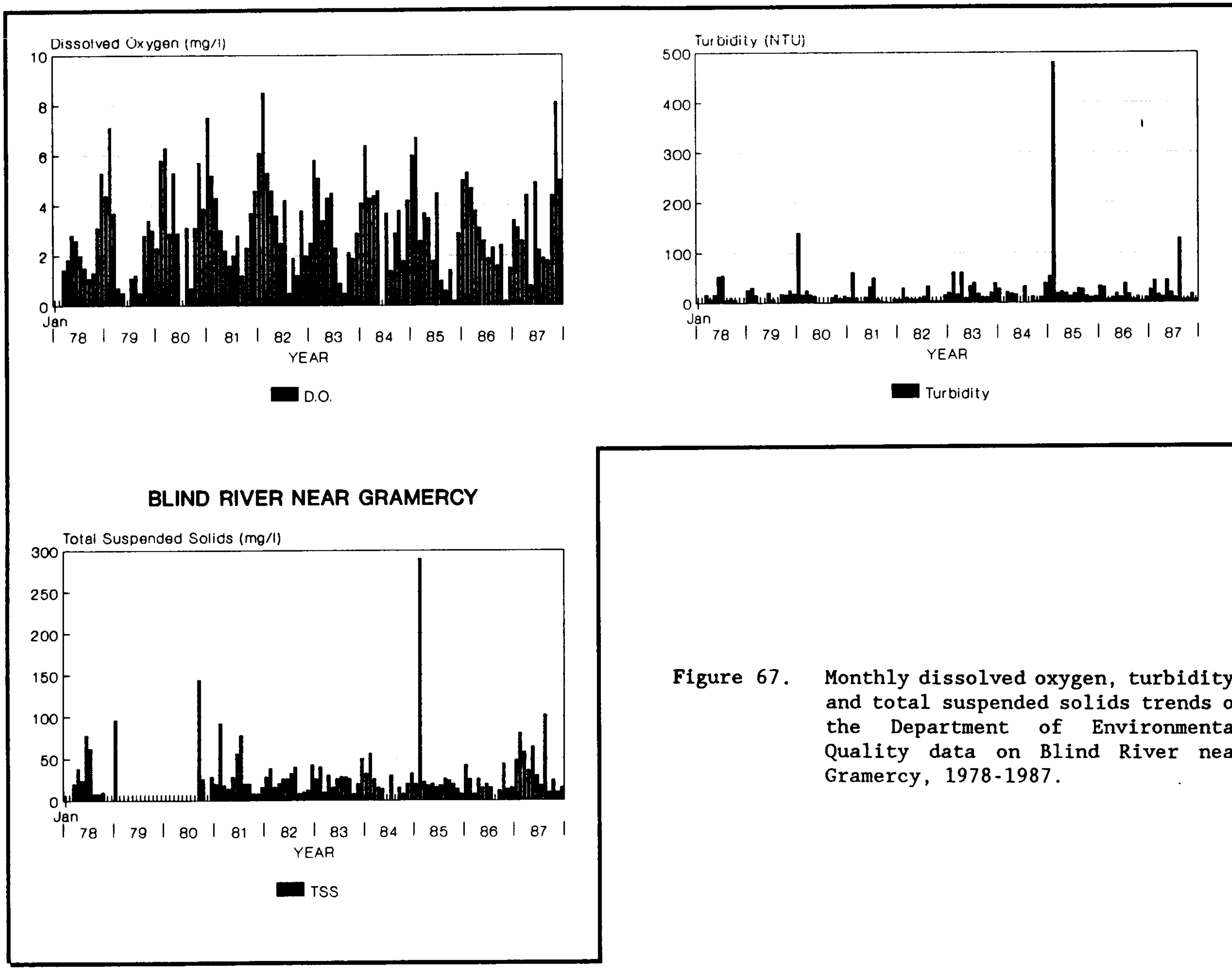
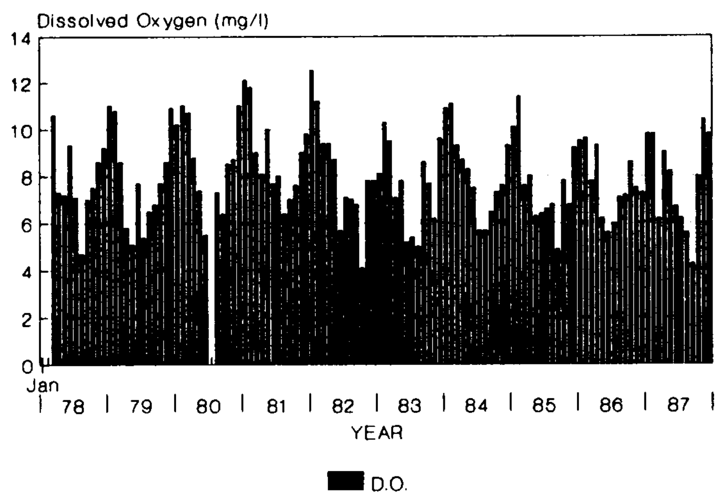
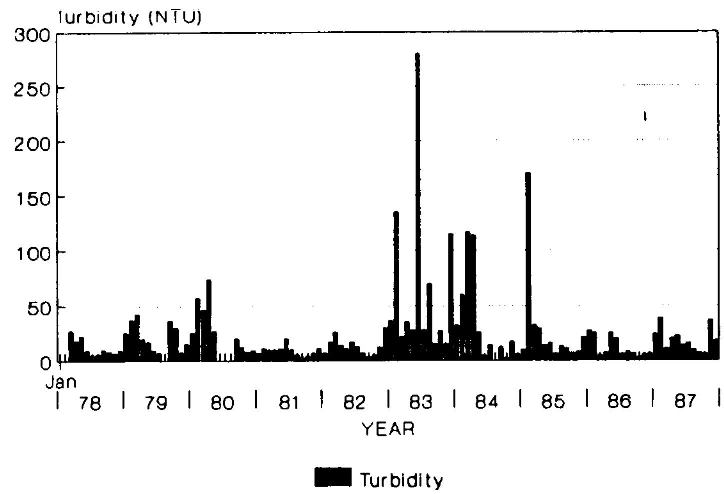


Figure 67. **Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on Blind River near Gramercy, 1978-1987.**





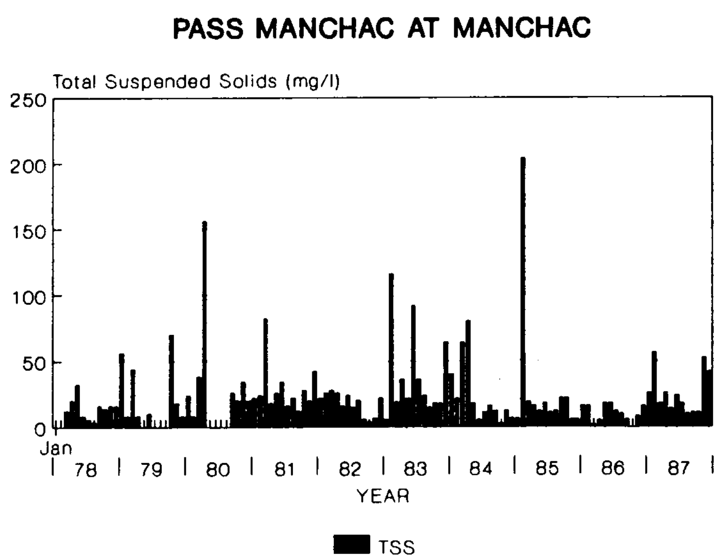
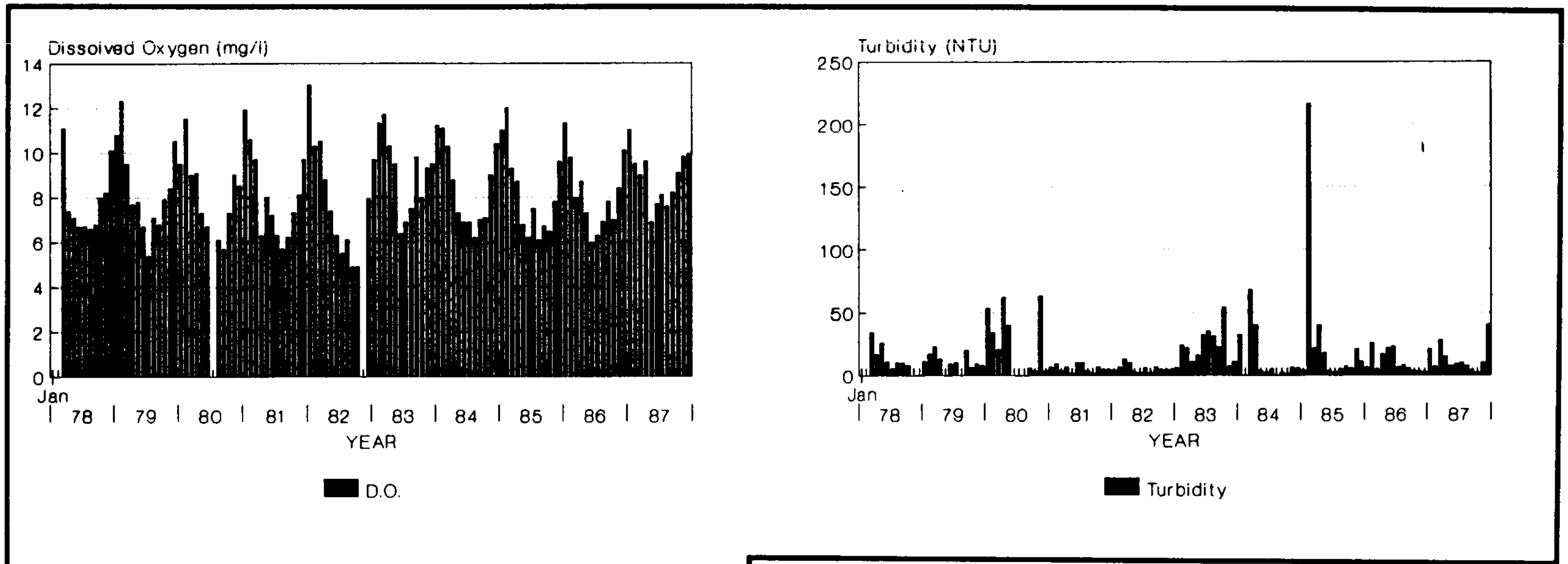


Figure 68. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Pass Manchac at Manchac, 1978-1987.



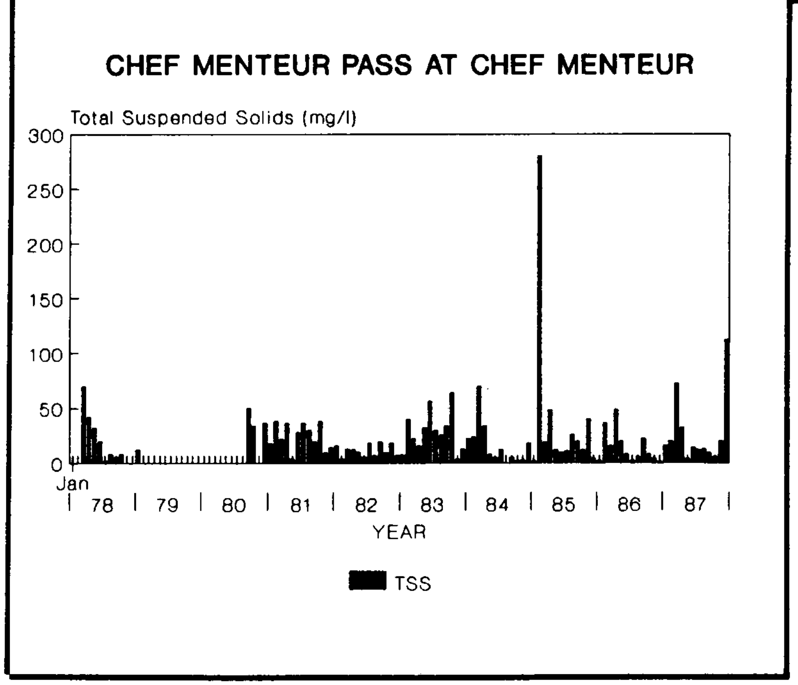


Figure 69. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Chef Menteur Pass at Chef Menteur, 1978-1987.

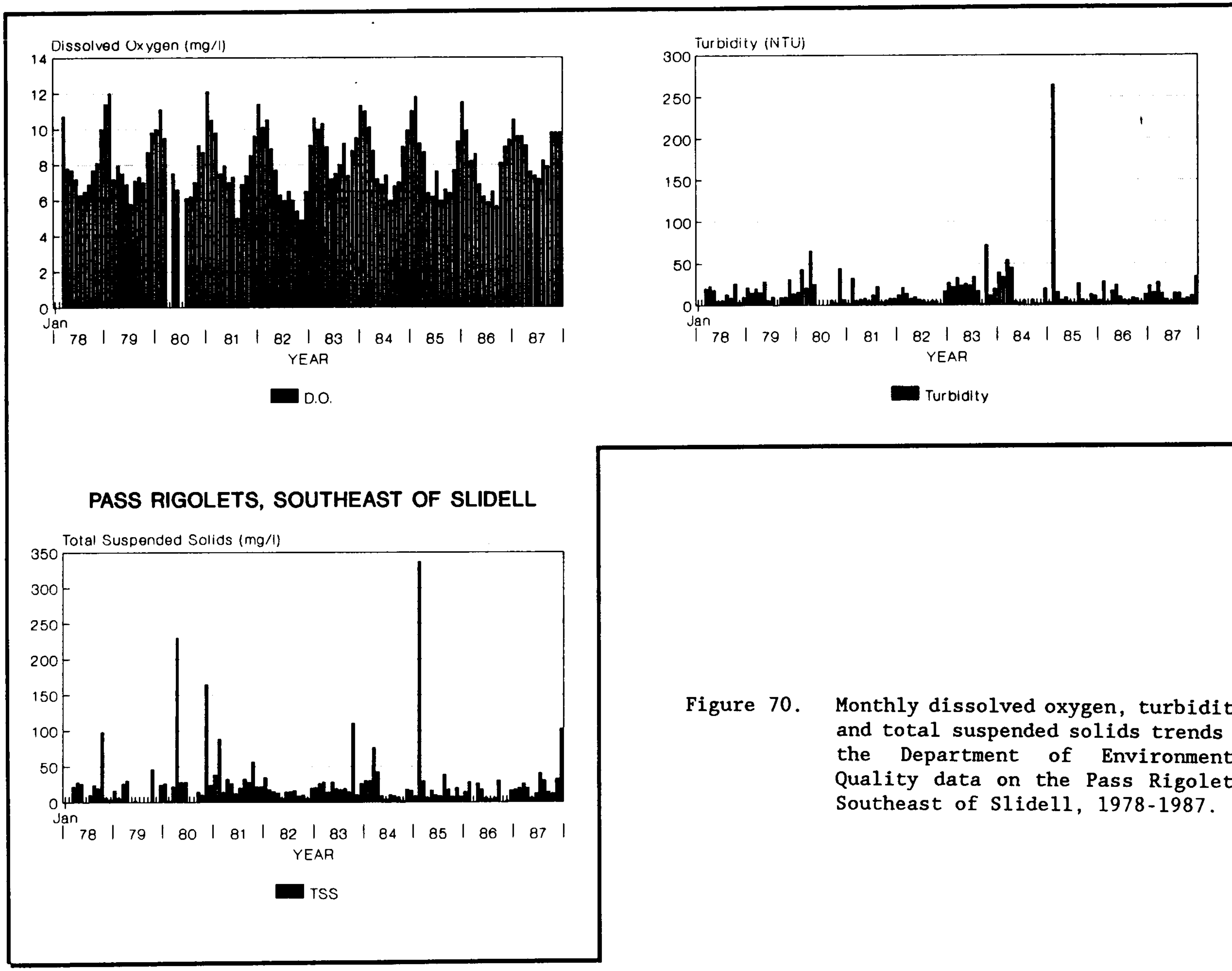


Figure 70. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Pass Rigolets, Southeast of Slidell, 1978-1987.

Lake Maurepas and Blind River both have low dissolved oxygen to severe oxygen depletion. Historically, Lake Maurepas has suffered from eutrophic conditions, low dissolved oxygen, and algal blooms during the summer, which had been complicated by turbidity associated with the mining of Rangia (clam) shells within the lake through December 1987. Saltwater conditions within the lake are sometimes misinterpreted as excessive dissolved solids.

Water quality problems in this basin stem mostly from urban development. Such impacted areas include the north shore of Lake Pontchartrain, affected by residential development causing increased stormwater runoff from the Slidell and Mandeville areas. Untreated domestic wastewater discharge from camps along the shoreline and on immediate tributaries is also a problem. The south shore of Lake Pontchartrain and the drainage ditches and canals in the New Orleans metropolitan area are subject to sewage-contaminated stormwater discharges, urban runoff, and domestic and industrial wastewater discharges.

The portion of the Tchefuncte River from headwaters to Lake Pontchartrain, including the Bogue Falaya and adjacent tributaries, has a Water quality index of 60.5, with the major problem being fecal coliform and dissolved oxygen. Lake Catherine, Rigolets, Chef Menteur Pass, and ancillary waterways, including Gulf Intracoastal Waterway from Chef Menteur Pass to Rigolets Pass, have a water quality index of 63.1, with the major problem being dissolved oxygen. Lake Pontchartrain has been closed to oyster harvesting since 1967. Lake Pontchartrain, minor streams draining into the lake in the vicinity of Mandeville, the water bodies northeast of the Mississippi River from the Bonnet Carre floodway to Chef Menteur and Caernarvon including the Gulf Intracoastal Waterway and the Inner Harbor Navigation Canal, and the Mississippi River Gulf Outlet are all classified as water quality limited due to fecal coliform violations. Water quality violations also occur in Bayou Bonfouca because of urban runoff and domestic and industrial wastewater discharges from Slidell, plus residual creosote deposits from a burned facility on the Superfund list. The Bogue Falaya river has coliform problems from domestic wastewater and storm sewer discharges. Turbidity is also a problem in Lake Pontchartrain because of riverine sediment input and surface runoff, occasional discharges from the Bonnet Carre Spillway (seven times since 1937), wind action, and by the active mining of clam shells. At present no more than six dredges are allowed to operate in the lake at once.

Brackish and saline marshes are predominant in the area southeast of Lake Pontchartrain and also occur along the northeast and southwest shores of the lake. Wiseman and Swenson (1987) computed mean salinities at nine locations in the coastal Pontchartrain basin. These include the highest mean values of 16.25 ppt at Grand Pass and 15.28 ppt on the Mississippi River Gulf Outlet at Navigation Light 101, and the lowest mean values of 3.95 ppt at Little Woods and 4.01 ppt at the Lake Pontchartrain North Shore station. The U.S. Army Corps of Engineers (1981) recognized high salinity levels in the Mississippi River Gulf Outlet and identified a gradient from 35 ppt at the channel entrance to 10 ppt at the Inner Harbor Navigation Canal. Some data suggest that no saltwater wedge exists (U.S. Army Corps of Engineers 1981; Wicker et al. 1982). Salinity levels of 10 to 20 ppt since Mississippi River Gulf Outlet construction have increased substantially from the previous 2-to-4 ppt level (Howard et al. 1984).

Tide gage data were examined at 11 stations in coastal Louisiana, with relative sea level changes ranging from 0.59"/yr (1.50 cm/yr) at Chef Menteur Pass near Lake Borgne to 0.43"/yr (1.09 cm/yr) at Lake Pontchartrain at Little

Woods. Eight of the stations showed water-level increases, whereas three stations showed decreases. Factoring out eustatic changes, other changes ranged from an increase in elevation of 0.68"/yr (1.73 cm/yr) to subsidence of 0.34"/yr (0.86 cm/yr).

Navigation projects in the coastal Pontchartrain basin include the Amite River and Bayou Manchac project, Bayou Bonfouca, Bayou Lacombe, Tchefuncte River and Bogue Falaya, Pass Manchac, Tangipahoa River, the Tickfaw, Natalbany, Pontchatoula, and Blood Rivers, and the Tangipahoa River Navigation Project. The Amite River and Bayou Manchac project consists of a 7'-by-60' channel from Lake Maurepas to Port Vincent that was completed in 1928. Channel obstructions were also removed between Port Vincent and mile 8.5 of Bayou Manchac.

The Bayou Bonfouca project consists of a 10'-deep, 8-mi-long channel, with a bottom width of 60'. The waterway extends from Slidell to deep water in Lake Pontchartrain. The Bayou Lacombe project consists of removal of snags and overhanging trees from mile 8.2 to the mouth, and a 60'-wide, 8'-deep channel through the entrance bar in Lake Pontchartrain. The Tchefuncte River and Bogue Falaya project completed in 1959 presently provides for a 10'-by-125' navigation channel from a 10' depth in Lake Pontchartrain to about mile 3.5 of the Tchefuncte River. The section from mile 3.5 to Covington is still 8' deep, the original dimensions of the project completed in 1929.

Pass Manchac, which provides access to Lakes Pontchartrain and Maurepas, was improved by removal of snags, logs, and other obstructions from the bars at the entrance of the pass and throughout its 7-mi length between Lakes Maurepas and Pontchartrain in 1912. The Tangipahoa River project provides for removal of overhanging trees, snags, and obstructions on the lower 53.5 mi of the river with intermittent maintenance. The Tangipahoa River Navigation project provided dredging of an 8'-by-10' boat channel through the bar in Lake Pontchartrain at the mouth of the Tangipahoa River. Obstructions have also been removed in the Tickfaw River from its mouth to mile 26, in the Blood River from its mouth to the head of navigation near mile 4, and in the Natalbany and Pontchatoula rivers for a distance of 15.5 mi.

Flood control projects in the Pontchartrain basin include the Amite River and Tributaries, Lake Pontchartrain and Vicinity Hurricane Project, and the Lake Pontchartrain Levees. The Amite River and Tributaries project consists of 1) a 10.6-mi diversion channel from the Amite River at mile 25.3 to 4.8 of Blind River; 2) enlargement of the Comite River from its mouth to Cypress Bayou; 3) clearing and snagging of the Amite River from its confluence with the Comite River (mile 54) to Bayou Manchac (mile 35.7); 4) enlargement and realignment of the Amite River from Bayou Manchac to mile 25.3; and 5) clearing and snagging of Bayou Manchac from the Amite River to Ward's Creek. The diversion channel is connected to the Amite River by a control weir that serves to retain low flows; boat access is allowed through a small navigation channel through the control.

The Lake Pontchartrain and Vicinity Hurricane Protection project provides protection from the standard project hurricane for the New Orleans metropolitan area on the east bank of the Mississippi River, which includes sections of Orleans, Jefferson, St. Bernard and St. Charles parishes. The construction of levees and floodwalls around the protected areas began in 1966 and is continuing. The Lake Pontchartrain levees project includes construction of 10.2 mi of levee along the Lake Pontchartrain shoreline of Jefferson Parish and the enlargement of 7.1 mi of existing levees. The Lake Pontchartrain north shore project provides for maintenance of the entrance channel of Bayou Castine and for the restoration of 0.9 mi of beach at Fontainbleau State Park, east of Mandeville.

Pearl River Basin

The Pearl River basin is flanked by the Lake Pontchartrain basin on the west and follows the upland topographic divide separating the basins. The Pearl River drains parts of southeastern Louisiana and south-central and southwestern Mississippi, with a drainage area of 8,637 mi^2 (22,455 km^2). The basin contains a swamp-alluvial lowland, and a fringe of coastal marsh. Major channels include the West Pearl River, the West Middle Pearl River, Middle River, Old River, Pearl River, Bayou Cowans, and Mulatto Bayou. The Pearl River and channels empty into the north shore of Lake Borgne of the Pontchartrain basin. The only lake of substantial size in the coastal Pearl basin is Little Lake.

The coastal Pearl basin includes sections of the Mississippi River delta plain, alluvium, and continuous areas and inliers of the late Pleistocene Prairie Terraces. The delta plain deposits are associated with the abandoned St. Bernard delta complex. In alluvial sections of the Pearl River basin, flow is divided into major anabranches, such as the East Pearl and West Pearl rivers, along with several other minor channels. Except for the major anabranches, these channels flow only at high discharges. At other times, the channels contain standing water and do not experience significant discharges except during floods.

Predominant soils in the coastal Pearl basin include, in order of dominance, 1) Medisaprists-Hydraquents, moderately saline, across the southern part of the basin; 2) Myatt-Stough, 0-3%, developed on late Pleistocene deposits in the northwestern part of the coastal basin; and 3) Haplaquepts-Dystrochrepts, frequently flooded, developed in the northeastern part of the coastal basin in the alluvial valley (figure 61).

Human activities in the coastal basin are limited, and the population is small. There are no oil and gas activities. Development is limited to small towns adjacent to the basin such as Pearlington. The Pearl River Wildlife Management area encompasses over half the basin. Highway 90 is the only major road to traverse the basin.

The coastal Pearl River basin does not have any water-level gages. The U.S. Geological Survey monitored stages on Canal W-15 at service road at Slidell from 1985 to 1987, with extremes of 15.26' as maximum and with the minimum not determined. There are no long-term discharge stations in or near the basin, but flow measurements are acquired on the Pearl River at Bogalusa. Maximum discharges during the period of record were 127,000 cfs on April 24, 1979, 109,000 cfs in 1983, and 104,000 cfs in 1980. Minimum discharge during the period of record was 1,020 cfs. Mean discharge for 49 years (1938-1987) is 9,891 cfs. A U.S. Geological Survey station upstream of the coastal area, on the Pearl River at Pearl River, has been monitored from 1963 to 1970, and 1975 to present, has a maximum recorded discharge of 230,000 cfs on April 9, 1983, and a gage height of 21.05', an average discharge for 7 yr (1964-1970) of 9,470 cfs, and a minimum discharge of 1,580 cfs on October 24 and November 10, 1968 (figure 71). The approximate reach of tidal influence is shown in figure 65.

Water quality data is collected at two locations in the coastal Pearl basin:

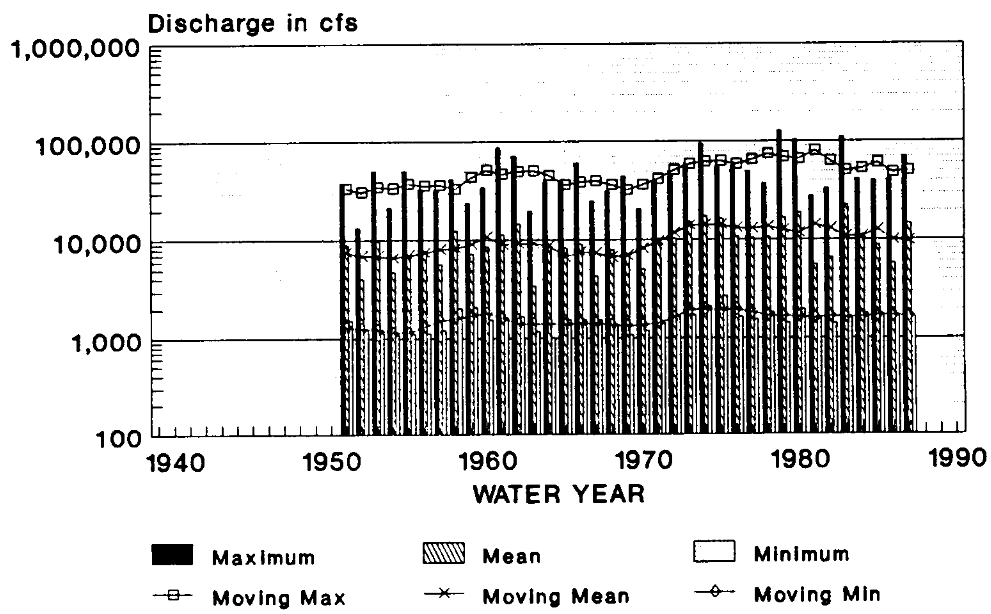


Figure 71. Maximum, mean, and minimum daily discharges on an annual basis and 5-year moving maxima, means, and minima for the Pearl River near Bogalusa, 1951-1987.

the Pearl River (East) at Pearlington, Mississippi, and the Pearl River (West), Southeast of Slidell. The Pearl River at Pearlington has experienced 22 dissolved oxygen observations below or equal to 5 ppt, and only one observation below 3 ppt. Turbidity has ranged from 0.6 to 315 NTU, and total suspended solids from 0 to 1888 mg/l. The West Pearl River, southeast of Slidell, has had five observations below or equal to 5 ppt. Turbidity ranged from 8 to 72 NTU, and total suspended solids from 4 to 96 mg/l. Turbidity and total suspended solids on the West Pearl are lower than at most of the other stations across coastal Louisiana (figures 72, 73).

Water quality in the Pearl River basin is generally good. At times, high fecal coliform counts are found in samples taken downstream of Bogalusa. Water pollution resulting from agricultural activities is not a serious problem. The water quality index for this basin is 33.6, indicating only moderate pollution. The major problem component is fecal coliform, attributable to poorly treated municipal wastes and non-point source discharges at the lower end of the river. There were also violations of pH standards, caused by natural conditions. The lower Pearl River, extending from Interstate 10 to Lake Borgne and contiguous channels, has the highest water quality index in the basin (47.1). Major problems include dissolved solids and turbidity.

There are no salinity stations in the coastal Pearl basin. Fresh and intermediate marshes dominate across the upper 75% of the basin; saline and brackish marshes occur across the lower 25% of the basin: Assessments of relative sea level rise are not available because there are no water-level stations.

Navigation projects in the coastal Pearl River basin include the Pearl River Waterway, Mississippi and Louisiana. The West Pearl River Waterway Project, completed in 1956, provides a navigation channel from the mouth of the West Pearl River to the vicinity of Bogalusa, a distance of about 58 mi. The project includes a 7'-deep channel with a bottom width of 100' in the river sections and an 80' width in the canal section, three navigation locks with inside dimensions of 65' by 310', and two sills to control water levels in the canal section. The last maintenance dredging to accommodate commercial traffic was performed in 1973. The project is not being maintained because it is no longer justified economically. Farther upstream on the Pearl River, near Jackson, lies the Ross Barnett Reservoir.

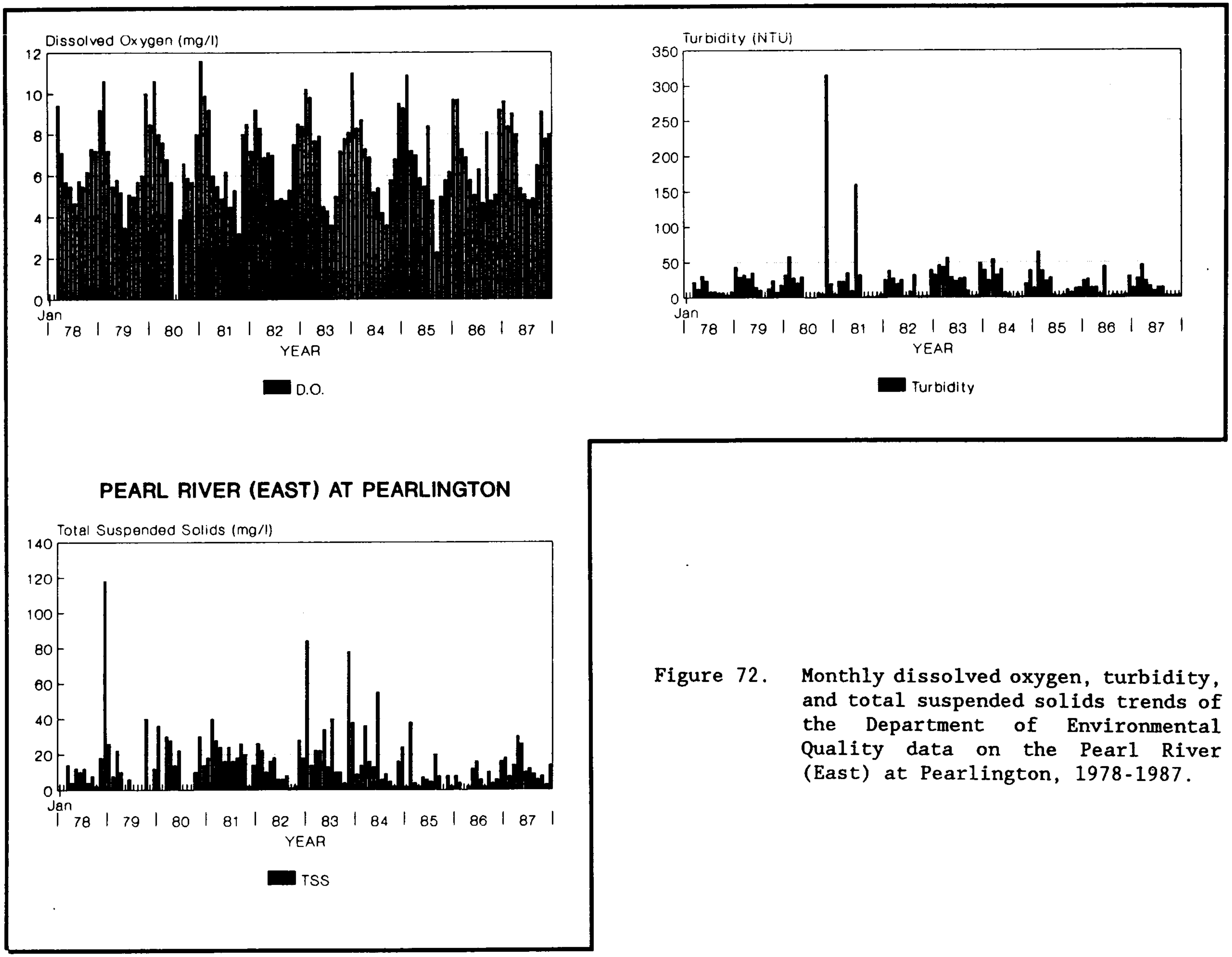


Figure 72. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Pearl River (East) at Pearlington, 1978-1987.

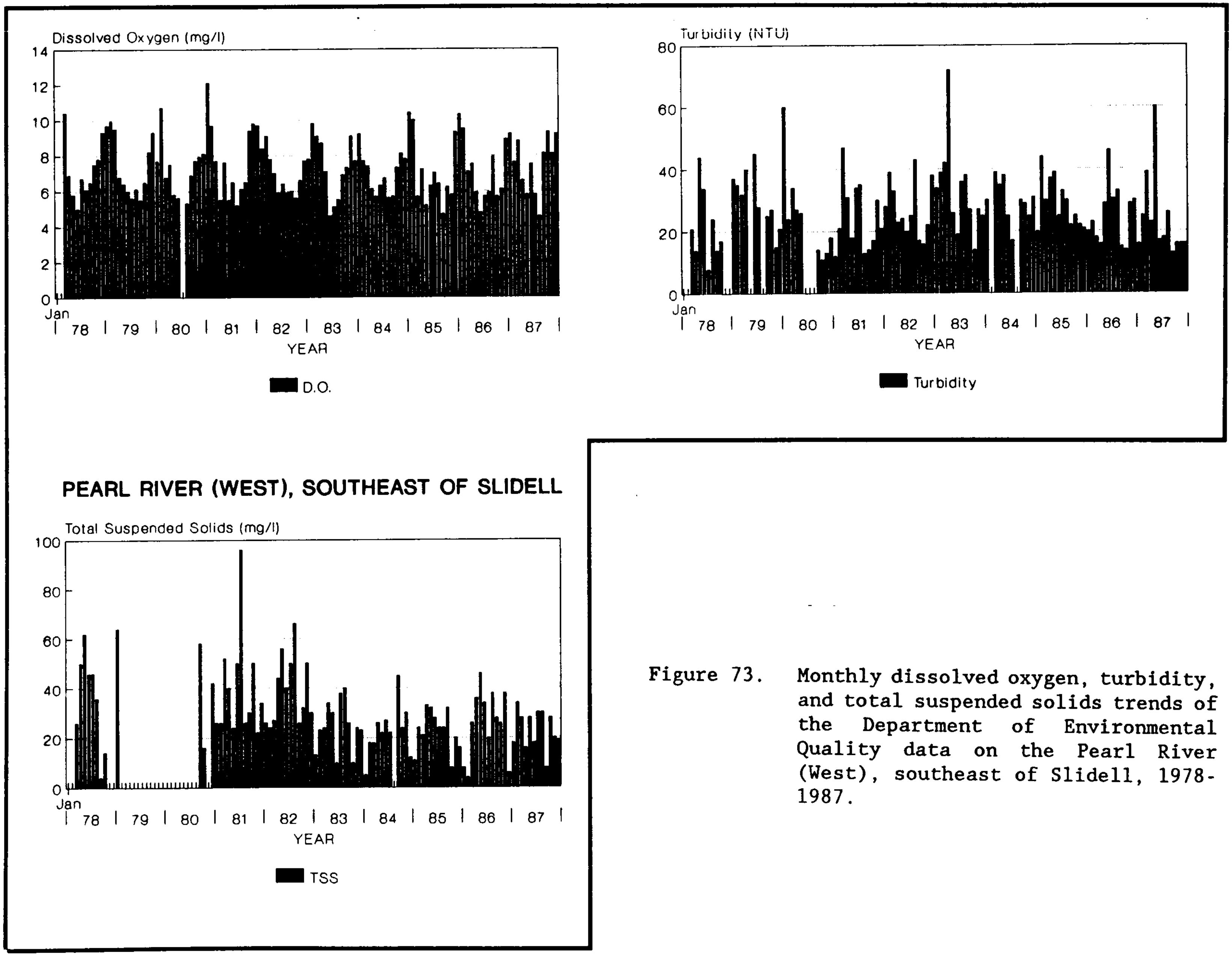


Figure 73. Monthly dissolved oxygen, turbidity, and total suspended solids trends of the Department of Environmental Quality data on the Pearl River (West), southeast of Slidell, 1978-1987.

CHAPTER III

REGIONAL HABITAT DESCRIPTIONS

Dianne M. Lindstedt

Habitat Descriptions

The main factors influencing the species composition of coastal plant communities are elevation, hydrology, and salinity. Salinity is mostly controlled by hydrology. In Louisiana, higher salinities occur at the southern end of each hydrologic unit because of the proximity to the Gulf and the higher tidal amplitude. The least favorable growing conditions for plants occur in this region of the hydrologic units because of the combined effects of salinity and flooding. Plant species, such as S. alterniflora, which dominate these areas, are well adapted to higher saline and flooding conditions. More favorable growing conditions for wetland plants occur at the upper end of the units where salinity is low, elevations are slightly higher, and flooding is less frequent. Consequently, plant diversity increases from the lower limits to the upper limits of each unit because of the decrease in salinity and thus reduced physiochemical stress. Species composition at the lower end of the units seems to be controlled by physiochemical parameters such as salinity and flooding frequency, while the composition in the upper limits (in the swamp, for example) seems to be regulated more by biological competition (Bahr and Hebrard 1976). Plant communities in the upper basin are susceptible to salt stress should saline water encroach farther inland. The following is a description of the habitats used in the mapping portion of this project. It is based upon the 1978 data because this was the most detailed for habitat interpretation (see plate 1 in main volume).

Habitats Occurring in the Louisiana Coastal Zone

Natural Water

Natural water consists of all naturally occurring water bodies, such as streams, rivers, ponds, lakes, bays, and marine waters. This habitat type occupies 47% (3,481,388 acres in 1978) of the total coastal zone (table 6). The habitat statistics for the natural water area include territorial waters out to the 3-mi limit, which make up a large portion of this habitat type. The deltaic plain has a larger proportion of natural water (52% or 2,816,387 acres in 1978) than does the chenier plain (33% or 665,002 acres). Salinity ranges from zero in the fresh areas to ocean salinity in the nearshore Gulf. Fish species common to natural water bodies in Louisiana are listed in table 7. Fifty-nine species are freshwater, 117 are marine, 32 are estuarine, and 37 are estuarine-marine (migratory). Sea turtles inhabit the open waters of the Gulf in Louisiana's coastal zone and their distributions are discussed in the endangered species section.

Loons, grebes, and cormorants are common in open-water habitat. The lesser scaup (Aythya affinis), brown pelican (Pelecanus occidentalis), and red-breasted

Table 6. Areal extent of habitat types on the chenier plain, delta plain, and coastal zone of Louisiana in 1978, in acres (percentages in parentheses).

	Sabine	Calca	Mermen	Vermil	Chenier Plain Total	Atchaf	Terre	Baratar	Miss. R	Pont.	Breton	Pearl	Delta Plain Total	Coastal Zone Total
Inland water (natural)	58,249 (22)	121,328 (41)	161,821 (24)	323,604 (42)	665,002 (33)	179,259 (57)	544,210 (45)	348,640 (37)	206,999 (55)	1,107,874 (61)	427,596 (61)	1,808 (5)	2,816,387 (52)	3,481,388 (47)
Water (artificial)	9,427 (4)	9,369 (3)	13,458 (2)	11,642 (2)	43,897 (2)	5,232 (2)	20,956 (2)	36,477 (4)	8,520 (2)	14,658 (1)	15,138 (2)	198 (1)	101,179 (2)	145,075 (2)
Fresh marsh	16,779 (6)	4,939 (2)	236,801 (35)	48,512 (6)	307,031 (15)	54,983 (17)	165,857 (14)	51,063 (5)	39,872 (11)	29,685 (2)	2,542 (<1)	2,603 (8)	346,605 (6)	653,636 (9)
Intermediate marsh	65,324 (25)	41,901 (14)	75,781 (11)	42,397 (6)	225,403 (11)	0 (0)	66,680 (6)	76,421 (8)	25,025 (7)	15,902 (1)	8,701 (1)	8,254 (25)	200,983 (4)	426,386 (6)
Brackish marsh	70,939 (27)	60,990 (21)	99,098 (15)	148,984 (19)	380,010 (19)	0 (0)	140,172 (12)	107,472 (12)	5,052 (1)	128,056 (7)	148,129 (21)	591 (2)	529,471 (10)	909,481 (12)
Saline marsh	4,498 (2)	4,706 (2)	15,287 (2)	6,389 (1)	30,881 (2)	0 (0)	152,402 (13)	156,927 (17)	2,147 (1)	62,494 (3)	50,194 (7)	0 (0)	424,164 (8)	455,044 (6)
Forest	813 (<1)	784 (<1)	6,614 (1)	17,651 (2)	25,862 (1)	2,089 (1)	16,788 (1)	28,483 (3)	7,444 (2)	101,263 (6)	12,399 (2)	5,248 (16)	173,715 (3)	199,577 (3)
Swamp	0 (0)	0 (0)	169 (<1)	37,032 (5)	37,201 (2)	53,387 (17)	34,237 (3)	23,698 (3)	12,000 (3)	171,637 (10)	1,751 (<1)	8,515 (26)	305,225 (6)	342,425 (5)
Shrub/scrub	1,935 (1)	816 (<1)	3,527 (<1)	10,193 (1)	16,471 (1)	2,012 (1)	12,176 (1)	5,703 (1)	2,330 (1)	8,277 (<1)	1,454 (<1)	73 (<1)	32,026 (1)	48,497 (1)
Shrub/scrub (spoil)	3,200 (1)	7,017 (2)	11,030 (2)	4,453 (1)	25,701 (1)	5,138 (2)	19,244 (2)	17,454 (2)	5,836 (2)	3,475 (<1)	17,124 (2)	0 (0)	68,272 (1)	93,973 (1)
Agric/pasture	14,370 (6)	32,990 (11)	43,053 (6)	98,985 (13)	189,398 (9)	5,506 (2)	10,940 (1)	29,767 (3)	12,942 (3)	46,758 (3)	6,229 (1)	1,662 (5)	113,804 (2)	303,202 (4)
Developed	1,962 (1)	4,486 (2)	4,912 (1)	10,665 (1)	22,025 (1)	2,143 (1)	4,416 (<1)	38,416 (4)	32,411 (9)	106,579 (6)	11,717 (2)	4,269 (13)	199,951 (4)	221,976 (3)
Aquatic vegetation	3,575 (1)	420 (<1)	1,694 (<1)	2,217 (<1)	7,905 (<1)	2,520 (1)	18,810 (2)	8,236 (1)	3,844 (1)	3,881 (<1)	366 (<1)	17 (0)	37,674 (1)	45,580 (1)
Unvegetated	8,465 (3)	3,849 (1)	6,186 (1)	1,511 (<1)	20,012 (1)	2,463 (1)	1,167 (<1)	3,603 (<1)	11,741 (3)	1,773 (<1)	2,292 (<1)	27 (<1)	23,066 (<1)	43,078 (1)
Beach	675 (<1)	292 (<1)	994 (<1)	578 (<1)	2,539 (<1)	37 (<1)	1,398 (<1)	1,098 (<1)	124 (<1)	1,930 (<1)	173 (<1)	0 (0)	4,761 (<1)	7,299 (<1)
TOTAL AREA:	260,212	293,887	680,425	764,814	1,999,336	314,770	1,209,454	933,458	376,286	1,804,243	705,807	33,265	5,377,282	7,376,619

Figures do not include 1,179,471 acres of offshore state waters within the coastal zone.

Table 7. Fishes found in marshes and water bodies of Louisiana coastal zone (Gosselink 1984; Gosselink et al. 1979).

Species	Common name	Distribution CP[1]	DP[2]	Vegetative type FW[3]	MA[4]	ES[5]	ESM[6]
Achirus lineatus	lined sole	x	x	--	--	--	x
Acipenser oxyrhynchus	Atlantic sturgeon	x		--	x	--	--
Adinia xenica	diamond killifish		x	--	--	x	--
Aetobatus narinari	spotted eagle ray	x		--	x	--	--
Aleuterus schoepfi	orange filefish	x		--	x	--	--
Aleuterus scriptus	scrawled filefish	x		--	x	--	--
Alosa chrysochloris	skipjack herring	x	x	x	x	--	--
Amia calva	bowfin		x	x	--	--	--
Anchoa mitchilli	bay anchovy	x	x	--	x	--	x
Anchoa hepsetus	striped anchovy	x		--	x	--	--
Anchoa lyolepis	dusky anchovy	x		--	x	--	--
Ancylopsetta quadrocellata	ocellated flounder	x		--	x	--	--
Anguilla rostrata	American eel	x	x	--	x	--	--
Aphredoderus sayanus	pirate perch		x	x	--	--	--
Aplodinotus grunniens	freshwater drum		x	x	--	--	--
Aprionodon isodon	finetooth shark	x		--	x	--	--
Archosargus probatocephalus	sheepshead	x	x	--	--	--	x
Arius felis	hardhead fish	x	x	--	--	--	x
Astroscopus graecum	southern stargazer	x		--	x	--	--
Bagre marinus	gafftopsail catfish	x	x	--	--	--	x
Bairdiella chrysoura	silver perch	x	x	--	--	--	x
Bollmannia communis	ragged goby	x		--	x	--	--
Bregmaceros atlanticus	antenna codlet	x		--	x	--	--
Brevoortia gunteri	finscale menhaden	x		--	x	--	--
Brevoortia patronus	gulf menhaden	x	x	--	x	--	x
Caranx crysos	blue runner	x	x	--	x	--	--
Caranx hippos	crevalle jack	x	x	--	x	--	--
Caranx latus	horse-eye jack	x		--	x	--	--
Carcharhinus leucas	bull shark	x		--	x	--	--
Carcharhinus limbatus	blacktip shark	x		--	x	--	--
Carpiodes carpio	river carpsucker		x	x	--	--	--
Centrarchus macropterus	flier		x	x	--	--	--
Centropristis philadelphica	rock sea bass	x		--	x	--	--
Chaetodipterus faber	Atlantic spadefish	x	x	--	--	--	x
Chasmodes bosquianus	striped blenny	x		--	x	--	--
Chilomycterus schoepfi	striped burrfish	x		--	x	--	--
Chloroscombrus chrysurus	Atlantic bumper	x	x	--	x	--	--
Citharichthys macrops	spotted whiff	x	x	--	--	--	x
Citharichthys spilopterus	bay whiff	x	x	--	x	--	x
Conodon nobilis	barred grunt	x		--	x	--	--
Coryphaena hippurus	dolphin	x	x	--	x	--	--
Cynoscion arenarius	sand seatrout	x	x	--	--	--	x
Cynoscion nebulosus	spotted seatrout	x	x	--	--	--	x
Cynoscion nothus	silver seatrout	x	x	--	x	--	x
Cyprinodon variegatus	sheepshead minnow	x	x	--	--	x	x
Cyprinus carpio	carp		x	x	--	--	--

Table 7. Fishes found in marshes and water bodies of Louisiana coastal zone (Gosselink 1984; Gosselink et al. 1979) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	FW[3]	MA[4]	ES[5]	ESM[6]
Cypselurus exsiliens	bandwing flyingfish	x		--	x	--	--
Cypselurus furcatus	spotfin flyingfish	x		--	x	--	--
Dasyatis americana	southern stingray	x		--	x	--	--
Diodon hystrix	porcupinefish	x		--	x	--	--
Dasyatis sayi	bluntnose stingray	x		--	x	--	--
Dasyatis sabina	Atlantic stingray	x	x	--	x	--	--
Dormitator maculatus	fat sleeper		x	--	--	x	--
Dorosoma cepedianum	gizzard shad	x	x	x	--	--	--
Dorosoma petenense	threadfin shad	x		--	x	--	--
Echeneis naucrates	sharksucker	x		--	x	--	--
Elassoma zonatum	banded pygmy sunfish		x	x	--	--	--
Eleotris pisonis	spinycheck sleeper		x	--	--	x	--
Elops saurus	ladyfish	x	x	--	--	--	x
Elotris pisonis	spinycheek sleeper		x	--	--	x	--
Erimyzon oblongus	creek chubsucker		x	x	--	--	--
Esox americanus vermiculatus	grass pickerel		x	x	--	--	--
Etheostoma chlorosomum	bluntnose darter		x	x	--	--	--
Etheostoma gracile	slough darter		x	x	--	--	--
Etheostoma proeliare	cypress darter		x	x	--	--	--
Etropus crossotus	fringed flounder	x	x	--	x	--	x
Eucinostomus argenteus	spotfin mojarra	x	x	--	x	x	x
Evorthodus lyricus	lyre goby		x	--	--	x	--
Fundulus chrysotus	golden topminnow		x	--	--	x	--
Fundulus grandis	gulf killifish	x	x	--	--	x	--
Fundulus jenkinsi	saltmarsh topminnow		x	--	--	x	--
Fundulus olivaceus	blackspotted topminnow		x	x	--	--	--
Fundulus pulvereus	*bayou killifish*		x	--	--	x	--
Fundulus similis	longnose killifish	x	x	--	--	x	--
Fundulus nottii	starhead topminnow		x	x	--	--	--
Gambusia affinis	mosquitofish	x	x	x	--	x	--
Gobiesox strumosus	skilletfish	x	x	--	x	--	x
Gobioides broussoneti	violet goby	x	x	--	--	x	--
Gobionellus boleosoma	darter goby	x	x	--	--	x	--
Gobionellus hastatus	sharptail goby		x	--	--	x	--
Gobionellus shufeldti	freshwater goby		x	--	--	x	--
Gobiosoma bosci	naked goby	x	x	--	--	x	--
Gobiosoma robustum	code goby		x	--	--	x	--
Gymnura micrura	smooth butterfly ray	x		--	x	--	--
Gymnachirus lexae	fringed sole	x		--	x	--	--
Gymnothorax moringua	spotted moray	x		--	x	--	--
Harengula pensacolae	scaled sardine	x		--	x	--	--
Heterandria formosa	least killifish		x	x	--	x	--
Histrio histrio	sargassumfish	x		--	x	--	--
Hyporhamphus unifasciatus	halfbeak	x	x	--	x	x	--
Hypsoblennius hentzi	feather blenny	x		--	x	--	--

Table 7. Fishes found in marshes and water bodies of Louisiana coastal zone (Gosselink 1984; Gosselink et al. 1979) (continued).

Species	Distribution Common name	Vegetative type CP[1]	 DP[2]	FW[3]	MA[4]	ES[5]	ESM[6]
Hypsoblennius ionthas	freckled blenny	x		--	x	--	--
Ictalurus furcatus	blue catfish		x	x	--	--	--
Ictalurus melas	black bullhead		x	x	--	--	--
Ictalurus natalis	yellow bullhead		x	x	--	--	--
Ictalurus punctatus	channel catfish		x	x	--	--	--
Ictiobus bubalus	smallmouth buffalo		x	x	--	--	--
Ictiobus cyprinellus	bigmouth buffalo		x	x	--	--	--
Labidesthes sicculus	brook silverside		x	x	--	x	--
Lactophrys quadricornis	scrawled cowfish	x		--	x	--	--
Lagocephalus laevigatus	smooth puffer	x	x	--	x	--	--
Lagodon rhomboides	pinfish	x	x	--	--	x	--
Larimus faciatus	banded drum	x		--	x	--	--
Leiostomus xanthurus	spot	x	x	--	--	--	x
Lepisosteus oculatus	spotted gar		x	x	--	--	--
Lepisosteus osseus	longnose gar	x		--	x	--	--
Lepisosteus spatula	alligator gar	x	x	x	--	--	--
Lepomis cyanellus	green sunfish		x	x	--	--	--
Lepomis gulosus	warmouth		x	x	--	--	--
Lepomis macrochirus	bluegill		x	x	--	--	--
Lepomis marginatus	dollar sunfish		x	x	--	--	-
Lepomis megalotis	longear sunfish		x	x	--	--	--
Lepomis microlophus	redear sunfish		x	x	--	--	--
Lepomis punctatus	spotted sunfish		x	x	--	--	--
Lepomis symmetricus	bantam sunfish		x	x	--	--	--
Lobotes surinamensis	tripletail	x	x	--	x	--	--
Lucania parva	rainwater killifish		x	--	--	x	--
Lutjanus griseus	gray snapper	x	x	--	x	--	--
Lutjanus synagris	Lane snapper	x	x	--	x	--	--
Manta birostris	Atlantic manta	x		--	x	--	--
Maraconger caudilimbatus	margintail conger	x		--	x	--	--
Megalops atlantica	Tarpon	x		--	x	--	--
Membras martinica	rough silverside		x	x	--	x	--
Menidia beryllina	inland silverside	x	x	--	--	x	--
Menticirrhus littoralis	Gulf kingfish	x		--	x	--	--
Menticirrhus americanus	southern kingfish	x		--	x	--	--
Microdesmus longipinnis	pink wormfish	x		--	x	--	--
Microgobius thalassinus	green goby		x	--	--	x	--
Microgobius gulosus	clown goby		x	--	--	x	--
Micropogonias undulatus	Atlantic croaker	x	x	--	x	--	x
Micropterus salmoides	largemouth bass		x	x	--	--	--
Minytrema melanops	spotted sucker		x	x	--	--	--
Monacanthus lispidus	planehead filefish	x		--	x	--	--
Morone chrysops	white bass		x	x	--	--	--
Morone mississippiensis	yellow bass		x	x	--	--	--
Morone saxatilis	striped bass	x	x	x	--	--	--

Table 7. Fishes found in marshes and water bodies of Louisiana coastal zone (Gosselink 1984; Gosselink et al. 1979) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	FW[3]	MA[4]	ES[5]	ESM[6]
Moxostoma poecilurum	blacktail redhorse		x	x	--	--	--
Mugil cephalus	striped mullet	x	x	--	--	--	x
Mugil curema	white mullet	x		--	x	--	x
Myrophis punctatus	speckled worm eel	x		--	x	--	--
Mystriophis mordax	snapper eel	x		--	x	--	--
Mystriophis intertinctus	spotted spoon-nose eel	x		--	x	--	--
Narcine brasiliensis	lesser electric ray	x		--	x	--	--
Negaprion brevirostris	lemon shark	x		--	x	--	--
Notemigonus crysoleucas	golden shiner		x	x	--	--	--
Notropis atherinoides	emerald shiner		x	x	--	--	--
Notropis buchanani	ghost shiner		x	x	--	--	--
Notropis emiliae	pugnose minnow		x	x	--	--	--
Notropis fumeus	ribbon shiner		x	x	--	--	--
Noturus gyrinus	tadpole madtom		x	x	--	--	--
Notropis lutrensis	red shiner		x	x	--	--	--
Notropis maculatus	taillight shiner		x	x	--	--	--
Notropis sabinae	Sabine shiner		x	x	--	--	--
Notropis texanus	weed shiner		x	x	--	--	--
Notropis volucellus	mimic shiner		x	x	--	--	--
Ogeocephalus radiatus	polka-dot batfish	x		--	x	--	--
Oligoplites saurus	leatherjacket	x	x	--	x	--	x
Ophichthus gomesi	shrimp eel	x		--	x	--	--
Ophidion welshi	crested cusk-eel	x	x	--	x	--	x
Opisthonema oglinum	Atlantic thread herring	x		--	x	--	--
Opsanus beta	gulf toadfish	x	x	x	x	--	x
Orthopristis chrysoptera	pigfish	x		--	x	--	--
Paralichthys albigutta	Gulf flounder	x	x	--	x	--	x
Paralichthys lethostigma	southern flounder	x	x	--	--	--	x
Paralichthys squamilentus	broad flounder	x		--	x	--	x
Peprilus alepidotus	harvest fish	x	x	--	x	--	--
Peprilus burti Fowler	Gulf butterfish	x	x	--	x	--	--
Pimephales vigilax	bullhead minnor		x	x	--	--	--
Poecilia latipinna	sailfin molly	x	x	x	--	--	--
Pogonias cromis	black drum	x	x	--	--	--	x
Polydactylus octonemus	Atlantic threadfin	x	x	--	x	--	--
Pomatomus saltrix	bluefish	x	x	--	x	x	x
Pomoxis annularis	white crappie		x	x	--	x	--
Pomoxis nigromaculatus	black crappie		x	x	--	--	--
Porichthys porosissimus	Atlantic midshipman	x		--	x	--	--
Prionotus martis	barred searobin	x		--	x	--	--
Prionotus rubio	blackfin searobin	x		--	x	--	--
Prionotus scitulus	leopard searobin	x		--	x	--	--
Prionotus tribulus	bighead searobin	x		--	x	--	--
Pristis pectinata	smalltooth sawfish	x		--	x	--	--
Pristis perotteti	largetooth sawfish	x		--	x	--	--

Table 7. Fishes found in marshes and water bodies of Louisiana coastal zone (Gosselink 1984; Gosselink et al. 1979) (continued).

Species	Distribution Common name	Vegetative type CP[1]	 DP[2]	FW[3]	MA[4]	ES[5]	ESM[6]
Pylodictis olivaris	flathead catfish		x	x	--	--	--
Rachycentron canadum	cobia	x	x	--	x	--	--
Raja texana	roundel skate	x		--	x	--	--
Remora remora	remora	x		--	x	--	--
Rhinobatos lentiginosus	Atlantic guitarfish	x		--	x	--	--
Rhinophtera bonasus	cownose ray	x		--	x	--	--
Rhizoprionodon terranovae	Atlantic sharpnose shark	x	x	--	x	--	--
Sciaenops ocellatus	red drum	x	x	--	--	--	x
Scomberomorus maculatus	spanish mackerel	x	x	--	x	--	--
Scorpaena calcarata	smoothhead scorpion-fish	x		--	x	--	--
Selena vomer	lookdown	x	x	--	x	--	--
Serranus subligarius	belted sandfish	x		--	x	--	--
Sphoeroides parvus	least puffer	x	x	--	x	--	--
Sphyraena barracuda	great barracuda	x	x	--	x	--	--
Sphyrna tiburo	bonnethead	x		--	x	--	--
Sphyrna tudes	smalleye hammerhead	x		--	x	--	--
Stellifer lanceolatus	star drum	x	x	--	--	--	x
Stenotomus caprinus	Longspine porgy	x		--	x	--	--
Strongylura marina	Atlantic needlefish	x	x	--	x	--	x
Syacium gunteri	shoal flounder	x		--	x	--	x
Symphurus parvus	pygmy tonguefish	x		--	x	--	--
Symphurus plagiusa	blackcheek tonguefish	x	x	--	x	--	--
Symphurus diomedianus	spottedfin tonguefish	x		--	x	--	--
Syngnathus louisianae	chain pipefish	x	x	--	--	--	x
Syngnathus scovelli	gulf pipefish	x	x	--	x	x	--
Syngnathus louisianae	chain pipefish	x		--	x	--	--
Synodus foetens	inshore lizardfish	x	x	--	x	--	x
Trachinotus carolinus	Florida pompano	x	x	--	x	--	--
Trachinotus falcatus	permit	x	x	--	x	--	--
Trichiurus lepturus	Atlantic cutlassfish	x		--	x	--	x
Trinectes maculatus	hogchoker	x	x	--	--	x	--
Urophycis floridanus	southern hake	x		--	x	--	--
Vomer setapinnis	Atlantic moonfish	x		--	x	--	--

CP - Chenier plain
DP - Mississippi deltaic plain
FW - freshwater
MA - marine
ES - estuarine
ESM - estuarine-marine (migratory)

merganser (Mergus serrator) may be also found in open water. Birds that are common along the beaches also frequent open-water areas (Abernethy 1987).

Artificial Water

Artificial water makes up about 2% (145,075 acres in 1978) of Louisiana's coastal area. Most of this habitat (69% or 101,179 acres) occurs in the deltaic plain (table 6). This habitat type consists of human-made or human-influenced water bodies that are dredged or excavated, such as canals, impoundments, ponds, pipelines, and brine discharge pits. It also includes failed agricultural impoundments, oilfield impoundments, navigation and oilfield access canals, and oil and natural gas pipeline canals. Canals and impoundments occur throughout the coastal zone; therefore, the salinity regime and fish communities are similar to those of naturally occurring water bodies.

Aquatic Vegetation

Aquatic vegetation habitat is fairly uncommon (1%, 45,580 acres). This habitat consists of both floating aquatics and submerged aquatics in fresh areas, which may be found in both natural and artificial water bodies, and submergent estuarine vegetation and submerged marine aquatics, which form grass beds in estuarine and marine areas.

Floating aquatics are found mainly in freshwater areas in water bodies adjacent to fresh and intermediate marshes. These species are listed on table 8 with other vegetation found in these areas. Floating aquatics found in more open water, bayous, and canals around fresh marshes are duckweeds (Lemna minor, Spirodela spp., Wolffia spp. and Wolffiella spp.), water hyacinth (Eichhornia crassipes) and water lettuce (Pistia stratiotes). In many areas, water milfoil (Myriophyllum spp.) is the dominant submerged aquatic species in low-salinity, brackish, and intermediate marshes. Other common submerged aquatics or rooted vegetation include pondweeds (Potamogeton spp.), alligator weed (Alternanthera philoxeroides), water lily (Nymphaea odorata), mosquito fern (Azolla caroliniana) and coontail (Ceratophyllum demersum) (Lester 1988, Conner et al. 1986, Chabreck 1972).

Although submergent estuarine vascular vegetation is found throughout the coastal zone, extensive beds are found in the Lake Pontchartrain and Barataria basins. The rooted vegetation of this habitat grows in shallow, protected waters with low turbidity. The factors that control species composition are temperature, salinity, substrate, wave action, and light penetration. These plants support many invertebrates and provide nursery grounds for many species of fish and shellfish, such as crabs (Callinectes sapidus), shrimp (Penaeus spp.), redfish (Sciaenops ocellata), and speckled trout (Cynoscion nebulosus). The plant community is composed mainly of wild celery (Vallisneria americana), widgeon grass (Ruppia maritima), southern naiad (Najas guadalupensis), and horned pondweed (Zannichellia palustris) (Lester 1988; Smith 1988).

Submerged marine aquatics form grassbeds composed mainly of turtle grass (Thalassia testudina), manatee grass (Cymodocea filiformis), seagrass (Halophila engelmanii), shoal grass (Halodule beaudettei), and widgeon grass (Ruppia maritima) (Lester 1988). This community occurs in shallow, sandy areas in relatively clear water. Wave action, currents, temperature, salinity, substrate, and turbidity determine which species are present. Submerged aquatics form extremely productive communities and provide food and nursery grounds for several

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977).

Species	Common name	Distribution		Vegetative type				
		CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Acnida alaamensis	Gulf coast waterhemp	x		--	x	--	--	--
Acnida cuspidata	southern waterhemp		x	--	x	--	--	--
Acnida tamariscina	Nuttall's waterhemp			--	--	--	--	x
Aeschynomene sp.	--		x	--	--	--	--	--
Aeschynomene indica	jointvetch		x	--	--	x	--	--
Aeschynomene virginica	sensitive jointweed		x	--	--	--	x	--
Agalinis maritima	seaside gerardia		x	--	--	x	--	x
Alternanthera sp.	--		x	--	--	x	x	x
Alternanthera philoxeroides	alligator weed	x	x	--	--	x	x	x
Amaranthus australis	southern waterhemp		x	--	x	x	x	--
Ambrosia trifida	giant ragweed	x		--	--	--	--	--
Ammannia sp.	--		x	--	--	--	--	--
Ammannia coccinea	purple ammannia		x	--	--	x	--	x
Anmonphilia breviligulata	American beach grass		x	--	--	--	--	x
Ampelopsis arborea	pepper-vine			--	--	--	--	x
Andropogon glomeratus	bushy beardgrass		x	--	--	x	--	x
Andropogon scoparius	broom sedge		x	--	--	--	--	x
Andropogon virginicus	--		x	--	--	--	--	x
Anthaenantia	--		x	--	--	--	--	x
Apios americana	American potatobean		x	--	--	--	x	--
Apios sp.	potatobean		x	--	--	--	x	--
Aster sp.	aster		x	--	x	x	x	--
Aster subulatus	annual saltmarsh aster	x	x	x	x	x	x	--
Aster tenuifolius	saltmarsh aster	x	x	x	x	x	--	--
Atriplex sp.	salt cedar	x		--	--	--	--	--
Avicennia germinans	black mangrove		x	x	--	--	--	x
Azolla caroliniana	Water fern		x	--	--	--	--	--
Baccharis sp.	baccharis	x	x	x	x	x	x	--
Baccharis halimifolia	eastern baccharis	x	x	x	x	x	x	--
Bacopa sp.	waterhyssop		x	--	--	--	--	--
Bacopa caroliniana	Carolina bacopa		x	--	--	x	x	--
Bacopa monnieri	coastal water hyssop		x	--	x	x	x	x
Bacopa rotundifolia	round leaf bacopa		x	--	x	x	--	--
Batis sp.	batis		x	--	--	--	--	-
Batis maritima	saltwort		x	x	--	--	--	x
Berchemia sp.	supple-jack		x	--	--	--	--	--
Berchemia scandens	rattan vine		x	--	--	--	--	--
Bidens sp.	beggarticks		x	--	--	--	--	--
Bidens laevis	smooth beggarticks		x	--	--	x	x	--
Boehmeria sp.	falsenettle		x	--	--	--	--	--
Boehmeria cylindrica	bog-hemp		x	--	--	--	x	--
Borrichia sp.	--		x	--	--	--	--	--
Borrichia frutescens	sea oxeye	x	x	x	x	--	--	x
Brasenia schreberi	water shield		x	--	--	--	x	--

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977) (continued).

	Distribution	Vegetative type						
Species	Common name	CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Cabomba sp.	--		x	--	--	--	--	- -
Cabomba caroliniana	fanwort		x	--	--	--	x	--
Cakile edentula	sea rocket		x	--	--	--	--	x
Calopogan pulchellus	grass pink orchid		x	--	--	--	x	--
Calystegia sepium	--		x	--	--	--	--	x
Cardius sp.	spinythistle	x		--	x	--	--	--
Carex sp.	sedge		x	--	--	--	x	--
Carex leavenworthii	--		x	--	--	--	x	--
Celtis laevigata	hackberry	x	x	--	--	--	x	--
Centella erecta			x	--	--	x	x	--
Cephalanthus	buttonbush		x	--	--	--	--	--
Cephalanthus occidentalis	common buttonbush		x	--	--	--	x	x
Ceratophyllum sp.	coontail hornwort		x	--	--	--	x	--
Ceratophyllum demersum	common coontail		x	--	--	--	x	--
Cladium sp.	sawgrass		x	--	--	--	x	--
Cladium jamaicense	Jamaica sawgrass	x	x	x	x	x	x	--
Colocasia antiquorum	elephants ear		x	--	--	--	x	--
Commelina sp.	dayflower		x	--	--	--	--	--
Commelina erecta var. angustifolia	widow's-tears		x	--	--	--	--	--
Crinum sp.	--		x	--	--	--	--	--
Crinum americanum	swamp-lily		x	--	--	--	x	--
Croton punctatus	beach-tea		x	x	--	--	--	x
Cuscuta sp.	dodder	x		x	--	--	--	--
Cuscuta indecora	pretty dodder		x	--	x	x	x	--
Cynanchum sp.	--		x	--	--	--	--	--
Cynanchum angustifolium	marsh swallow-wort		x	--	--	x	--	x
Cynodon compressus	sedge		x	--	--	--	x	x
Cynodon dactylon	Bermuda grass		x	--	--	--	x	x
Cyperus sp.	flatsedge		x	--	--	x	x	--
Cyperus filicinus	umbrella sedge	x		x	x	--	x	--
Cyperus ochraceus	flatsedge		x	--	--	--	x	--
Cyperus odoratus	fragrant flatsedge		x	--	x	x	x	x
Cyperus polystachyos	flatsedge		x	--	--	x	x	--
Decodon sp.	--		x	--	--	--	--	--
Decodon verticillatus	swamp loosestrife		x	--	--	x	x	--
Dichromena sp.	whitetop		x	--	--	--	--	--
Dichromena colorata	whitetop umbrella grass		x	--	--	x	x	x
Distichlis spicata	seashore saltgrass	x	x	x	x	x	x	x
Echinochloa sp.	cockspur		x	--	--	--	--	--
Echinochloa walteri	Walter's millet	x	x	--	x	x	x	--
Echinodorus sp.	burhead		x	--	--	--	--	--
Echinodorus cordifolius	creeping burhead		x	--	--	--	--	--

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Eclipta alba	yerta-de-tage	x		--	x	--	x	x
Eichhornia sp.	--		x	--	--	--	--	--
Eichnornia crassipes	water hyacinth	x	x	--	--	x	x	--
Eleocharis sp.	spikerush		x	--	x	x	x	x
Eleocharis cellulosa	gulf spikerush		x	--	--	x	--	--
Eleocharis geniculata	capitate spikerush		x	--	--	x	--	--
Eleocharis macrostachya	creeping spikerush		x	--	--	x	--	--
Eleocharis palustris	common spike rush	x		x	x	--	--	--
Eleocharis parvula	dwarf spikerush	x	x	x	x	x	x	--
Eleocharis rostellata	spikerush		x	--	--	x	x	--
Epidendrum conopseum	green-fly orchid		x	--	--	--	--	x
Eragrostis sp.	--		x	--	--	--	--	x
Erianthus giganteus	sugarcane plumegrass		x	--	--	--	x	--
Erigeron canadensis	daisy fleabane		x	--	--	--	--	x
Eupatorium sp.	thoroughwort		x	--	--	x	x	--
Eupatorium capillifolium	Yankee weed		x	--	--	--	x	--
Eupatorium coelestinum	mistflower		x	--	--	x	--	--
Eupatorium perfoliatum	thoroughwort		x	--	--	--	x	--
Eupatorium pulchellus	--		x	--	--	--	x	--
Eupatorium serotinum	late eupatorium		x	--	--	--	x	--
Eustoma exaltatum	--		x	--	--	--	--	x
Fimbristylis castanea	sand rush		x	x	x	x	--	x
Galium tinctorium	dye bedstraw		x	--	--	x	x	--
Gerardia maritima	--		x	x	x	--	--	--
Gratiola sp.	hedgehyssop		x	--	--	--	x	--
Heliotropium sp.	heliotrope		x	x	--	--	--	--
Heliotropium curassavicum	seaside heliotrope	x		x	x	--	x	x
Heterotheca subaxillaris	--		x	--	--	--	--	x
Hibiscus sp.	hibiscus		x	--	--	--	x	--
Hibiscus lasiocarpus	rose mallow	x		--	x	--	x	--
Hibiscus militaris	halberd-leaved rosemallow		x	--	--	--	x	--
Hibiscus moscheutos	marsh mallow		x	--	--	x	x	--
Hydrocotyle sp.	pennywort	x	x	--	--	--	--	x
Hydrocotyle bonariensis	pennywort		x	--	--	--	x	x
Hydrocotyle ranunculoides	floating pennywort		x	--	--	x	x	--
Hydrocotyle umbellata	umbrella pennywort		x	--	--	--	x	--
Hymenocallis crassifolia	spider lily	x		--	--	--	x	--
Hymenocallis occidentalis	spider lily		x	--	--	x	x	--
Hypericum sp.	St. John's wort		x	--	--	--	--	--
Hypericum drummondii	nits-and-lice		x	--	--	--	x	--
Hypericum fasciculatum	St. John's wort		x	--	--	x	--	--
Hypericum mutilum	dwarf St. John's wort		x	--	--	--	x	--
Hypericum virginicum	marsh St. John's wort		x	--	--	--	x	--
Hypericum walteri	--		x	--	--	--	x	--

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Ipomoea sp.	morning-glory		x	--	--	--	--	x
Ipomoea sagittata	saltmarsh morning-glory	x	x	--	x	x	x	
Ipomoea stolonifera	beach morning-glory	x	x	x	x	--	x	x
Iris sp.	iris		x	--	--	--	x	--
Iris giganticaerulea	giant blue Iris	x		--	x	--	x	--
Itea sp.	sweet-spire		x	--	--	--	x	--
Itea virginica	Virginia-willow		x	--	--	--	--	--
Iva ciliata	swampweed	x		--	--	--	--	--
Iva sp.	sumpweed		x	--	--	x	--	--
Iva frutescens	marsh elder sumpweed	x	x	x	x	x	--	x
Juncus sp.	rush		x	--	--	x	x	--
Juncus effusus	soft rush		x	--	--	--	x	x
Juncus marginatus	grass-leaf rush		x	--	--	--	x	--
Juncus roemerianus	black needle rush	x	x	x	x	x	x	--
Juncus tenuis	slender rush		x	--	--	x	x	--
Kosteletzkya virginica	saltmarsh mallow	x	x	x	x	x	x	--
Lantana horrida	calico bush		x	x	x	--	--	--
Leersia sp.	cutgrass		x	--	--	--	x	--
Leersia oryzoides	rice cutgrass		x	--	--	--	x	--
Lemna minor	common duckweed	x	x	--	x	x	x	--
Lemna sp.	duckweed	x	x	--	--	--	x	--
Leptochloa sp.	sprangletop		x	--	--	--	--	--
Leptochloa fascicularis	bearded sprangletop		x	--	x	x	x	--
Leptochloa filiformis	red sprangle top		x	--	--	x	--	x
Limnobium spongia	American frogbit		x	--	--	--	x	--
Lippia nodiflora	--		x	--	--	--	--	x
Lobelia cardinalis	cardinal-flower lobelia		x	--	--	--	x	--
Ludwigia sp.	primrose		x	--	--	--	x	--
Ludwigia leptocarpa	anglestem waterprimrose		x	--	--	--	x	x
Ludwigia peploides	floating waterprimrose		x	--	--	x	--	--
Ludwigia suffruticosa	water primrose		x	--	--	--	x	--
Lycium carolinianum	salt matrimony vine		x	x	--	--	--	--
Lycium halimfolium	matrimony vine	x	--	--	--	--	--	--
Lythrum lineare	saltmarsh lythrum	x	x	x	x	x	x	--
Myrica cerifera	waxmyrtle		x	--	--	x	x	x
Myriophyllum sp.	water-milfoil		x	--	--	--	x	--
Myriophyllum heterophyllum	Euasian watermilfoil		x	--	--	--	x	--
Myriophyllum spicatum	watermilfoil		x	--	x	x	x	--
Najas sp.	waternymph		x	--	--	x	x	--
Najas guadalupensis	southern waternymph		x	--	--	x	x	--
Nelumbo sp.	lotus		x	--	--	--	x	--
Nelumbo lutea	American lotus		x	--	--	--	x	--
Nymphaea sp.	waterlily		x	--	--	--	x	--
Nymphaea odorata	white water-lily		x	--	--	--	x	--

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Nymphoides aquatica	floating heart		x	--	--	--	x	--
Oenothear sp.	prim rose		x	--	--	--	--	x
Osmunda sp.	royal fern		x	--	--	x	x	--
Osmunda regalis	royal fern		x	--	--	x	x	--
Ottelia alismoides	--		x	--	--	--	x	--
Panicum sp.	panic grass		x	--	--	--	x	--
Panicum amarum	beachgrass		x	x	--	--	--	x
Panicum dichotomiflorum	fall panicgrass		x	--	--	x	x	x
Panicum hemitomon	maidencane		x	--	--	x	x	--
Panicum repens	dog tooth grass		x	--	--	x	x	x
Panicum scoparium			x	--	--	--	x	--
Panicum virgatum	feather grass		x	--	x	x	x	--
Paspalum sp.	paspalum		x	x	x	x	x	--
Paspalum vaginatum	seashore paspalum		x	x	x	x	x	--
Philoxerus vermicularis	Salt alligator weed		x	--	--	x	x	--
Phragmites sp.	--		x	--	--	x	x	--
Phragmites australis	roseau cane		x	--	x	x	x	--
Phyla sp.	frog-fruit		x	--	--	--	--	--
Phyla lanceolata	northern frog-fruit		x	--	--	x	x	--
Phyla nodiflora	common frog-fruit		x	--	--	--	x	--
Pluchea sp.	pluchea		x	--	--	--	x	--
Pluchea camphorata	camphor weed		x	--	x	x	x	--
Pluchea foetida	stinking fleabane		x	--	--	--	x	--
Pluchea odorata	saltmarsh pluchea		x	x	--	--	--	--
Pluchea purpurascens	saltmarsh pluchea		x	--	--	x	--	x
Polygonum sp.	smart weed		x	--	--	--	x	--
Polygonum punctatum	dotted smartweed		x	--	--	x	x	x
Polygonum sagittatum	tearthumb		x	--	--	--	x	--
Pontederia cordata	pickerel weed		x	--	--	--	x	--
Potamogeton nodosus	eongleaf pond weed		x	--	--	x	x	--
Potamogeton pusillus	slender pond weed		x	--	--	x	x	--
Ptilimnium sp.	mock-bishopweed		x	--	--	--	x	--
Ptilimnium capillaceum	threadleaf mock-bishopweed		x	--	--	--	x	--
Rhynchospora sp.	beakrush		x	--	--	--	x	--
Rhynchospora caduca	angelstem beakrush		x	--	--	--	x	--
Rhynchospora inexpanansa	nodding beakrush		x	--	--	--	x	--
Rotala sp.	toothcup		x	--	--	--	--	--
Rotala ramosior	toothcup		x	--	--	x	--	x
Rubus sp.	dewberry		x	--	--	--	--	x
Rubus sp.	blackberry		x	--	--	--	--	x
Ruppia maritima	widgeon grass		x	--	x	x	--	--
Sacciolepis sp.	--		x	--	--	--	--	--
Sacciolepis striata	American cupscale		x	--	--	x	x	--
Sagittaria sp.	arrowhead		x	--	--	x	--	--

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Sagittaria falcata	bull tongue		x	--	--	x	x	--
Sagittaria lancifolia	bulltongue arrowhead		x	--	--	x	x	--
Sagittaria latifolia	broadleaf arrowhead		x	--	--	x	x	x
Sagittaria platyphylla	delta duckpotato		x	--	--	--	x	--
Salicornia sp.	glasswort		x	x	--	--	--	--
Salicornia bigelovii	glasswort	x	x	x	--	--	--	--
Salicornia virginica	woody glasswort		x	x	--	--	--	--
Salix sp.	willow		x	--	--	--	x	--
Salix nigra	black willow		x	--	--	--	x	--
Saururus sp.	--		x	--	--	--	x	--
Saururus cernuus	lizard tail		x	--	--	--	x	--
Schizachyrium maritimum	seacoast bluestem		x	--	--	--	--	x
Scirpus sp.	bulrush		x	--	--	x	--	--
Scirpus americanus	freshwater three square	x	x	--	--	x	x	x
Scirpus californicus	hardstem bulrush	x	x	--	x	x	x	--
Scirpus lineatus	rusty bulrush		x	--	--	--	x	--
Scirpus olneyi	Olney three square	x	x	x	x	x	x	--
Scirpus robustus	leafy three square	x	x	x	x	x	--	--
Scirpus validus	soft-stem bulrush		x	--	x	x	--	x
Sesbania sp.	rattlebox		x	--	--	x	x	--
Senecio glabellus	butterweed		x	--	--	--	x	--
Sesbania exaltata	tall sesbane	x	x	--	x	x	--	--
Sesuvium sp.	purslane		x	--	x	--	--	--
Sesuvium maritimum	marsh purslane		x	x	--	--	--	--
Sesuvium portulacastrum	sea purslane		x	x	x	--	--	x
Setaria sp.	bristlegrass		x	--	--	x	--	--
Setaria geniculata	knotroot bristlegrass		x	--	--	x	--	x
Setaria glauca	yellow foxtail		x	--	x	--	--	x
Setaria magna	giant bristle grass	x	x	--	x	x	x	--
Setaria verticillata	--		x	--	--	--	x	--
Smilax rotundifolia	common greenbrier		x	--	--	--	--	--
Smilax sp.	greenbrier	x		--	--	--	--	--
Solidago sp.	goldenrod		x	--	--	x	x	--
Solidago sempervirens	seaside goldenrod	x	x	x	x	x	x	x
Sparganium sp.	burreed	x		--	--	--	x	--
Sparganium americanum	eastern burreed		x	--	--	--	x	--
Spartina sp.	cordgrass		x	--	--	--	--	--
Spartina alterniflora	smooth cordgrass	x	x	x	x	x	x	x
Spartina cynosuroides	big cord grass	x	x	--	x	x	x	--
Spartina patens	wire grass	x	x	x	x	x	x	x
Spartina spartinae			x	x	x	x	--	--
Spiranthes sp.	ladies tresses		x	--	--	--	--	--
Spiranthes cernua	nodding ladies tresses		x	--	--	--	x	--
Spirodela polyrhza	duckweed		x	--	--	--	x	--

Table 8. Plant species of Louisiana coastal marshes and beaches (Gosselink 1984; Gosselink et al. 1979; Peterson et al. 1987; Chabreck 1972; Lester 1988; Montz 1977) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]	BC[7]
Sporobolus virginicus	coast dropseed		x	--	--	--	--	x
Strophostyles helvola	wild bean		x	--	--	--	x	x
Styrax americana	American snowbell		x	--	--	--	--	--
Suaeda linearis	sea-blite		x	x	--	--	--	--
Taraxacum officianale	dandelion		x	--	--	x	--	--
Thelypteris sp.	marsh fern		x	--	--	--	x	--
Thelypteris palustris	hale's marsh fern		x	--	--	x	x	--
Thelypteris thelypteroides	Southern marsh fern		x	--	--	--	--	--
Triadenum virginicum	marsh St. John's wort		x	--	--	--	x	--
Typha sp.	cattail		x	--	--	x	x	--
Typha latifolia	broadleaf cattail	x	x	--	x	--	x	--
Uniola paniculata	sea oats		x	--	--	--	--	x
Utricularia subulata	zigzag bladderwort		x	--	--	--	x	--
Utricularia sp.	bladderwort		x	--	--	--	--	--
Utricularia cornuta	horned bladderwort		x	--	--	--	x	--
Utricularia juncea	rush bladderpod		x	--	--	--	--	--
Vallisneria americana	wildcelery		x	--	x	--	--	--
Vicia ludoviciana	Louisiana vetch	x		--	--	--	--	--
Vicia augustifolia	--		x	--	--	--	--	x
Vigna sp.	--		x	--	--	--	--	--
Vigna luteola	yellow cowpea		x	--	x	x	x	--
Vigna repens	cowpea	x		--	x	--	x	--
Vitis sp.	grape		x	--	--	--	--	--
Wolffia sp.	watermeal		x	--	--	--	x	--
Wolffiella sp.	mud-midget		x	--	--	--	--	--
Woodwardia virginica	Virginia chain fern		x	--	--	--	x	--
Woodwardia sp.	chain fern		x	--	--	--	x	--
Xyris iridifolia	iris leaf yelloweye grass		x	--	--	--	x	--
Zanthoxylum americanum	toothache tree		x	x	x	--	--	--
Zizania sp.	--		x	x	x	--	--	--
Zizania aquatica	wildrice		x	--	--	--	x	--
Zizaniopsis sp.	cutgrass		x	--	--	--	--	--
Zizaniopsis miliacea	giant cutgrass	x	x	--	x	--	x	--

[1]CP = Chenier plain (absence from the column may indicate lack of detailed studies)
[2]DP = Mississippi deltaic plain
[3]SA = Saline marsh
[4]BR = Brackish marsh
[5]IN = Intermediate marsh
[6]FR = Fresh marsh
[7]BC = Beach

species of fish and invertebrates. These are mainly located in the Chandeleur Islands.

Forest

Forest habitat includes both upland and bottomland hardwood forests. It consists of broad-leaved deciduous, broad-leaved evergreen, and needle-leaved evergreen vegetation over 20' high, which occurs in elevated and drained areas. This habitat type is usually found along natural levee systems or older spoil banks. Most of the forests in the coastal zone are bottomland hardwoods, except in the Florida Parishes of southeastern Louisiana where pine forests may be found.

Forests occupy about 3% (199,577 acres) of the coastal zone (table 6). Bottomland hardwoods are the more common coastal habitat simply because they are dominated by flood-tolerant species. Bottomland hardwood forests flank rivers and bayous and serve as a transition zone from swamps and marshes to drier upland areas. This habitat type has the least-flooded, best-drained soils in wetland areas. These areas were once natural levees that were dominated by upland hardwood trees; they have since subsided and are now dominated by flood-tolerant species. Because many of these areas are so well drained, they have been cleared and used for residential areas, roads, industry, and agriculture. The lower portions of the natural levee are less well drained and are usually the sites of the bottomland hardwoods, which grade into cypress-tupelo swamps. Bottomland hardwoods are flooded each year for several weeks to a few months, usually in the winter and early spring. During the rest of the year the water table is near or just below the soil surface. Salinity is virtually zero in these areas. They are important natural communities for maintaining water quality and for providing habitat for a variety of fish and wildlife.

Bottomland hardwoods are dominated by hardwood trees and woody shrubs (Conner et al. 1975, Wharton et al. 1982). Table 9 lists the plant species found in Louisiana bottomland hardwood forests. The most common are the American elm (Ulmus americana), sweet gum (Liquidambar styraciflua), hackberry (Celtis laevigata), and red maple (Acer rubrum var. drummondii). The woody understory is composed mainly of red maple (A. rubrum var. drummondii) and box elder (A. negundo) saplings. A variety of herbaceous plants is found in bottomland hardwood forests, especially along the edges and in open areas where light can penetrate. The most common herbaceous plants and vines found in Louisiana bottomland hardwoods are poison ivy (Rhus radicans), and other vines such as Smilax spp., pepper vine (Ampelopsis arborea), and Virginia creeper (Parthenocissus quinquefolia) (Lester 1988, Smith 1988, Conner et al. 1975).

Another natural forest community in the Louisiana coastal zone is the overcup oak-water hickory community, which is dominated by the overcup oak (Quercus lyrata) and water hickory (Carya aquatica). Common associates are described in Lester (1988) and Smith (1988). These communities occur on low ridges with clay soils and are semi-permanently inundated or saturated for a major portion of the growing season.

The hackberry--American elm--green ash community, which is dominated by hackberry (Celtis laevigata), American elm (Ulmus americana), and green ash (Fraxinus pennsylvanica), occurs in the floodplains of major rivers. Common associates are described in Lester (1988) and Smith (1988). Soils are seasonally inundated or saturated periodically for 1-2 months during the growing

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Acalypha rhomboidea	three-seeded mercury	--	--	x
Acer negundo	boxelder	x	x	x
Acer rubrum var. *drummmondi*	swamp red maple	x	x	x
Aeschynomene indica	joint vetch	--	--	x
Agalinis purpurea	--	--	--	x
Allium bivalve	false garlic	--	--	x
Allium canadense	wild onion	x	--	x
Alternanthera philoxeroides	alligatorweed	--	x	--
Ambrosia artemisiifolia	ragweed	--	--	x
Ambrosia psilostachya	ragweed	--	--	x
Ambrosia trifida	giant ragweed	x	--	x
Ammannia coccinea	tooth-cup	--	--	x
Ampelopsis arborea	peppervine	x	--	x
Ampelopsis cordata	heartleaf peppervine	x	--	x
Amphora fruticosa	lead plant	--	--	x
Anagallis arvensis	scarlet pimpernel	--	--	x
Andropogon virginicus	broom sedge	--	--	x
Anisostichus capreolata	crossvine	x	x	--
Apium leptophyllum	marsh parsley	x	--	--
Arisaema dracontium	green dragon	x	--	--
Aristida	three awn grass	--	--	x
Arthraxon hispidus	makino	--	--	x
Arundinaria gigantea	cane	--	x	--
Asclepias perennis	milkweed	x	--	--
Asplenium platyneuron	ebony spleenwort	x	--	--
Aster lateriflorus	starved aster	--	--	x
Aster praealtus	blue aster	--	--	x
Avicennia germinans	black mangrove	--	--	x
Azolla caroliniana	mosquito fern	--	x	--
Baccharis halimifolia	groundsel-tree	--	x	--
Bacopa caroliniana	--	--	--	x
Bacopa monnieri	water hyssop	--	--	x
Bacopa rotundifolia	--	--	--	x
Batis maritima	saltwort	--	--	x
Berchemia scandens	rattan vine	x	x	x
Bidens bipinnata	Spanish needles	--	--	x
Bidens laevis	beggar ticks	--	x	--
Boehmeria cylindrica	false nettle	x	x	--
Borrichia frutescens	sea oxeye	--	--	x
Bromus catharticus	--	--	--	x
Brunnichia cirrhosa	ladies'-eardrops	x	--	--
Cabomba caroliniana	fanwort	--	x	--
Callicarpa americana	french mulberry	x	--	--
Calystegia sepium	hedge bindweed	x	--	--
Campsis radicans	trumpet creeper	x	--	--
Cardamine pensylvanica	bitter-cress	x	--	--

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type BLH[1]	SW[2]	D[3]
Cardiospermum halicacabum	ballon vine	--	--	x
Carduus spinosissimus	yellow thistle	x	--	x
Carex cephalophora	caric sedge	--	--	x
Carex cherokeensis	caric sedge	--	--	x
Carex comosa	bristly sedge	--	x	--
Carex crus-corvi	crowfoot sedge	--	x	--
Carex hyalinolepis	caric sedge	--	--	x
Carex lupulina	hop sedge		x	
Carya sp.	hickory	--	--	x
Carya aquatica	water hickory	x	x	--
Carya cordiformis	bitternut hickory	x	--	--
Carya illioensis	pecan	x	--	--
Carya ovata	shagbark hickory	x	--	--
Cassia fasciculata	partridge pea	--	--	x
Celtis laevigata	hackberry	x	--	x
Centrosema virginianum	butterfly pea	--	--	x
Cephalanthus occidentalis	buttonbush	x	x	x
Cerastium glomeratum	mouse-ear	x	--	--
Ceratophyllum demersum	hornwort	--	x	--
Chaerophyllum tainturieri	chervil	x	--	--
Chenopodium album	pigweed	--	x	--
Cicuta mexicana	water-hemlock	--	--	x
Cinnamomum camphora	camphor tree	x	--	--
Cissus incisa	marine-ivy	--	--	x
Citrus sp.	--	x	--	--
Cleistes divaricata	spreading pogonia	x	--	--
Clematis crispa	leather-flower	x	--	x
Clematis ternifolia	Japanese virgins-bower	x	--	--
Cocculus carolinus	coralbeads	x	x	x
Colocasia antiquorum	elephant's ear	--	x	x
Commelina communis	dayflower	--	--	x
Commelina diffusa	dayflower	x	--	--
Commelina erecta	dayflower	--	x	--
Commelina virginica	widow's-tears	--	--	x
Cornus drummondii	swamp dogwood	x	x	x
Crataegus opaca	western mayhaw	--	--	x
Crataegus viridis	--	x	--	--
Crepis japonica	hawk's-beard	--	--	x
Crinum americanum	swamp lily	x	x	--
Croton punctatus	--	--	--	x
Cuphea carthagensis	--	--	--	x
Cuscuta gronovii	love-vine	--	x	--
Cynoctonum mitreola	miterwort	--	--	x
Cynodon dactylon	Bermuda grass	--	--	x
Cyperus aristatus	--	--	--	x
Cyperus compressus	--	--	--	x

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Cyperus elegans	flatsedge	--	--	x
Cyperus erythrorhizos	flatsedge	--	--	x
Cyperus esculentus	yellow nutgrass	--	--	x
Cyperus filicinus	--	--	--	x
Cyperus globulosus	--	--	--	x
Cyperus retrorsus	--	--	--	x
Cyperus virens	swamp sedge	--	x	--
Desmanthus illinoensis	prairie Mimosa	--	--	x
Desmodium canescens	beggar lice	x	--	x
Desmodium glabellum	beggar's-ticks	--	--	x
Desmodium laevigatum	beggar's-ticks	--	--	x
Desmodium paniculatum	beggar's-ticks	--	--	x
Dichondra caroliensis	--	x	--	--
Dicliptera brachiata	--	--	--	x
Digitaria ischaemum	crab grass	--	--	x
Digitaria sanguinalis	crab grass	--	--	x
Diodia virginiana	buttonweed	--	--	x
Diospyros virginiana	persimmon	x	x	--
Distichlis spicata	salt grass	--	--	x
Dryopteris ludoviciana	southern shield fern	--	x	--
Duchesnea indica	Indian strawberry	x	--	--
Echinochloa colonum	--	--	--	x
Echinochloa crusgalli	barnyard grass	--	--	x
Echinochloa walteri	Walter's millet	--	--	x
Echinodorus cordifolius	creeping burhead	--	x	--
Eclipta alba	--	--	--	x
Egeria densa	Brazilian elodea	--	x	--
Eichhornia crassipes	water hyacinth	--	x	--
Eleocharis albida	spike-rush	--	x	--
Eleocharis montevidensis	spike-rush	--	--	x
Eleocharis obtusa	--	--	--	x
Elephantopus carolinianus	elephant's-foot	--	--	x
Eleusine indica	goose grass	--	--	x
Elymus virginicus	wild rye	--	--	x
Epidendrum conopseum	green fly orchid	x	x	--
Equisetum sp.	horsetail	--	x	--
Eragrostis hypnoides	--	--	--	x
Eragrostis pilosa	--	--	--	x
Erianthus giganteus	sugarcane plumegrass	--	x	x
Erigeron canadensis	horseweed	x	--	--
Erigeron philadelphicus	daisy fleabane	--	--	x
Eupatorium capillifolium	dog-fennel	--	--	x
Eupatorium coelestinum	mistflower	x	x	x
Eupatorium rugosum	white snakeroot	--	--	x
Euphorbia cordifolia	spurge	--	--	x
Euphorbia heterophylla	painted leaf	x	--	--

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Euphorbia hirta	spurge	--	--	x
Euphorbia nutans	spurge	--	--	x
Euphorbia prostrata	spurge	--	--	x
Euphorbia supina	spurge	--	--	x
Eustoma exaltatum	catchfly-gentian	--	--	x
Fagus gradifolia	beech	x	--	--
Forestiera acuminata	swamp privet	x	--	--
Fragaria virginiana	wild strawberry	x	--	--
Fraxinus caroliniana	water ash	x	--	--
Fraxinus pennsylvanica	green ash	x	x	x
Fraxinus tomentosa	pumpkin ash	x	x	--
Galium aparine	redstraw	--	--	x
Galium tinctorium	bedstraw	x	--	--
Gaura parviflora	--	--	--	x
Gelsemium sempervirens	yellow jessamine	--	x	--
Geranium carolinianum	wild geranium	--	--	x
Geum canadense	white avens	x	--	--
Gleditsia aquatica	water locust	x	x	--
Gleditsia triacanthos	honey locust	x	--	x
Habenaria repens	water-spider orchid	--	x	--
Helianthus strumosus	daisy	--	--	x
Heliotropium curassavicum	seaside heliotrope	--	--	x
Hemophila aphylla	baby blue-eyes	x	--	--
Hibiscus lasiocarpus	rose-mallow	--	x	--
Hibiscus militaris	Halberd-leaved marsh-mallow	--	x	--
Hordeum pusillum	little barley	--	--	x
Hydrocotyle ranunculoides	floating pennywort	--	x	--
Hydrocotyle umbellata	umbrella pennywort	--	x	x
Hydrocotyle verticillata	pennywort	--	x	--
Hydrolea ovata	--	--	x	--
Hygrophila lacustris	--	x	x	--
Hymenocallis eulae	spider lily	--	x	--
Hymenocallis occidentalis	spider lily	--	x	--
Hypericum sp.	St. John's wort	x	--	--
Hypericum hypericoides	St. Andrew's cross	--	--	x
Hypericum walteri	--	--	x	x
Ilex cassine	dahoon holly	--	--	x
Ilex decidua	possum haw	x	--	--
Ilex vomitoria	yaupon	x	--	x
Impatiens capensis	spotted touch-me-not	x	--	--
Ipomoea quamocit	cypress vine	--	x	--
Ipomoea sagittata	saltmarsh morning glory	--	x	x
Ipomoea trichocarpa	morning glory	--	--	x
Ipomoea wrightii	morning glory	--	x	--
Iris fulva	red-flag Iris	--	x	--
Iris giganticaerulea	giant blue Iris	--	x	--

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Itea virginica	Virginia willow	--	x	--
Iva annua	marsh elder	--	--	x
Iva frutescens	marsh elder	--	x	x
Juncus effusus	soft rush	--	x	x
Juncus roemerianus	needle rush	--	--	x
Justicia lanceolata	lance-leaved water-willow	x	--	--
Koelreuteria paniculata	golden raintree	--	--	x
Kosteletskya virginica	seashore mallow	--	x	x
Lactuca canadensis	wild lettuce	x	--	x
Lactuca floridana	wild lettuce	--	--	x
Lantana camara	Lantana	--	--	x
Leersia virginica	white grass	--	--	x
Lemna minor	duckweed	--	x	--
Lepidium virginicum	pepperwort	--	--	x
Leptochloa filiformis	--	--	--	x
Leptochloa panicoides	--	--	--	x
Leptochloa uninervia	--	--	--	x
Ligustrum japonicum	privet	x	--	--
Ligustrum sinense	common privet	x	--	--
Lilaeopsis carolinensis	--	--	x	--
Limnobium spongia	frog's-bite	--	x	--
Limonium nashii	sea lavender	--	--	x
Lippia lanceolata	northern frog-fruit	--	--	x
Lippia nodiflora	frog-fruit	--	--	x
Liquidambar styraciflua	sweetgum	x	x	--
Lithospermum tuberosum	gromwell	x	--	--
Lobelia cardinalis	cardinal flower	--	x	--
Lonicera japonica	Japanese honeysuckle	x	--	--
Ludwigia glandulosa	ludwigia	--	x	--
Ludwigia octovalvis	primrose	--	x	--
Ludwigia palustris	marsh purslane	--	x	--
Ludwigia peploides	floating water primrose	--	x	x
Lycopersicon esculentum	tomato	--	--	x
Lycopus rubellus	water horehound	--	x	--
Lycopus virginicus	bugle-weed	x	--	--
Lygodium japonicum	Japanese climbing fern	x	x	x
Lythrum lanceolatum	loosestrife	--	--	x
Lythrum lineare	loosestrife	--	--	x
Magnolia virginiana	sweet bay	x	x	--
Matelea gonocarpa	shinners	x	--	--
Mayaca aubletti	bog moss	--	x	--
Mazus japonicus	--	--	--	x
Mecardonia acuminata	chelone	--	x	x
Mecardonia procumbens	--	--	--	x
Medicago arabica	spotted medic	--	--	x
Medicago lupulina	black medic	--	--	x

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Medicago polymorpha	bur clover	--	--	x
Melia azedarach	Chinaberry	--	--	x
Melilotus indica	sour clover	--	--	x
Melothria pendula	creeping cucumber	--	--	x
Micranthemum umbrosum	shade mud-flower	--	x	--
Mikania scandens	climbing hempweed	x	x	x
Mimosa strigillosa	powder-puff	--	--	x
Mimulus alatus	monkey-flower	x	--	--
Modiola caroliniana	mauve	--	--	x
Mollugo verticillata	carpet-weed	--	--	x
Morus alba	white mulberry	--	--	x
Morus rubra	red mulberry	x	--	--
Myosotis macrosperma	forget-me-not	x	--	--
Myrica cerifera	wax myrtle	x	x	x
Myriophyllum brasiliense	parrot-feather	--	x	--
Nelumbo lutea	yellow nelumbo	--	x	--
Nymphaea odorata	white waterlily	--	x	--
Nyssa aquatica	water tupelo	--	x	--
Nyssa sylvatica	swamp blackgum	x	x	--
Oenothera biennis	evening primrose	x	--	x
Oenothera laciniata	cut-leaf evening primose	x	--	x
Oenothera speciosa	Mexican primrose	x	--	x
Onoclea sensibilis	sensitive fern	--	x	--
Oplismenus hirtellus	--	x	--	x
Oplismenus setaris	--	x	--	--
Osmunda cinnamonmea	cinnamon fern	--	x	--
Osmunda regalis	royal fern	--	x	--
Oxalis corymbosa	--	x	--	--
Oxalis dillenii	wood sorrel	--	--	x
Oxalis stricta	wood sorrel	--	--	x
Panicum anceps	panic-grass	--	--	x
Panicum capillare	--	--	--	x
Panicum commutatum	panic-grass	--	--	x
Panicum gymnocarpon	swamp panic-grass	--	x	--
Panicum hemitomon	maidencane	--	x	x
Panicum repens	torpedo grass	--	--	x
Panicum rigidulum	panic-grass	--	x	x
Panicum scoparium	--	--	x	--
Panicum virgatum	switchgrass	--	--	x
Parthenocissus quinquefolia	Virginia creeper	x	--	x
Paspalum dilatatlum	dallis grass	--	--	x
Paspalum distichum	knotgrass	--	--	x
Paspalum fluitans	water paspalum	--	x	--
Paspalum urvillei	vasey grass	--	--	x
Passiflora incarnata	maypopos	--	--	x
Passiflora lutea	yellow passion-flower	--	--	x

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Persea borbonia	red bay	x	--	--
Persea palustris	sweetbay	x	--	--
Petunia parviflora	wild petunia	--	--	x
Phalaris caroliniana	canary grass	--	--	x
Phoradendron serotinum	mistletoe	x	x	--
Phyllanthus urinaria	leaf-flower	--	--	x
Physalis angulata	ground cherry	--	--	x
Phytolacca americana	pokeweed	x	--	x
Pilea pumila	clearweed	x	--	--
Pistia stratiotes	water lettuce	--	x	--
Planera aquatica	water elm	--	x	--
Plantago major	plantain	--	--	x
Platanus occidentalis	sycamore	x	--	--
Pluchea camphorata	fleabane	x	--	x
Pluchea odorata	camphor-weed	--	--	x
Poa annua blue grass	--	--	x	--
Polygonum densiflorum	giant knotweed	--	x	--
Polygonum hydropiperoides	smartweed	--	x	--
Polygonum lapathifolium	--	--	--	x
Polygonum punctatum	dotted smartweed	--	x	x
Polygonum setacea	--	--	--	x
Polygonum virginianum	jump-seed	x	--	--
Polymnia uvedalia	bearsfoot	x	--	--
Polypodium polypodiodes	resurrection fern	x	x	--
Polypogon monspeliensis	rabbit-foot grass	--	--	x
Pontederia cordata	pickerelweed	--	x	--
Populus deltoides	cottonwood	x	--	x
Populus heterophylla	swamp cottonwood	x	x	--
Proserpinaca pectinata	--	--	--	x
Prunus serotina	black cherry	x	--	--
Ptilimnium capillaceum	bishop's-weed	--	x	--
Pueraria lobata	kudzu	--	--	x
Pyrrhopappus carolinianus	false dandelion	--	--	x
Quercus laurifolia	laurel oak	x	x	--
Quercus lyrata	overcup oak	x	--	--
Quercus nigra	water oak	x	x	x
Quercus nuttallii	nuttall oak	x	x	--
Quercus phellos	willow oak	x	--	--
Quercus shumardii	swamp red oak	x	--	x
Quercus virginiana	live oak	x	--	x
Ranunculus platensis	--	--	--	x
Ranunculus pusillus	buttercup	--	--	x
Ranunculus sceleratus	buttercup	--	--	x
Ranunculus trilobus	buttercup	x	--	--
Rhus radicans	poison ivy	x	--	x
Rhynchosia minima	snout-bean	--	--	x

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type BLH[1]	SW[2]	D[3]
Rhynchospora caduca	--	--	x	--
Rhynchospora corniculata	horned rush	--	x	x
Rhynchospora macrostachya	--	--	x	x
Rhynchospora miliacae	--	--	x	--
Robinia pseudoacacia	black locust	x	x	--
Rorippa islandica	borbas	--	--	x
Rorippa sessiliflora	--	--	--	x
Rubus argutus	blackberry	x	--	--
Rubus trivialis	dewberry	x	--	x
Ruellia nudiflora	--	--	--	x
Rumex crispus	yellow dock	--	--	x
Rumex pulcher	fiddle dock	--	--	x
Rumex verticillatus	swamp dock	--	--	x
Sabal minor	palmetto	x	x	x
Sabatia calycina	rose-gentian	x	--	--
Sacciolepis striata	American cupscale	--	x	--
Sagittaria lancifolia	bulltongue	--	x	x
Sagittaria platyphylla	swamp potato	--	x	--
Salicornia bigelovii	Bigelow glasswort	--	--	x
Salix interior	sandbar willow	--	--	x
Salix nigra	black willow	x	x	x
Salvia coccinea	red sage	--	--	x
Sambucus canadensis	elderberry	x	--	--
Samolus parviflorus	water pimpernel	x	x	--
Sanicula canadensis	black snakeroot	--	--	x
Sapium sebiferum	tallow-tree	x	--	--
Saururus cernuus	lizard's tail	x	x	x
Scirpus lineatus	rusty bulrush	x	--	--
Scutellaria lateriflora	mad-dog skullcap	--	x	--
Senecio glabellus	butterweed	x	x	--
Sesbania drummondii	rattlebox	x	--	x
Sesbania macrocarpa	hemp sesbania	x	--	x
Sesbania punicea	red rattlebox	--	--	x
Sesbania vesicaria	bladder-pod	x	--	x
Setaria glauca	yellow foxtail	--	--	x
Setaria magna	giant foxtail	--	--	x
Sida rhombifolia	--	--	--	x
Sisyrinchium rosulatum	blue-eyed grass	x	--	--
Smilax smallii	greenbriar	x	x	--
Smilax bona-nox	catbriar	x	--	--
Smilax glauca	sawbriar	x	--	--
Smilax hispida	dwarf greenbriar	x	--	--
Smilax laurifolia	bamboo-vine	x	--	--
Smilax rotundifolia	common greenbriar	x	x	x
Smilax walteri	coral greenbriar	--	x	--
Solanum americanum	nightshade	x	--	--

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type BLH[1]	SW[2]	D[3]
Solanum carolinense	horse-nettle	--	--	x
Solidago altissima	goldenrod	--	--	x
Solidago sempervirens	seaside goldenrod	--	x	x
Sonchus asper	spiny-leaved sowthistle	x	--	x
Sorghum halepense	Johnson grass	--	x	--
Sparganium americanum	eastern burreed	--	x	--
Spartina alterniflora	oystergrass	--	--	x
Spartina cynosuroides	big cordgrass	--	--	x
Spartina patens	marsh hay cordgrass	--	--	x
Spartina spartinae	gulf cordgrass	--	--	x
Spergularia marina	sand spurrey	--	--	x
Sphenoclea zeylanica	--	--	--	x
Sphenopholis obtusata	wedge grass	x	--	--
Spilanthes americana		x	--	--
Spiranthes cernua	fragrant ladies'-tresses	x	x	--
Spiranthes vernalis	spring ladies'-tresses	x	x	--
Spirodela polyrhiza	giant duckweed	--	x	--
Sporobolus indicus	smut grass	--	--	x
Sporobolus virginicus	seashore dropseed	--	--	x
Stachys crenata	shade betony	--	--	x
Stachys tenuifolia	helge nettle	x	--	--
Stellaria media	chick-weed	x	--	x
Stenotaphrum secundatum	St. Augustine grass	--	--	x
Strophostyles helvola	wild bean	--	--	x
Styrax americana	American snowbell	--	x	--
Styrax grandifolia	bigleaf snowbell	--	x	--
Suaeda linearis	--	--	--	x
Tamarix gallica	--	--	--	x
Taraxacum officinale	common dandelion	--	--	x
Taxodium distichum var. ascendens	pond cypress	--	x	--
Taxodium distichum	bald cypress	--	x	x
Thalictrum dasycarpum	purple meadow-rue	x	--	--
Thelypteris kunthii	southern shield fern	x	--	--
Thelypteris palustris	marsh fern	--	x	--
Tillandsia usneoides	spanish moss	x	x	--
Tradescantia ohioensis	spiderwort	x	--	--
Trifolium repens	white clover	x	--	x
Trifolium resupinatum	Persian clover	--	--	x
Trisetum pensylvanicum	--	--	--	x
Typha angustifolia	narrow-leaved cattail	--	x	--
Typha latifolia	common cattail	--	x	x
Ulmus alata	winged elm	x	x	--
Ulmus americana	American elm	x	--	x
Ulmus rubra	slippery elm	x	--	--
Urtica chaemaedryoides	nettle	x	--	--
Utricularia inflata	floating bladderwort	--	x	--

Table 9. Plant species found in bottomland hardwood forest, swamps, levees, and disturbed areas of Louisiana's coastal zone (Conner et al. 1986) (continued).

Species	Common name	Vegetative type		
		BLH[1]	SW[2]	D[3]
Utricularia vulgaris	common bladderwort	--	x	--
Verbena brasiliensis	Brazilian vervain	--	--	x
Verbena rigida	vervain	--	--	x
Verbena urticifolia	white vervain	--	--	x
Verbesina encelioides	cowpen daisy	--	--	x
Verbesina virginica	frost-weed	--	--	x
Vernonia gigantea	ironweed	--	--	x
Veronica peregrina	speedwell	--	--	x
Veronica persica	Persian speedwell	--	--	x
Viburnum dentatum	arrow-wood	--	--	x
Vicia ludoviciana	vetch	--	--	x
Vigna luteola	yellow cowpea	x	--	x
Viola septemloba	violet	--	--	x
Vitis rotundifolia	muscadine	x	x	--
Vitis cinerea	pigeon grape	x	--	--
Wolffia columbiana	water-meal	--	x	--
Wolffiella sp.	mud-midget	--	x	--
Wolffiella lingulata	--	--	x	--
Woodwardia virginica	Virginia chain-fern	--	x	--
Xanthium strumarium	cocklebur	--	--	x
Zanthoxylum americana	toothache tree	--	--	x
Zanthoxylum clava-herculis	Hercules'-club	--	--	x
Zizaniopsis miliacea	giant cutgrass	--	x	x

[1]BLH - Bottomland hardwood
[2]SW - Swamp
[3]D - Disturbed areas (levees)

season.

The sycamore--sweet gum--American elm community is dominated by sycamore (Platanus occidentalis), sweet gum (Liquidambar styraciflua), and American elm (U. americana). Common associates are described in Lester (1988) and Smith (1988). This community occurs on banks and front lands of major streams and rivers. It is seasonally inundated and soils may be saturated periodically for 1 to 2 months during the growing season.

The sweet gum--water oak community is dominated by sweet gum (Liquidambar styraciflua) and water oak (Quercus nigra). Major associates are hackberry (Celtis laevigata), green ash (Fraxinus pennsylvanica), American elm (Ulmus americana), and nuttall oak (Q. nuttallii). It occurs in alluvial floodplains. Soils are seasonally saturated or inundated for 1 to 2 months of the growing season (Smith 1988).

Upland forests may include the maritime forest and live oak--hackberry forest, which occur on abandoned beach ridges or cheniers. These communities are dominated by live oaks (Quercus virginiana) and hackberry (Celtis laevigata). Associate species include red maple (Acer rubrum var. drummondii), green ash (Fraxinus pennsylvanica), water oak (Q. nigra), sweet gum (Liquidambar styraciflua), American elm (Ulmus americana), dwarf palmetto (Sabal minor), and trumpet creeper (Campsis radicans) (Lester 1988; Smith 1988).

Another upland forest community in the coastal zone is the beech--magnolia forest or hardwood slope forest. This is a mixed hardwood forest occurring on ridges, knolls, and slopes rising out of the floodplains of small streams that intersect pinelands and on salt domes. Dominant species are the beech (Fagus grandifolia) and southern magnolia (Magnolia grandifolia), and several associated overstory species (Lester 1988; Smith 1988).

Natural levee forests, dominated by live oaks (Quercus virginiana), occur on natural levees, frontlands, or on islands within marshes and swamps. Other common community members include water oak (Q. nigra), American elm (Ulmus americana), hackberry (Celtis laevigata), red maple (Acer rubrum var. drummondii), and green ash (Fraxinus pennsylvanica). The dwarf palmetto (Sabal minor) is the most common understory shrub, followed by elderberry (Sambucus canadensis), and Virginia creeper (Parthenocissus quinquefolia). Lester (1988) and Smith (1988) have extensive lists of associated vegetation within these forest communities, along with descriptions of several other minor mixed forest communities that occur in Louisiana's coastal zone.

The Florida Parishes have slash pine--cypress--hardwood forest, riparian forest, riparian sandy branch bottom, and pine savannah. Lester (1988) and Smith (1988) describe other forests, such as mixed hardwood--loblolly, pine flatwoods, and live oak--pine--magnolia forests, that may also be found in the coastal zone.

Swamp

Swamp consists of palustrine forested broad-leaved and needle-leaved deciduous vegetation. Cypress-tupelo swamps are the primary forested wetlands in fresh, poorly drained areas where the soil is saturated or covered with water for at least one month during the growing season (Penfound 1952). This habitat occupied about 5% (342,425 acres) of the coastal zone in 1978 (table 6). The deltaic plain contains a higher proportion (6% or 305,225 acres) of swamp than the chenier plain (2% or 37,201 acres). The dominant species found in the swamp are the bald cypress (Taxodium distichum) and the water tupelo (Nyssa aquatica), hence the name cypress-tupelo swamp. Often swamps are composed of pure stands of one of these species or a mixture of the two trees. Table 9 lists plants that may be found in Louisiana swamps. Other trees that may be commonly found in the swamp are ash (Fraxinus tomentosa), green ash (F. pennsylvanica), pumpkin ash (F. profunda), black willow (Salix nigra), water elm (Planera aquatica), water locust (Gleditsia aquatica), swamp blackgum (Nyssa sylvatica), and the red maple (Acer rubrum var. drummondii). Common species found in the woody understory where light is able to penetrate include saplings of the red maple (A. rubrum var. drummondii), Virginia willow (Itea virginica), button bush (Cephalanthus occidentalis), and American snowbell (Styrax americana) (Lester 1988; Smith 1988, Conner et al. 1986).

Tupelo--blackgum swamps are also forested wetlands where the dominant overstory is composed of gums (Nyssa spp.). Common associates are similar to cypress and cypress--tupelo swamps (Lester 1988; Smith 1988)

Because water is often present in the swamp, it is not uncommon to find floating aquatic and emergent plants. The most common floating aquatics include duckweed (Lemna minor), water hyacinth, (Eichhornia crassipes), water fern (Azolla caroliniana), and American frogbit (Limnobium spongia). The most common emergent plants include lizard tail (Saururus cernuus) and smart weed (Polygonum punctatum). Herbaceous plants can also be found in such drier areas as on and around logs, stumps, and cypress knees.

Opossum (Didelphus virginiana), bobcat (Lynx rufus), fox squirrels (Sciurus carolinensis, S. niger), cottontails and swamp rabbits (Sylvilagus floridans, S. aquaticus), nutria (Myocastor coypus), and white tailed deer (Odocoileus virginianus) are common wildlife species in Louisiana swamps.

Birds common to the swamp are anhingas (Anhinga anhinga), gallinules (Porphyrula maritinica, Galliunula chloropus), wood duck (Aix sponsa), red shouldered hawk (Buteo lineatus), barn owl (Tyto alba), great horned owl (Bubo virginianus), barred owl (Strix varia), black vulture (Coragyps atratus), and turkey vulture (Cathartes aura). The bald eagle (Haliaeetus leucocephalus) nests in swamps of Louisiana.

Amphibians and reptiles are especially common in swamp forest communities, especially the alligator (Alligator mississippiensis) and cottonmouth snake (Agkistrodon piscivorus) (Abernethy 1987).

Fresh Marsh

Fresh marshes consist of all marsh types identified as fresh marsh. This may include partially drained or ditched fresh marsh as well as fresh marsh that is leveed for water-level management. Fresh marshes occupy the northernmost extent of coastal marshes in Louisiana. In 1978, 9% (653,636 acres) of the coastal zone was fresh marsh (table 6). The chenier plain has a greater proportion of fresh marsh (15% or 307,031 acres) than the deltaic plain (6% or 346,605 acres), although in absolute area the deltaic plain is larger. Fresh marshes are located adjacent to intermediate marshes or in areas where large volumes of fresh water are entering a bay, such as Atchafalaya Bay and the Mississippi River delta area. Frequency and duration of flooding are related to micro-topography and are the primary factors governing species distribution. Substrate, current flow, salinity, and competition are important factors governing species distribution as well (Smith 1988). Fresh marsh has the greatest plant diversity and the highest soil organic content of all the marsh types.

Salinity is usually less than 2 ppt and normally averages about 0.5 to 1 ppt. (Smith 1988). Mean salinities (depending upon the hydrologic unit) in fresh marshes in Louisiana range from 0.4 to 4 ppt and reach 7 ppt (Chabreck 1972). Mean soil salinities range from 0.5 to 2 ppt and can be almost zero or as high as 9 ppt (Chabreck 1972).

Plant species composition in the fresh marshes of coastal Louisiana is extremely diverse; Chabreck (1972) identified 93 plant species in Louisiana fresh marshes. Table 8 lists 150 plant species found in fresh marshes by various authors. Fresh marshes in Louisiana are divided into two types--emergent and flotant. Flotant marsh is composed of a dense mat of vegetation dominated by a grass, maiden cane (Panicum hemitomon), which grows on a detritus layer which is held together by a matrix of roots. While this plant community appears to be firmly anchored into the substrate, it is generally floating on a layer of water and moves up and down with the tides. The plant community is diverse and capable of supporting vegetation that is less flood tolerant than other marsh vegetation, such as the marsh fern (Thelypteris palustris) and the royal fern (Osmunda regalis). Other plants common to this community include the vine (Vigna luteola), a grass (Eleocharis spp.), and tear thumb (Polygonum sagittatum) (Conner et al. 1986; Chabreck 1972).

Emergent fresh marshes have many of the same species as the flotant but these communities are anchored in the sediments. The dominant plants of these fresh marsh communities are broad-leaved plants such as arrowhead (Sagittaria latifolia), and bulltongue (S. falcata), and grasses such as roseau cane (Phragmites australis formerly P. communis), cattail (Typha latifolia), pickerelweed (Pontederia cordata), bladderwort (Utricularia spp.), and spikesedge (Eleocharis spp.). Other common species are alligator weed (Alternanthera philoxeroides) and southern wild rice (Zizaniopsis miliacea) (Conner et. al 1986; Chabreck 1972; Lester 1988; Smith 1988).

Floating and submerged aquatic vegetation found in open water, bayous, and canals around fresh marshes include duckweed (Lemna minor), water hyacinth (Eichhornia crassipes), water lettuce (Pistia stratiotes), watermilfoil (Myriophyllum spp.) and coontail (Ceratophyllum demersum) (Conner et al. 1986; Chabreck 1972).

Wildlife populations generally have greatest diversity and numbers in fresh marsh. Table 10 lists mammals found in the fresh marsh. The muskrat (Ondatra zibethicus) and nutria (Myocastor coypus) are common commercial furbearers in fresh marsh. Fresh marsh is the preferred habitat for nutria. Other mammals, such as the raccoon (Procyon lotor), mink (Mustela vison), otter (Lutra canadensis), white-tailed deer (Odocoileus virginianus), and harvest mouse (Reithrodontomys fulvescens) live in fresh marshes.

Common birds in fresh marshes include loons, grebes, and cormorants. Table 11 lists birds found in fresh marshes, such as anhingas (Anhinga anhinga), gallinules (Porphyrula maritinica, Galliunula chloropus), and king rails (Rallus elegans). Bald eagles (Haliaeetus leucocephalus), which are federally endangered, nest in trees in and around fresh marshes. Several ducks are common. For example, the mottled duck (Anas fulvigula) is a permanent resident while mallards (Anas platyrhynchos), blue-winged teal (Anas discors), and green winged teal (Anas crecca) are common migratory waterfowl. Wading birds, such as great egrets (Casmerodius albus) and great blue herons (Ardea herodias), are common in fresh marshes.

Several reptiles and amphibians (tables 12, 13) occupy fresh marshes such as the alligator (Alligator mississippiensis), cottonmouth snake (Agkistrodon

Table 10. Mammal species of Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979).

Species	Common name	Distribution CP[1]	Distribution DP[2]	Vegetative type SA[3]	Vegetative type BR[4]	Vegetative type IN[5]	Vegetative type FR[6]
*Canis rufus**	red wolf	x					
Dasypus novemcinctus	nine-banded armadillo	x	x	x	x	x	x
Didelphis virginiana	Virginia opossum	x	x	x	x	x	x
Lasiurus borealis	red bat		x	--	--	--	x
Lasiurus seminolus	seminole bat	x	x	--	--	--	x
Lutra canadensis	river otter	x	x	x	x	x	x
Mustela vison	North American mink	x	x	--	x	x	x
Myocastor coypus	nutria	x	x	--	--	x	x
Myotis austroriparius	southeastern myotis	x	x	--	--	--	x
Odocoileus virginianus	white-tailed deer	x	x	--	x	x	x
Ondatra zibethicus	common muskrat	x	x	x	x	x	x
Oryzomys palustris	marsh rice rat	x	x	x	x	x	x
Procyon lotor	northern raccoon	x	x	x	x	x	x
Reithrodontomys fulvescens	harvest mouse	x	x	--	--	--	x
Sylvilagus aquaticus	swamp rabbit	x	x	x	x	x	x

*The red wolf is probably extinct in Louisiana
[1]CP - chenier plain
[2]DP - Mississippi deltaic plain
[3]SA - Saline marsh
[4]BR - Brackish marsh
[5]IN - Intermediate marsh
[6]FR - Fresh marsh

Table 11. Bird species of Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979).

Species	Common name	Distribution		Vegetative type			
		CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]
Grebes and Waterfowl							
Anas acuta	northern pintail	x	x	x	x	x	x
Anser albifrons	greater white-fronted goose	x	x	x	x	x	x
Anas americana	American wigeon	x	x	x	x	x	x
Anas clypeata	northern shoveler	x	x	x	x	x	x
Anas crecca	green-winged teal	x	x	x	x	x	x
Anas discors	blue-winged teal	x	x	x	x	x	x
Anas fulvigula	mottled duck	x	x	x	x	x	x
Anas platyrhynchos	mallard	x	x	x	x	x	x
Anas rubripes	American black duck	x	x	x	x	x	x
Anas strepera	gadwall	x	x	x	x	x	x
Aythya affinis	lesser scaup	x	x	x	x	x	x
Aythya collaris	ring-necked duck	x	x	x	x	x	x
Branta canadensis	Canada goose	x	x	x	x	x	x
Bucephala albeola	bufflehead	x	x	x	x	x	x
Chen caerulescens	snow goose	x	x	x	x	x	x
Dendrocygna bicolor	fulvous tree duck	x	x	x	x	x	x
Fulica americana	American coot	x	x	--	x	x	x
Gallinula chloropus	common moorhen	x	x	--	x	x	x
Lophodytes cucullatus	hooded merganser	x	x	--	--	x	x
Oxyura jamaicensis	ruddy duck	x	x	x	x	x	x
Podiceps nigricollis	eared grebe	x	x	x	x	x	x
Podilymbus podiceps	pied-billed grebe	x	x	x	x	x	x
Porphyrula martinica	purple gallinule	x	x	--	--	--	x
Wading Birds							
Ajaia ajaja	roseate spoonbill	x		x	x	x	x
Ardea herodias	great blue heron	x	x	x	x	x	x
Botaurus lentiginosus	American bittern	x	x	x	x	x	x
Bubulcus ibis	cattle egret	x	x	x	x	x	x
Butorides striatus	green-backed heron	x	x	x	x	x	x
Casmerodius albus	great egret	x	x	x	x	x	x
Egretta caerulea	little blue heron		x	x	x	x	x
Egretta rufescens	reddish egret	x	x	x	x	--	--
Egretta thula	snowy egret	x	x	x	x	x	x
Egretta tricolor	tricolored heron		x	x	x	x	x
Eudocimus albus	white ibis	x	x	x	x	x	x
Florida caerules	little blue heron	x	x	x	x	x	x
Hydranassa tricolor	Louisiana Heron	x		x	x	x	x
Ixobrychus exilis	least bittern	x	x	x	x	x	x
Mycteria americana	wood stork	x	x	--	x	x	x
Nycticorax nycticorax	black-crowned night-heron	x	x	x	x	x	x

Table 11. Bird species of Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979) (continued).

Species	Common name	Distribution CP[1]	DP[2]	Vegetative type SA[3]	BR[4]	IN[5]	FR[6]
Nycticorax violaceus	yellow-crowned night-heron		x	x	x	x	x
Nyctanassa violacea	yellow-crowned night heron	x	x	x	x	x	x
Pledgadis falcinellus	glossy ibis	x	x	x	x	x	x
Plegadis chihi	white-faced ibis	x	x	x	x	x	x
Shore Birds							
Actitis macularia	spotted sandpiper	x	x	x	x	x	x
Calidris alpina	dunlin	x	x	x	x	x	x
Calidris bairdii	Baird's sandpiper	x	x	x	x	x	x
Calidris himantopus	stilt sandpiper	x	x	x	x	x	x
Calidris mauri	western sandpiper	x	x	x	x	x	x
Calidris melanotos	pectoral sandpiper	x		x	x	x	x
Calidris minutilla	least sandpiper	x	x	x	x	x	x
Calidris pusilla	semipalmated sandpiper	x	x	x	x	x	--
Catoptrophorus semipalmatus	willet	x	x	x	x	x	--
Charadrius semipalmatus	semipalmated plover		x	x	--	--	--
Gallinago gallinago	common snipe	x	x	x	x	x	x
Himantopus mexicanus	black-necked stilt	x	x	x	x	x	x
Limnodromus griseus	short-billed dowitcher	x	x	x	x	x	x
Limnodromus scolopaceus	long-billed dowitcher	x	x	x	x	x	x
Limosa haemastica	Hudsonian godwit	x	x	x	x	x	x
Mergus seator	red breasted merganser	x	x	x	x	--	--
Numenius phaeopus	whimbrel	x	x	x	x	x	x
Phalaropus tricolor	Wilson's phalarope	x	x	x	x	x	x
Pluvialis squatarola	black-bellied plover	x	x	x	x	x	x
Recurvirostra americana	American avocet	x	x	x	x	x	x
Tringa flavipes	lesser yellowlegs	x	x	x	x	x	x
Tringa solitaria	solitary sandpiper	x	x	x	x	x	x
Tringa melanoleuca	greater yellowlegs	x	x	x	x	x	x
Fishing Birds							
Ceryle alcyon	belted kingfisher		x	x	x	x	x
Childonias niger	black tern	x	x	--	--	x	x
Gelochelidon nilotica	gull-billed tern	x		--	--	x	--
Larus atricilla	laughing gull	x	x	x	x	x	--
Megaceryle alcyon	belted kingfisher	x		x	x	x	x
Pelecanus erythrorhynchus	American white pelican	x	x	x	x	--	--
Sterna caspia	Caspian tern	x	x	x	x	x	--
Sterna forsteri	Forster's tern	x	x	x	x	x	--
Sterna nilotica	gull-billed tern	x	x	x	x	x	--

Table 11. Bird species of Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979) (continued).

Species	Common name	Distribution CP[1]	DP[2]	Vegetative type SA[3]	BR[4]	IN[5]	FR[6]
Birds of Prey							
Asio flammeus	short-eared owl	x	x	x	x	x	x
Circus cyaneus	marsh hawk	x	x	x	x	x	x
Falco columbarius	Merlin	x	x	x	x	x	x
Falco sparverius	Amercian kestrel	x	x	x	x	x	x
Falco peregrinus	peregrine falcon	x	x	x	x	x	--
Haliaeetus leucocephalus	bald eagle	x	x	--	--	--	x
Other Marsh Birds							
Agelaius phoeniceus	red-winged blackbird	x	x	x	x	x	x
Ammodramus caudacutus	sharp-tailed sparrow	x	x	x	x	--	--
Ammodramus maritimus	seaside sparrow	x	x	x	--	--	--
Anthus spinoletta	water pipit	x	x	x	x	x	x
Chaetura pelagica	chimney swift	x		x	x	x	x
Chordeiles minor	common nighthawk	x	x	x	x	x	x
Cistothorus palustris	marsh wren	x	x	x	x	x	x
Cistothorus platensis	sedge wren	x	x	x	x	x	x
Corvus ossifragus	fish crow	x	x	x	x	x	x
Coturnicops noveboracensis	yellow rail	x	x	x	x	x	x
Dolichonyx oryzivorus	bobolink	x	x	x	x	x	x
Geothlypis trichas	common yellowthroat	x	x	x	x	x	x
Grus americana	whooping crane	x		x	--	--	--
Hirundo pyrrhonota	cliff swallow		x	x	x	x	--
Hirundo rustica	barn swallow	x	x	x	x	x	x
Iridoprocne bicolor	tree swallow	x		x	x	x	x
Laterallus jamaicensis	black rail	x	x	x	x	x	x
Melospiza georgiana	swamp sparrow	x	x	--	--	x	x
Passerculus sandwichensis	savannah sparrow	x	x	x	x	x	x
Petrochelidon pyrrhonota	cliff swallow	x		x	x	x	--
Porzana carolina	sora	x	x	x	x	x	x
Pulica americans	American coot	x		--	x	--	--
Quiscalus major	boat-tailed grackle	x	x	x	x	x	x
Quiscalus mexicanus	great-tailed grackle	x		x	x	--	--
Rallus elegans	king rail	x	x	--	x	x	x
Rallus limicola	Virginia rail	x	x	x	x	x	x
Rallus longirostris	clapper rail	x	x	x	x	--	--
Riparia riparia	bank swallow	x	x	x	x	x	x
Tachycineta bicolor	tree swallow		x	x	x	x	x

[1]CP - Chenier plain
[2]DP - Mississippi deltaic plain
[3]SA - Saline marsh
[4]BR - Brackish marsh
[5]IN - Intermediate marsh
[6]FR - Fresh marsh

Table 12. Amphibian species of the Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979; Conner and Day 1987).

Species	Common name	Distribution		Vegetative type			
		CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]
Acris crepitans	northern cricket frog	x	x	--	--	--	x
Ambystoma opacum	marbled salamander	x	x	--	--	--	x
Ambystoma texanum	small-mouth salamander	x	x	--	--	--	x
Amphiuma tridactylum	three-toed amphiuma	x	x	--	--	--	x
Bufo valliceps	gulf coast toad	x	x	--	--	--	x
Bufo woodhousel	woodhouse's toad	x	x	--	x	x	x
Desmognathus auriculatus	southern dusky salamander		x	--	--	--	--
Eumeces fasciatus	five-lined skink		x	--	--	--	--
Eumeces laticeps	broad-headed skink		x	--	--	--	--
Eurycea guadridigitata	dwarf salamander	x	x	--	--	x	x
Gastrophryne carolinensis	eastern narrowmouth toad	x	x	--	x	x	x
Hyla avivoca	bird-voiced treefrog		x	--	--	--	--
Hyla chrysocelis-versicolor complex	gray treefrog		x	--	--	--	--
Hyla cinerea	green tree frog	x	x	--	x	x	x
Hyla crucifer	spring peeper	x	x	--	--	--	x
Hyla squirella	squirrel tree frog	x	x	--	--	--	x
Notophthalmus viridescens	central newt	x	x	--	--	--	x
Ophisaurus attenuatus	slender glass lizard		x	--	--	--	--
Ophisaurus ventralis	eastern glass lizard		x	--	--	--	--
Pseudacris triseriata	upland chorus frog	x	x	--	--	--	x
Rana catesbeiana	bull frog	x	x	--	--	--	x
Rana clamitans	bronze frog	x	x	--	x	x	x
Rana grylio	pig frog	x	x	--	--	--	x
Rana sphenocephala	southern leopard frog		x	--	x	x	x
Rana utricularia	southern leopard frog	x	x	--	--	--	x
Scinella lateralis	ground skink		x	--	--	--	--
Siren intermedia	lesser siren	x	x	--	--	--	x

[1]CP - chenier plain
[2]DP - Delta plain
[3]SA - Saline marsh
[4]BR - Brackish marsh
[5]IN - Intermediate marsh
[6]FR - Fresh marsh

Table 13. Reptile species of the Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979; Conner and Day 1987).

Species	Common name	Distribution		Vegetative type			
		CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]
Agkistrodon contortrix	southern copperhead		x	--	--	--	--
Agkistrodon piscivorus	cottonmouth	x	x	--	x	x	x
Alligator mississippiensis	American alligator	x	x	x	x	x	x
Anolis caroliniensis	green anole		x	--	--	--	x
Caretta caretta	Atlantic loggerhead	x	x	--	--	--	--
Chelonia mydas	Atlantic green seaturtle	x	x	--	--	--	--
Chelydra serpentina	snapping turtle	x	x	--	x	x	x
Chrysemys concinna	mobile cooter	x		x	--	--	--
Chrysemus floridana	Missouri slider	x		--	x	x	x
Chrysemys picta	southern painted turtle	x	x	--	--	--	x
Chrysemys scripta	red-eared turtle	x		--	--	--	x
Coluber constrictor	eastern yellow-bellied racer	x	x	--	x	x	x
Crotalus horridus	canebrake rattlesnake		x	--	--	--	--
Deirochelys reticularia	chicken turtle		x	--	x	x	x
Dermochelys coriacea	Atlantic leatherback	x	x	--	--	--	--
Diadophis punctatus	ringneck snake		x	--	--	--	--
Elaphe obsoleta	Texas rat snake		x	--	--	--	--
Eretromechelys imbricata	hawksbill sea turtle	x	x	--	--	--	--
Eumeces fasciatus	five-lined skink		x	--	--	--	x
Farancia abacura	mud snake	x	x	--	--	--	x
Graptemys kohnii	Mississippi map turtle	x	x	--	--	--	x
Graptemys pseudogeographica	Sabine map turtle	x	x	--	--	--	x
Hyla cinerea	green tree frog		x	--	--	--	x
Hetrodon platyrhinos	eastern hognose snake		x	--	--	--	--
Kinosternon subrubrum	eastern mud turtle	x	x	--	x	x	x
Lampropeltis getulus	speckled king snake	x	x	--	x	x	x
Lampropeltis triangulum	Louisiana milksnake		x	--	--	--	--
Lepidochelys kempi	Atlantic ridley	x	x	--	--	--	--
Macroclemys temminckii	alligator snapping turtle	x	x	--	--	x	--
Malaclemys terrapin	diamondback terrapin	x	x	x	x	--	--
Microhyla carolinensis	--		x	--	--	--	x
Natrix cyclopion	snake		x	--	--	--	x
Natrix sipedon	snake		x	--	--	--	x
Nerodia clarkii	Gulf salt marsh snake	x	x	x	x	--	--
Nerodia cyclopion	green water snake	x	x	--	x	x	x

Table 13. Reptile species of the Louisiana coastal marshes (Gosselink 1984; Gosselink et al. 1979; Conner and Day 1987) (continued).

Species	Distribution Common name	Vegetative type CP[1]	DP[2]	SA[3]	BR[4]	IN[5]	FR[6]
Nerodia erythrogaster	yellow-bellied water snake		x	--	--	--	--
Nerodia fasciata confluens	broad-banded water snake	x	x	--	x	x	x
Nerodia rhombifera	diamondback water snake	x	x	--	x	x	x
Opheodrys aestivus	rough green snake		x	--	--	--	--
Rana clamitans	green frog		x	--	--	--	x
Pseudemys concinna	river cooter		x	x	--	--	--
Pseudemys floridana	Missouri slider		x	--	x	x	x
Pseudemys picta	southern painted turtle		x	--	--	--	x
Pseudemys scripta	red-eared turtle		x	--	--	--	x
Regina grahamii	Graham's crayfish snake	x	x	--	--	x	x
Regina rigida	glossy crayfish snake	x	x	--	x	x	x
Sistrurus miliarius	western pygmy rattlesnake		x	--	--	--	--
Sternotherus odoratus	stinkpot	x	x	--	--	x	x
Storeria dekayi	brown snake	x	x	--	x	x	x
Terrapene carolina	box turtle		x	--	--	--	--
Thamnophis proximus	western ribbon snake	x	x	--	x	x	x
Thamnophis sirtalis	common garter snake	x	x	--	--	x	x
Trionyx muticus	smooth soft shell turtle		x	--	--	--	--
Trionyx spiniferus	spiny softshell	x	x	--	--	--	x

[1]CP - Chenier plain
[2]DP - Delta plain
[3]SA - Saline marsh
[4]BR - Brackish marsh
[5]IN - Intermediate marsh
[6]FR - Fresh marsh

piscivorus), snapping turtle (Chelydra serpentina), and bullfrog (Rana catesbeiana).

Fresh marshes also act as nursery areas for the young of many marine species such as croaker (Micropogonlas undulatus), spotted sea trout (Cynoscion nebulosus), blackdrum (Pogonias cromis), and flounder (Paralichthys spp.) (Smith 1988).

Intermediate Marsh

The intermediate marsh, which forms a transition zone from brackish to fresh marshes, is often overlooked as a separate habitat in other areas of the country. However, because Louisiana marshes are so extensive, this marsh type is often treated separately. Intermediate marshes are oligohaline and may include partially drained/ditched intermediate marsh, and leveed intermediate marsh.

This marsh type occupies 6% (426,386 acres in 1978) of the coastal zone. The chenier plain contains more intermediate marsh (11% or 225,403 acres) than the deltaic plain (4% or 200,983 acres). The intermediate marsh has an irregular tidal regime, and is dominated by narrow-leaved species. Plant diversity and organic content of the soil are higher than in the brackish marsh. It is very productive for many species of wildlife and some larval marine organisms.

Salinity averages about 3 ppt (Lester 1988). Mean salinity ranges from 2 to 5 ppt with minimum readings at 0.3 and maximum at 10 ppt (Chabreck 1972). Soil salinities are generally from 2 to 5 ppt but may be as low as 0.2 and as high as 17 ppt (Chabreck 1972).

Chabreck (1972) identified 54 plant species in intermediate marshes of Louisiana. Table 8 lists 97 plant species which may be found in intermediate marshes. Species that are common to both fresh and brackish marshes may be found together in intermediate marshes. The dominant plants are wire grass (Spartina patens), roseau cane (Phragmites australis), and bulltongue (Sagittaria falcata). Other species commonly found in intermediate marshes are the spikesedge (Eleocharis spp.), water hyssop (Bacopa monnieri), three-cornered grass (Scirpus olneyi), giant bulrush (S.californicus), common threesquare (S. americanus), seashore paspalum (Paspalum vaginatum), cowpea (Vigna repens), deer pea (V. luteola), switch grass (Panicum virgatum), and alligator weed (Alternanthera philoxeroides) (Chabreck 1972; Lester 1988).

Mammals common to intermediate marsh are the muskrat (Ondatra zibethicus), raccoon (Procyon lotor), mink (Mustela vison), and otter (Lutra canadensis). White-tailed deer (Odocoileus virginianus) are also found in intermediate marshes, especially along ridges and levees (Conner and Day 1987; Chabreck 1988). Table 10 lists other mammals which live in this habitat.

Several ducks may be found in intermediate marshes, including mottled duck (Anas fulvigula), which is a permanent resident, and migratory ducks such as the mallard (Anas platyrhynchos), blue-winged teal (Anas discors), and green-winged teal (Anas crecca). Other birds include great egrets (Casmerodius), great blue herons (Ardea herodias), marsh hawk (Circus cyaneus), and the common snipe (Capella gallinago). Table 11 lists birds common to intermediate marshes.

Reptiles and amphibians that inhabit intermediate marshes are listed in tables 12 and 13.

Brackish Marsh

Brackish marsh consists of all marsh types identified as brackish (mesohaline) marsh. This includes partially drained or ditched and leveed marsh. The brackish marsh community occupied 12% (909,481 acres) of the coastal zone in 1978 (table 6). Proportionately, the chenier plain has more brackish marsh (19% or 380,010 acres) than the deltaic plain (10% or 529,471 acres). Brackish marsh is usually found between saline and intermediate marshes. Brackish marshes are irregularly tidally flooded and dominated by salt-tolerant plants. Plant diversity and organic matter in the soil are higher than in the salt marsh.

Salinity averages about 8 ppt in brackish marshes (Lester 1988) and mean salinity in brackish marshes ranges from 4 to 12 ppt but can vary from almost fresh to ocean salinity levels (0.4 to 28 ppt) (Chabreck 1972). Soil salinities are usually from 6 to 9 ppt but may be as low as 1 and as high as 21 ppt (Chabreck 1972).

Because many species overlap brackish and intermediate marshes, these two habitats are often combined in the literature (Conner et al. 1986). Chabreck (1972) identified 40 plant species in brackish marshes. Table 8 lists 61 plant species found in brackish marshes of Louisiana. The dominant species of the brackish marsh is wire grass (Spartina patens) with other common species including saltgrass (Distichlis spicata), black needle rush (Juncus roemerianus), three-cornered grass (Scirpus olneyi), dwarf spikesedge (Eleocharis parvula), bulrush (Scirpus robustus), widgeon grass (Ruppia maritima, seashore paspalum (Paspalum vaginatum), water hyssop (Bacopa monnieri), smooth cordgrass (Spartina alterniflora), and big cordgrass (S. cynosuroides) (Conner et al. 1986, Chabreck 1972; Lester 1988).

In general, there are more vertebrate species in the brackish marsh than in the salt marsh (Lester 1988). Common mammals in brackish marshes include the muskrat (Ondatra zibethicus), raccoon (Procyon lotor), mink (Mustela vison), and otter (Lutra canadensis) (Conner and Day 1987; Chabreck 1988). Table 13 lists other mammals present in brackish marshes.

Loons, grebes, and cormorants often winter in brackish marshes. Common ducks are gadwall (Anas strepera), and mottled duck (Anas fulvigula). Birds include the wading birds such as great egrets (Casmerodius albus) and great blue herons (Ardea herodias), and others such as marsh hawk (Circus cyaneus), night heron, clapper rail, and seaside sparrow (Abernethy 1987, Chabreck 1988). Table 14 lists birds found in brackish marshes.

As salinity increases, reptiles and amphibians because less common, but the gulf salt marsh snake (Nerodia clarkii) may be found in brackish marshes, as can an occasional alligator (Alligator mississippiensis) (Abernethy 1987; Chabreck 1988). Tables 12 and 13 list other reptiles and amphibians found in brackish marsh. Brackish marshes are very productive and provide havens for estuarine larval shrimp (Penaeus spp.), crabs, and finfishes.

Saline Marsh

Saline (mesohaline) marsh includes partially drained or ditched saline marsh, and leveed saline marsh. Saline marshes are the habitat closest to the Gulf of Mexico and may range from 1 to 15 mi wide in coastal Louisiana (Lester 1988). Saline marshes occupied 6% (455,044 acres) of the coastal zone in 1978 (table 6). The deltaic plain contains much more (8%, 424,164 acres) salt marsh

Table 14. Endangered plant species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Amaranthus greggi	Greg's amaranth	x	x									
Aster texanus	Texas aster				x							
Astragalus crassicarpus	ground plum			x								
Athyrium pycnocarpon	glade fern				x							
Celastrus scandens	climbing bittersweet				x							
Cenchrus myosuroides	big sandbur				x	x		x				
Cenchrus tribuloides	dune sand bur							x			x	
Ceratopteris pteridoides	floating antler-fern						x	x				
Coreopsis nudata	Georgia tickseed										x	
Diplanzium lonchophyllum	lance-leaved glade fern				x							
Dryopteris ludoviciana	southern shield wood-fern				x							
Eragrostis curtipedicellata	gummy lovegrass	x		x								
Eriochloa punctata	punctate cupgrass	x	x	x								
Euthamia tenuifolia	flat-topped goldenrod										x	
Fuirena simplex	western umbrella grass							x				
Justicia americana	common water-willow											x
Lithospermum incisum	narrow-leaved puccoon	x										
Monanthochloe littoralis	saltflat grass	x	x	x								
Odontonychia corymbosa	flat-topped odontonychia											x
Potamogeton perfoliatus	clasping-leaf pond weed										x	
Paspalum monostachyum	gulfdune paspalum	x	x									
Physostegia correllii[1]	Correll's false dragon-head									x		
Poa sylvestris	woodland bluegrass				x							
Rudbeckia triloba	three-lobed coneflower				x							
Sabatia arenicola	sand rose-gentian						x	x	x		x	
Scaevola plumieri	scaevola						x					
Schizachyrium maritimum	gull bluestem							x				
Scutellaria thieretii[C2]	Thieret's skullcap			x	x							
Selaginella ludoviciana	Louisiana spikemoss										x	
Sium suave	hemlock water-parsnip										x	x
Stipulicidia setacea	pineland scaly pink											x

Table 14. Endangered plant species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks) (continued).

Species	Common Name	Chenier Plain				Deltaic Plain						
		SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Thalassia testudina	turtle-grass										x	
Thelypteris interrupta	Willdenow's fern				x							
Tidestromia lanuginosa	woolly honeysweet	x	x									
Tradescantia subaspera	broad-leafed spiderwort				x							
Uniola paniculata	sea oats	x					x	x			x	

[1]Available information indicates proposing to list as endangered or threatened may be appropriate, but substantial data do not exist to support such action.

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

than does the chenier plain (2%, 30,881 acres). Saline marshes are regularly flooded and dominated by salt-tolerant species. They are more subject to physical processes than the other marsh types simply because of their proximity to the Gulf. For example, the saline marsh is more often subjected to diurnal tides, which average about 30 cm, and wind stress; this results in a salinity level that varies from almost fresh to hypersaline (0.6 to 52 ppt) during certain times of the year. The mean salinity for saline marshes is about 16 ppt (Lester 1988) and generally salinities are from 11 to 19 in Louisiana saline marshes (Chabreck 1972). Soil salinities are also variable (0.6 to 30 ppt) but are generally from 3 to 11 ppt. (Chabreck 1972).

Chabreck (1972) identified 17 species of plants in Louisiana saline marshes. Table 8 lists 38 species found by various authors in Louisiana saline marshes. The smooth cord grass (Spartina alterniflora) is the dominant plant in the saline marsh. Often the saline marsh is composed of pure stands of this salt- and flood-tolerant plant. Other common species include black needle rush (Juncus roemerianus), salt grass (Distichlis spicata), and wire grass (Spartina patens). Sea oxeye (Borrichia frutescens) and saltwort (Batis maritima) may be found at slightly higher elevations where soil salinity is higher.

Relative to other marsh types, the saline marsh has fewest vertebrate species (Lester 1988). Raccoons (Procyon lotor) may be found in the salt marsh. Table 10 lists other mammals found in saline marshes. Several birds, including clapper rail (Rallus longirostris), seaside sparrow (Ammondramous maritimus), night heron (Nycticorax sp.), laughing gull (Larus atricilla), Foster's tern (Sterna forsteri), royal tern (Thalasseus maximus) and caspian tern (Hydroprogne caspia) (Abernethy 1987; Chabreck 1988), live in saline marshes.

Few reptiles or amphibians favor saline marshes; exceptions are the gulf salt marsh snake (Nerodia clarkii), the gulf coast toad (Bufo valliceps), and the diamondback terrapin (Malaclemys terrapin) (Abernethy 1987; Chabreck 1988). Other reptiles and amphibians found in the salt marsh are listed on tables 12 and 13.

Saline marshes are extremely productive and serve as nursery areas for several commercially important species of shrimp (Penaeus spp.), crabs, and fish, such as redfish (Sciaenops ocellata), spotted sea trout (Cynoscion nebulosus), and menhaden (Brevoortia patronus).

The black mangrove (Avicennia germinans) is another species found in highly saline areas of Louisiana where marsh elevation is slightly higher along the edge of some bayous. Because Louisiana is in the northern edge of its range, freezes cause diebacks of this plant, preventing large established stands. Often these plants are only a few years old and seldom exceed 1.5 m. However, some have been reported about 3 m tall in the state (Bahr and Hebrard 1976). The brown pelican (Pelecanus occidentalis) and white-faced ibis (Plegadis chihi) may be found nesting in this habitat (Abernethy 1987; Chabreck 1988).

Beach

Beach consists of wave-reworked sand and/or shell material along a land-water interface. Less than 1% (7,299 acres) of the coastal zone is beach habitat. The beach habitat consists of a very small portion of the landforms in coastal Louisiana (<1% land area), but distinct plant communities inhabit the beaches and have adapted to this harsh environment. Beach plant communities are divided into dune and swale habitats. The dune habitat contains marsh hay cordgrass (Spartina patens), gulf cordgrass (S. spartinae), American beachgrass (Ammonphila breviligulata), bitter panicum (Panicum amarum), beach tea (Croton punctatus), seacoast bluestem (Schizachyrium maritimum), and seashore dropseed (Sporobolus virginicus), which are predominant (Lester 1988; Smith 1988). Sea oats (Uniola paniculata), which is a very common dune grass in the southeast United States, is seldom found in Louisiana; S. patens is more commonly found in this habitat.

The swale habitat (a lower area behind the dune) is generally a less hostile environment. Species diversity is higher in these areas. Common plants found in the swales of Louisiana are three-corner grass (Scirpus americanus), sandrush (Fimbristylis castanea), wiregrass (S. patens), pennywort (Hydrocotyle bonariensis), seaside goldenrod (Solidago americanus), and broom sedge (Andropogon scoparius). Other plants found in beach habitats are included in table 8.

Several birds may be found along beaches and many of them nest there, including laughing gull (Larus atricilla), royal tern (Thalasseus maximus), caspian tern (Hydroprogne caspia), black skimmers (Rynchops niger), least tern (Sterna albifrons), Foster's tern (Sterna forsteri), brown pelican (Pelecanus occidentalis), king rail (Rallus elegans), clapper rail (Rallus longirostris), black necked stilt (Himantopus mexicanus), killdeer (Charadrius vociferus), and willet (Catoptrophus semipalmatus) (Abernethy 1987; Chabreck 1988).

Shrub/Scrub

Shrub/scrub consists of broad-leaved deciduous, needle-leaved deciduous, broad-leaved evergreen, and needle-leaved evergreen vegetation less than 20' high. In 1978 1% (48,497 acres) of the coastal zone was labeled shrub/scrub (natural levees). One third of that habitat is in the chenier plain and two-thirds in the deltaic plain. Scrub/shrub is a low, flat wetland dominated by woody vegetation less than 20' tall. Soils are poorly drained and surface water is present for extended periods. These communities are often associated with newly accreted lands and partially drained wetlands (Smith 1988).

The vegetation includes true shrubs, young trees, and shrubs or trees that are stunted due to environmental conditions (Smith 1988). Common species include buttonbush (Cephalanthus occidentalis), eastern baccharis (Baccharis halimifolia), dwarf palmetto (Sabal minor), and wax myrtle (Myrica cerifera). Other plants include marsh elder (Iva frutescens), lead plant (Amorpha fruticosa, and red maple (Acer rubrum var. drummondii) (Lester 1988; Smith 1988).

Mammals that live in shrub/scrub areas include opossum (Didelphus virginiana), bobcat (Lynx rufus), fox squirrels (Sciurus carolinensis, S. niger), cottontail and swamp rabbits (Sylvilagus floridans, S. aquaticus), and white-tailed deer (Odocoileus virginianus).

Ridges are used by reptiles and amphibians, including the racer (Coluber constrictor), speckled kingsnake (Lampropeltis getulus), and the Texas rat snake (Elaphe obsoleta). Other common species on ridges are the cottonmouth snake (Agkistrodon piscivorus), green water snake (Nerodia cyclopian), broad-banded watersnake (N. fasciata), diamondback water snake (N. rhombifera), western ribbon snake (Thamnophis proximus), green anole (Anolis carolinensis), five lined skink (Eumeces fasciatus), ground skink (Scinella lateralis), green treefrog (Hyla cinerea), eastern narrow mouthed toad (Gastrophyrne carolinensis), and bronze frog (Rana clamitans).

Shrub/Scrub (spoil)

Shrub/scrub (spoil) consists of spoil deposits and contains vegetation similar to that in natural shrub/scrub areas. In 1978 1% (93,973 acres) of the coastal zone was shrub/scrub (spoil) (table 6). Elevated spoil banks have been created by dumping spoil from the construction of canals, roads, flood control structures, and other human activity in an otherwise flat topography. Monte (1978) studied vegetation along spoil banks and found distinct plant succession along these areas leading to species common to bottomland hardwood forests. Spoil bank communities are extremely diverse and in their early stages often tend to be inhabited by species common to the adjacent marsh. Species that are commonly found on all spoil banks include black willow (Salix nigra), hackberry (Celtis laevigata), elderberry (Sambucus canadensis), marsh elder sumpweed (Iva frutescens), and eastern baccharis (Baccharis halimifolia).

Fauna common to shrub/scrub habitat classified as spoil banks are similar to fauna along natural levee communities.

Agriculture/Pasture

Agriculture/pasture consists of non-wetland areas that are cultivated for crops, maintained as pasture, or left as grasslands. It includes any wetlands that have been drained and are now used for agriculture or pasture. This category also includes vegetated dunes. About 4% (303,202 acres) of the coastal zone is agriculture/pasture. Proportionately, the chenier plain has more agriculture/pasture (9%) than the deltaic plain (2%). However, the area is not much different (189,398 vs 113,804 acres). This habitat is not a natural community and may require an input of fossil fuel, fertilizer, and watering for successful monospecific harvests. It can be especially beneficial to wildlife, especially waterfowl, by providing alternative food sources (Gosselink et al. 1979). Much of the pasture on the chenier plain was created by impounding and draining wetlands.

Major agricultural products in the coastal zone are sugarcane, soybeans, tobacco, pasture and livestock, fruits and nuts, and vegetables in the Mississippi deltaic plain (Bahr et al. 1983) and rice, crawfish, and pasture and livestock in the chenier plain (Gosselink et al. 1979). The major cultivated areas occur along natural levees and levee flanks where rich alluvial soils occur. However, natural levees are fairly uncommon in the chenier plain and agriculture there occurs principally in areas adjacent to Pleistocene terraces, where soil stability is higher.

A variety of mammals, birds, reptiles, amphibians, and crustaceans uses agricultural and pasture habitats. For example, mottled duck (Anas fulvigula) and the snow goose (Chen caerulescens) may be found in rice fields, as may the white-tailed deer (Odocoileus virginianus) in other agricultural areas (Chabreck 1988).

Developed

Developed habitat consists of regularly maintained rights-of-way and urban, residential, commercial, industrial, and mineral developments on upland sites or in areas protected from flooding by levees or drainage canals. In 1978, three percent (221,976 acres) of the coastal zone was developed. Most of the developed wetlands (4% or 199,951 acres) occur in the deltaic plain. Developed habitat includes areas that have been completely changed by human activities. Developed areas include cities, towns, residential and industrial areas, roads, and other artificial features.

Unvegetated

Unvegetated areas contain unvegetated land not designated as developed or beach. This includes unvegetated spoil banks, tidal flats, exposed reefs, rock jetties, drained ponds, and mud banks exposed along bayous and tidal streams. About 1% (43,078 acres) of the coastal zone falls into this habitat classification.

Broken Marsh

Broken marsh is a category developed in the 1984 data. Areas so designated may be marshes that are stressed or are beginning to break up. If so, classification is useful for targeting areas where land loss is likely to occur. However, some broken marsh could represent healthy areas or early stages of colonization of mud flats.

Non-Fresh Marsh

Non-fresh marsh is specific to 1956 habitat maps and consists of marsh types identified as non-fresh, intermediate, brackish and saline marsh types which were lumped into one category.

Mixed Vegetation

Mixed vegetation is a habitat classification used only in the 1984 data. It is a mixture of two or more vegetative habitats and usually occurs at transition zones. For example, it may represent a habitat along a marsh creek where wax myrtles are present along the edge.

Obscured by Clouds

The habitat type could not be distinguished because the are was obscured by cloud cover.

Unclassified

Unclassified represents land cover that could not be classified. For example, vegetation under cloud shadows could not be classified.

Floating Vegetation

The 1984 imagery identified floating vegetation only. The category did not include areas of submerged aquatics. Table 1 of appendix A in the main text lists land classifications in this category under aquatic vegetation. Species common to floating vegetation are described in the aquatic vegetation section.

CHAPTER IV
THREATENED AND ENDANGERED SPECIES IN THE LOUISIANA COASTAL ZONE

Dianne Lindstedt

Introduction

The information for this chapter was derived from the Louisiana Wildlife and Fisheries' Natural Heritage Program's data base of plant and animal species of special concern. This data base contains locations of habitat where threatened, endangered, and state-rare species have been documented.

Threatened and endangered species are federally protected under the Endangered Species Act, which includes the Migratory Bird Act of 1973 (Pub. L. 93-205). Other federal legislation that protects species in Louisiana's coastal zone includes the Bald Eagle Protection Act of 1962 (Pub. L. 87-884), the Endangered Species Conservation Act of 1969 (Pub. L. 91-135), and the Marine Mammal Protection Act of 1972 (Pub. L. 92-522). The state protects threatened and endangered animals under La. Rev. Stat. 56:8 (1981), but the list of animals protected was not adopted until 1989.

The Natural Heritage Program of Louisiana's Department of Wildlife and Fisheries has compiled a list of plant and animal species of special concern (Lester 1988), many of which are considered endangered or threatened in the state but are not federally listed species. Tables 15-19, which were generated from the program's data base, list all of the species considered "endangered" in the state and include occurrences by hydrologic unit. Generalized locations of threatened and endangered animals, plants, and waterbird colonies in each hydrologic unit are shown in plate 6 of the main volume. Exact locations of the habitats for these species are available through the Natural Heritage Program at the Louisiana Department of Wildlife and Fisheries.

The Natural Heritage Program uses its own system for classifying species and lists endangered species with S1 and S2 rankings (table 20). Those species considered "threatened" were taken from S3 rankings and are listed in tables 21-25.

Federally Listed Threatened and Endangered Species

Louisiana's coastal zone has occurrences of 11 federally endangered and 3 threatened species (table 26). Of the endangered species, three are reptiles (sea turtles), three are birds, and five are mammals. All but one mammal, _Felis concolor coryi_, which is now probably extinct, are cetaceans. Of the threatened species, two are reptiles (sea turtles) and one is a bird (see plate 6 in main volume).

Reptiles

All five species of sea turtles occur in both the chenier plain and the deltaic plain (table 19). Because stranding records for these endangered animals are so numerous (as compared to data on other endangered species), the Natural Heritage Program only maps nesting areas of these species on their data base.

Table 15. Endangered bird species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks).

Species	Common Name	Chenier Plain				Deltaic Plain						
		SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Ajaia ajaja	roseate spoonbill		x	x	x		x					
Charadrius alexandrinus[1]	snowy plover	x		x								
Charadrius melodus[2]	piping plover	x	x	x			x	x			x	
Columbina passerina	common ground-dove (nesting)	x			x							
Egretta rufescens[3]	reddish egret						x	x	x		x	
Grus canadensis	sandhill crane		x								x	
Haematopus palliatus	American oystercatcher										x	
Pandion haliaetus	osprey (nesting)							x				
Pelecanus occidentalis[4]	brown pelican						x	x			x	
Picoides borealis[4]	red-cockaded woodpecker										x	
Polyborus plancus	crested Caracara		x									
Sterna nilotica	gull-billed tern				x					x	x	
Sterna antillarum	least tern				x		x	x				

[1]Candidate for federal listing but taxa more abundant than previously thought so listing not warranted.
[2]Federally listed threatened/endangered
[3]Federal listing probably warranted, data inconclusive
[4]Federally endangered

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to ccur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataia
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 16. Endangered mammal species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks).

Species	Common Name	Chenier Plain				Deltaic Plain						
		SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Balaenoptera borealis[1]	sei whale								x			
Balaenoptera physalus[1]	finback whale	x					x	x	x			
Eptesicus fuscus	big brown bat										x	
Felis concolor (coryi)[1]	Florida panther		x									
Mustela frenata	long-tailed weasel									x		
Physeter macrocephalus[1]	sperm whale	x								x		
Spilogale putorius	eastern spotted skunk		x							x		
Trichechus manatus[1]	western Indian manatee		x			x			x	x	x	
Urus americanus luteolus[2]	Louisiana black bear				x							

[1]Federally listed as endangered
[2]Candidate for federal listing but data inconclusive but listing probably warranted

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 17. Endangered fish species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Acipenser oxyrhynchus[1]	Atlantic sturgeon										x	x
Fundulus jenkinsi	saltmarsh topminnow									x		
Scaphirhynchus albus[2]	pallid sturgeon									x		

[1]Candidate for federal listing but data inconclusive but listing probably warranted
[2]Candidate for federal listing where data warrants listing

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 18. Endangered amphibian species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Amphiuma means	two-toed amphiuma											x

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 19. **Endangered reptile species of coastal Louisiana (Louisiana Natural Heritage Program S1 and S2 ranks).**

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Caretta caretta[1]	loggerhead sea turtle	x	x	x	x	x	x	x	x	x	x	x
Chelonia mydas[1]	green sea turtle		x		x		x	x	x			x
Dermochelys coriacea[2]	leatherback sea turtle		x		x		x	x	x	x		
Eretromechelys imbricata[2]	hawksbill sea turtle		x					x				
Farancia erytrogramma	rainbow snake											x
Lepidochelys kempi[2]	Kemp's ridley sea turtle	x	x	x	x	x	x	x	x	x	x	x
Malaclemys terrapin pileata	Mississississippi diamondback terrapin		x	x	x		x	x	x	x	x	
Rhadinaea flavilata	pine woods snake										x	
Terrapene ornata	ornate box turtle		x									

[1]Federally threatened
[2]Federally endangered

Source: Louisiana Natural Heritage Program (1989).
D. Fuller (1989).
D. Fuller et al. (1987).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 20. Louisiana Natural Heritage Program ranking for threatened and endangered species.

S1 -	Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state. Equivalent to federal endangered status.
S2 -	Imperiled in the state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state. Equivalent to federal endangered status.
S3 -	Rare or uncommon in the state (on order of 21 to 100 occurrences). Equivalent to federal threatened status.

Table 21. Threatened plant species of coastal Louisiana (Louisiana Natural Heritage Program S3 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Astragalus nuttallianus	a milk-vetch	x	x	x								
Avicennia germinans	black mangrove						x	x	x	x	x	
Canna flaccida	golden canna	x		x				x		x		
Chamaelirium luteum	fairy wand										x	
Coelorachis tessellata	lattion joint grass										x	
Dalea emarginata	wedge-leaf prairie-clover	x	x									
Ilex cassine	dahoon holly						x		x			x
Machaeranthera phyllocephala	camphor daisy	x	x	x	x							
Mimulus ringens	square stemmed monkey-flower					x					x	
Nymphea elegans	blue water lily			x								
Psoralea rhombifolia	roundleaf scarf-pea	x	x	x								
Ratibida peduncularis	mexican hat	x	x									
Thalia dealbata	powdery thalia				x							
Utricularia purpurea	purple bladderwort			x							x	

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 22. Threatened bird species of coastal Louisiana (Louisiana Natural Heritage Program S3 ranks).

Species	Common Name	Chenier Plain				Deltaic Plain						
		SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Crotophaga sulcirostris	groove-billed Ani									x		
Haliaeetus leucocephalus[1]	bald eagle				x	x	x	x		x	x	x

[1]Federally endangered

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 23. Threatened mammal species of coastal Louisiana (Louisiana Natural Heritage Program S3 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Balaenoptera acutorostrata	little piked (minke) whale	x			x							
Globicephala macrorhynchus	short finned pilot whale			x		x		x				
Kogia simus	dwarf sperm whale				x							
Stenella coeruleoalba	striped dolphin	x							x			
Stenella clymene	short snouted spinner dolphin				x							
Stenella plagiodon	Atlantic spotted dolphin	x							x			
Ziphus cavirostris	goose-beaked whale										x	

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 24. Threatened amphibian species coastal of Louisiana (Louisiana Natural Heritage Program S3 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Eurycea cirrigera	southern two-lined salamander										x	

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 25. Threatened reptile species of coastal Louisiana (Louisiana Natural Heritage Program S3 ranks).

		Chenier Plain				Deltaic Plain						
Species	Common Name	SA	CA	ME	VT	AT	TE	BA	BS	MS	PN	PR
Macroclemys temminckii[1]	alligator snapping turtle										x	x
Ophisaurus ventralis	eastern glass lizard										x	

[1]Candiate for federal listing-data inconclusive but listing possibly warranted

Source: Louisiana Natural Heritage Program (1989).

x - Species has been reported to occur in this basin.
SA - Sabine
CA - Calcasieu
ME - Mermentau
VT - Vermilion-Teche
AT - Atchafalaya
TE - Terrebonne
BA - Barataria
BS - Breton Sound
MS - Mississippi River
PN - Pontchartrain
PR - Pearl River

Table 26. Louisiana wildlife federally listed as threatened or endangered.

Species	Common name	Status
Reptiles		
Caretta caretta	loggerhead sea turtle	T
Chelonia mydas	green sea turtle	T
Dermochelys coriacea	leatherback sea turtle	E
Eretmochelys imbricata	hawksbill sea turtle	E
Lepidochelys kempii	Kemp's ridley sea turtle	E
Birds		
Charadrius melodus	piping plover	T/E
Haliaeetus leucocephalus	bald eagle	E
Pelecanus occidentalis	brown pelican	E
Picoides borealis	red-cockaded woodpecker	E
Mammals		
Balaenoptera physalus	finback whale	E
Balaenoptera borealis	sei whale	E
Felis concolor coryi	Florida panther	E
Physeter macrocephalus	sperm whale	E
Trichechus manatus	West Indian manatee	E

T = threatened
E = endangered

Records of sightings were obtained through Fuller et al. (1987) and Fuller (1989). The loggerhead (Caretta caretta) and Kemp's ridley (Lepidochelys kempi) are the most common sea turtles found in Louisiana, and they have been recorded in all 11 hydrologic basins. All Louisiana reports of sea turtles have been nearshore and offshore sitings or beach strandings. Historically, sea turtles have nested along the Louisiana coast, but no documentation of nesting had been verified in the last 10-15 years until the summer of 1989, when verified nesting of loggerheads was documented on the Chandeleur Islands by the National Marine Fisheries Service (Fuller 1989).

Although less commonly observed in Louisiana, both the leatherback (Dermochelys coriacea) and the green turtles (Chelonia mydas) occur in six basins (table 19). The hawksbill turtle (Eretromechelys imbricata) is the rarest in the state and occurs in only two basins (Calcasieu and Barataria).

Birds

Four federally endangered birds occur in the coastal zone (table 22). Two of these are the bald eagle (Haliaeetus leucocephalus) and the piping plover (Charadrius melodus), which are found in both the chenier plain and the deltaic plain (tables 15, 22). The brown pelican (Pelecanus occidentalis) and the red-cockaded woodpecker (Picoides borealis) are found only in the deltaic plain.

The bald eagle, which is federally listed as endangered, is fairly common in Louisiana and is therefore considered only threatened in the state. It occurs and nests in 7 of the 11 hydrologic basins (Vermilion-Teche, Atchafalaya, Terrebonne, Barataria, Mississippi, Ponchartrain, and Pearl). Nesting sites are well documented by the Natural Heritage Program, but because this is a federally protected species, the locations of these nests are not made public; researchers may obtain the information through the Natural Heritage Program.

The brown pelican is found in nesting colonies only in the Terrebonne, Barataria, and Ponchartrain basins. It is found throughout the coastal zone during non-breeding seasons. The piping plover is found in six basins (Sabine, Calcasieu, Mermentau, Terrebonne, Barataria, and Ponchartrain) and the red-cockaded woodpecker is found only in the Ponchartrain Basin.

Mammals

Five federally listed mammals occur in Louisiana's coastal zone (table 23). Three are whales: the finback (Balaenoptera physalus), sei (B. borealis), and sperm whale (Physeter macrocephalus); the fourth is the West Indian manatee (Trichecus manatus); the fifth is the Florida panther (Felis concolor coryi).

Whales are usually sighted offshore, but the Natural Heritage Program has documented sightings within 9 of the 11 hydrologic basins. Two of the whales, the finback and the sperm, are found both in the chenier plain and the deltaic plain (table 16). The finback is found in four basins (Sabine, Terrebonne, Barataria, and Breton Sound) and the sperm whale is found in two (Sabine and Mississippi).

The manatee has been found in both the chenier plain and the deltaic plain. While it has occurred in six basins (Calcasieu, Atchafalaya, Breton Sound, Mississippi, and Ponchartrain North) its presence in the state is considered accidental because Louisiana is on the westernmost boundary of its range. These sightings are usually solitary males who appear to be lost and seldom stay long (Martin 1989).

The sei whale is found only in the deltaic plain in Breton Sound basin, and the Florida panther, according to historical records, is found only in the chenier plain in Calcasieu basin.

State Threatened and Endangered Species

Data from the Natural Heritage Program data base indicate that 97 plant and animal species considered threatened or endangered occur in Louisiana's coastal zone. Fifty of those are plants and the remaining 47 are animals. Fifteen are birds, 11 are reptiles, 2 are amphibians, 3 are fish, and 16 are mammals. There are 45 eagles' nests and 154 waterbird colonies across the coastal zone. Tables 14-19 and 21-25 list all of the endangered and threatened species present in Louisiana's coastal zone, by hydrologic basin. Plate 6 of the main volume gives the locations of threatened and endangered species and waterbird colonies in Louisiana.

Chenier Plain

The chenier plain has a total of 55 threatened and endangered plants and animals. Twenty-seven are plants (18 endangered and 9 threatened) and 28 (21 endangered and 7 threatened) are animals, including birds, reptiles, and mammals.

Eighteen endangered plants and eight threatened plants are specific to the chenier plain. Three birds, the snowy plover (Charadrius alexandrinus), common ground dove (Columbia passerina), and the crested caracara (Polyborus plancus) are specific to the chenier plain. One of these birds, the snowy plover, is a candidate for federal listing. Only one eagles' nest and 24 (15%) of the waterbird colonies occur in specific to the chenier plain. Mammals specific to the chenier plain are the Florida panther (Felis concolor coryi) and the Louisiana black bear (Urus americanus). One reptile, the ornate box turtle (Terrapene ornata), occurs only in the chenier plain. There are no threatened or endangered fish or amphibians in the chenier plain.

Sabine Basin

Twenty-four threatened and endangered species (14 plants and 10 animals) occur in the Sabine basin. Eight plants are endangered and six are threatened. One plant, narrow-leaved puccoon (Lithospermum incisum), occurs only in Sabine basin within the coastal zone. Of the 10 animals, 3 are birds, 2 are reptiles, and 5 are mammals; none is specific to this basin. There are no eagles' nests and only one waterbird colony in Sabine Basin.

Calcasieu Basin

Twenty-four threatened and endangered species (10 plants and 14 animals) occur in Calcasieu basin; five plants are endangered and five are threatened. Of the 14 animals, 4 are birds, 7 are reptiles, and 3 are mammals. One bird, the crested caracara (Polyborus plancus), one reptile, the ornate box turtle

(Terrapene ornata), and one mammal, the Florida panther (Felis concolor coryi), occur only in this basin. There are no eagles' nests and only five waterbird colonies in Calcasieu Basin.

Mermentau Basin

Eighteen threatened and endangered species (11 plants and 7 animals) occur in Mermentau basin. Five plants are endangered and six are threatened. The ground plum (Astragalus crassicarpus), the blue water lily (Nymphea elegans), and purple bladderwort (Utricularia purpurea) occur only in Mermentau basin. Of the seven animals, three are birds, three are reptiles, and one is a mammal. None of these species is specific to this basin. There are no eagles' nests and nine waterbird colonies in Mermentau basin.

Vermilion-Teche Basin

Twenty-seven threatened and endangered species (13 plants and 14 animals) occur in the Vermilion-Teche basin. Eleven plants are endangered and two are threatened. Eight of the endangered plants and one of the threatened plants are specific to this basin. Three mammals, the Louisiana black bear (Urus americanus), the dwarf sperm whale (Kogia simus), and the short-snouted spinner dolphin (Stenella clymene), occur only in this basin. There are nine waterbird colonies and one eagles' nest in Vermilion-Teche basin.

Deltaic Plain

A total of 62 threatened and endangered species occurs in the deltaic plain. Twenty-four are plants (18 endangered and 6 threatened) and 38 are animals (29 endangered and 18 threatened), which include birds, reptiles, amphibians, fish, and mammals. All but one (44) of the eagles' nests occurring in the coastal zone and 85% (130) of the waterbird colonies lie in the deltaic plain.

Sixteen endangered and five threatened plants are specific to the deltaic plain. Five endangered and one threatened bird occur only in the deltaic plain. Three mammals, the sei whale (Balaenoptera borealis), the big brown bat (Eptesicus fuscus), and the long tailed weasel (Mustela frenata), and three fish, the Atlantic sturgeon (Acipenser oxyrhynehus), saltmarsh topminnow (Fundulus jenkinsi), and pallid sturgeon (Scaphirhynchus albus), are specific to the deltaic plain. The two threatened and endangered amphibians occur only in the deltaic plain and four reptiles, the rainbow snake (Farancia erytrogramma), pine woods snake (Rhadinaea flavilata), alligator snapping turtle (Macroclemys temminckii), and the eastern glass lizard (Ophisaurus ventralis), are specific to this physiographic unit.

Atchafalaya Basin

The Atchafalaya basin contains the fewest threatened and endangered species of all the hydrologic basins of this study, with seven endangered and threatened species (two plants and five animals) occurring there. One plant is endangered and one is threatened. Of the five animals, one is a bird, two are reptiles, and two are mammals. None of the plants or animals is specific to this basin. There are five waterbird colonies and one eagles' nest in the Atchafalaya basin.

Terrebonne Basin

Eighteen threatened and endangered species (6 plants and 12 animals) occur in the Terrebonne basin. Four plants are endangered and two are threatened. One plant, scaevola (Scaevola plumieri), occurs only in this basin. Of the animals, six are birds, five are reptiles, and one is a mammal. None of the animals is specific to this basin. Terrebonne Basin has the highest concentration (22) of eagles' nests of all the basins and also contains 26 waterbird colonies.

Barataria Basin

Twenty-three threatened and endangered species (9 plants and 13 animals) occur in Barataria basin. Seven plants are endangered and two are threatened. Two plants, western umbrella grass (Fuirena simplex), and gull bluestem (Schizachyrium maritimum), occur only in this basin. Of the animals, six are birds, six are reptiles, and two are mammals. The osprey (Pandion haliaetus) is specific to this basin. There are 10 eagles' nests and 33 waterbird colonies in Barataria basin.

Breton Sound Basin

Fourteen threatened and endangered species (3 plants and 11 animals) occur in Breton Sound basin. One plant is endangered and two are threatened. None of the plants is specific to this basin. Of the animals, one is a bird, five are reptiles, and five are mammals. Only one mammal, the sei whale (Balaenoptera borealis) occurs only in this basin. There are no eagles' nests; there are 19 waterbird colonies in Breton Sound basin.

Mississippi River Basin

Sixteen threatened and endangered species (3 plants and 13 animals) occur in the Mississippi basin. One plant is endangered and two are threatened. One plant, Correll's false dragon-head (Physostegia correllii), is specific to this basin. Of the animals, three are birds, four are reptiles, two are fish, and four are mammals. One bird, the groove billed ani (Crotophaga sulcirostris), one mammal, the long-tailed weasel (Mustela frenata), and two fish, the saltmarsh topminnow (Fundulus jenkinsi) and the pallid sturgeon (Scaphirynchus albus), are specific to this basin. There are eight waterbird colonies and one eagles' nest in the Mississippi River basin.

Pontchartrain Basin

The Pontchartrain basin contains more threatened and endangered species (32) than any other single hydrologic unit. Thirteen of these species are plants and 19 are animals. Nine plants are endangered and four are threatened. Eight plants are unique to this basin. Of the animals present, eight are birds, six are reptiles, one is an amphibian, one is a fish, and three are mammals. Two birds, the American oystercatcher (Haematopus palliatus) and the red-cockaded woodpecker (Picoides borealis); two mammals, the goose-beaked whale (Ziphus cavirostris) and the big brown bat (Eptesicus fuscus); two reptiles, the eastern glass lizard (Ophisaurus ventralis) and the pinewoods snake (Rhadinaea flavilata); and one amphibian, the southern two-lined salamander (Eurycea cirrigera), occurs only in this basin. There are nine eagles' nests and 38 waterbird colonies in the Pontchartrain basin.

Pearl River Basin

Thirteen threatened and endangered species (5 plants and 8 animals) occur in the Pearl River basin. Four plants are endangered and one is threatened. Five plants, the common water willow (Justicia americana), flat-topped odontonchia, (Odontoncyhia corymbosa), pineland scaly pink (Stipulicidia setacea), the fairy wand (Chamaelirium luteum), and lattion joint grass (Coelorachis tessellata) are specific to this basin in the coastal zone. Of the animals present, one is a bird, five are reptiles, one is an amphibian, and one is a fish. One amphibian, the two-toed amphiuma (Amphiuma means) and one reptile, the rainbow snake (Farancia erytrogramma), occur only in this basin. There is one eagles' nest and also one waterbird colony in the Pearl River basin.

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