LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Summary and Complete Text of the CWPPRA

Exhibit 1

COASTAL WETLANDS PLANNING, PROTECTION, & RESTORATION ACT
(Public Law 101-646, Title III)

SECTION 303. Priority Louisiana Coastal Wetlands Restoration Projects.

- Section 303a. Priority Project List.
  - NLT 13 Jan 91, Sec. of the Army (Secretary) will convene a Task Force.
    - •Secretary
    - •Administrator, EPA
    - •Governor, Louisiana
    - •Secretary, Interior
    - •Secretary, Agriculture
    - •Secretary, Commerce
  - NLT 28 Nov 91, Task Force will prepare and transmit to Congress a Priority List of wetland restoration projects based on cost effectiveness and wetland quality.
  - Priority List is revised and submitted annually as part of President's budget.
- Section 303b. Federal and State Project Planning.
  - NLT 28 Nov 93, Task Force will prepare a comprehensive coastal wetlands Restoration Plan for Louisiana.
  - Restoration Plan will consist of a list of wetland projects, ranked by cost effectiveness and wetland quality.
  - Completed Restoration Plan will become Priority List.
  - Secretary will ensure that navigation and flood control projects are consistent with the purpose of the Restoration Plan.
  - Upon submission of the Restoration Plan to Congress, the Task Force will conduct a scientific evaluation of the completed wetland restoration projects every 3 years and report the findings to Congress.

SECTION 304. Louisiana Coastal Wetlands Conservation Planning.

- Secretary; Administrator, EPA; and Director, USFWS will:
  - Sign an agreement with the Governor specifying how Louisiana will develop and implement the Conservation Plan.
  - Approve the Conservation Plan.
  - Provide Congress with periodic status reports on Plan implementation.
- NLT 3 years after agreement is signed, Louisiana will develop a Wetland Conservation Plan to achieve no net loss of wetlands resulting from development.

SECTION 305. National Coastal Wetlands Conservation Grants.

- Director, USFWS, will make matching grants to any coastal state to implement Wetland Conservation Projects (projects to acquire, restore, manage, and enhance real property interest in coastal lands and waters).
- Cost sharing is 50% Federal / 50% State *

SECTION 306. Distribution of Appropriations.

- 70% of annual appropriations not to exceed (NTE) $70 million used as follows:
  - NTE $5 million annually to fund Task Force preparation of Priority List and Restoration Plan -- Secretary disburses funds.
  - NTE $10 million to fund 75% of Louisiana's cost to complete Conservation Plan -- Administrator disburses funds.
  - Balance to fund wetland restoration projects at 75% Federal/ 25% Louisiana ** -- Secretary disburses funds.
- 15% of annual appropriations, NTE $15 million for Wetland Conservation Grants - Director, USFWS disburses funds.
- 15% of annual appropriations, NTE $15 million for projects authorized by the North American Wetlands Conservation Act - Secretary, Interior disburses funds.

SECTION 307. Additional Authority for the Corps of Engineers.

- Section 307a. Secretary authorized to:
  - Carry out projects to protect, restore, and enhance wetlands and aquatic/coastal ecosystems.
- Section 307b. Secretary authorized and directed to study feasibility of modifying the MR&T to increase flows and sediment to the Atchafalaya River for land building and wetland nourishment.

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* 25% if the state has dedicated trust fund from which principal is not spent.

** 15% when Louisiana's Conservation Plan is approved.

activities, where appropriate, that would contribute to the restoration or improvement of one or more fish stocks of the Great Lakes Basin; and

"(2) activities undertaken to accomplish the goals stated in section 2006.

16 USC 941g.

"SEC. 2009. AUTHORIZATION OF APPROPRIATIONS.

"(a) There are authorized to be appropriated to the Director—

"(1) for conducting a study under section 2005 not more than $4,000,000 for each of fiscal years 1991 through 1994;

"(2) to establish and operate the Great Lakes Coordination Office under section 2008(a) and Upper Great Lakes Fishery Resources Offices under section 2008(c), not more than $4,000,000 for each of fiscal years 1991 through 1995; and

"(3) to establish and operate the Lower Great Lakes Fishery Resources Offices under section 2008(b), not more than $2,000,000 for each of fiscal years 1991 through 1995.

"(b) There are authorized to be appropriated to the Secretary to carry out this Act, not more than $1,500,000 for each of fiscal years 1991 through 1995.".

TITLE III—WETLANDS

Coastal Wetlands Planning, Protection and Restoration Act. 16 USC 3951 note.

SEC. 301. SHORT TITLE.

This title may be cited as the "Coastal Wetlands Planning, Protection and Restoration Act".

16 USC 3951.

SEC. 302. DEFINITIONS.

As used in this title, the term—

(1) "Secretary" means the Secretary of the Army;

(2) "Administrator" means the Administrator of the Environmental Protection Agency;

(3) "development activities" means any activity, including the discharge of dredged or fill material, which results directly in a more than de minimus change in the hydrologic regime, bottom contour, or the type, distribution or diversity of hydrophytic vegetation, or which impairs the flow, reach, or circulation of surface water within wetlands or other waters;

(4) "State" means the State of Louisiana;

(5) "coastal State" means a State of the United States in, or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes; for the purposes of this title, the term also includes Puerto Rico, the Virgin Islands, Guam, the Commonwealth of the Northern Mariana Islands, and the Trust Territories of the Pacific Islands, and American Samoa;

(6) "coastal wetlands restoration project" means any technically feasible activity to create, restore, protect, or enhance coastal wetlands through sediment and freshwater diversion, water management, or other measures that the Task Force finds will significantly contribute to the long-term restoration or protection of the physical, chemical and biological integrity of coastal wetlands in the State of Louisiana, and includes any such activity authorized under this title or under any other provision of law, including, but not limited to, new projects, completion or expansion of existing or on-going projects, individ-

ual phases, portions, or components of projects and operation, maintanence and rehabilitation of completed projects; the primary purpose of a "coastal wetlands restoration project" shall not be to provide navigation, irrigation or flood control benefits;

(7) "coastal wetlands conservation project" means—

(A) the obtaining of a real property interest in coastal lands or waters, if the obtaining of such interest is subject to terms and conditions that will ensure that the real property will be administered for the long-term conservation of such lands and waters and the hydrology, water quality and fish and wildlife dependent thereon; and

(B) the restoration, management, or enhancement of coastal wetlands ecosystems if such restoration, management, or enhancement is conducted on coastal lands and waters that are administered for the long-term conservation of such lands and waters and the hydrology, water quality and fish and wildlife dependent thereon;

(8) "Governor" means the Governor of Louisiana;

(9) "Task Force" means the Louisiana Coastal Wetlands Conservation and Restoration Task Force which shall consist of the Secretary, who shall serve as chairman, the Administrator, the Governor, the Secretary of the Interior, the Secretary of Agriculture and the Secretary of Commerce; and

(10) "Director" means the Director of the United States Fish and Wildlife Service.

SEC. 303. PRIORITY LOUISIANA COASTAL WETLANDS RESTORATION PROJECTS. 16 USC 3952.

(a) PRIORITY PROJECT LIST.—

(1) PREPARATION OF LIST.—Within forty-five days after the date of enactment of this title, the Secretary shall convene the Task Force to initiate a process to identify and prepare a list of coastal wetlands restoration projects in Louisiana to provide for the long-term conservation of such wetlands and dependent fish and wildlife populations in order of priority, based on the cost-effectiveness of such projects in creating, restoring, protecting, or enhancing coastal wetlands, taking into account the quality of such coastal wetlands, with due allowance for small-scale projects necessary to demonstrate the use of new techniques or materials for coastal wetlands restoration.

(2) TASK FORCE PROCEDURES.—The Secretary shall convene meetings of the Task Force as appropriate to ensure that the list is produced and transmitted annually to the Congress as required by this subsection. If necessary to ensure transmittal of the list on a timely basis, the Task Force shall produce the list by a majority vote of those Task Force members who are present and voting; except that no coastal wetlands restoration project shall be placed on the list without the concurrence of the lead Task Force member that the project is cost effective and sound from an engineering perspective. Those projects which potentially impact navigation or flood control on the lower Mississippi River System shall be constructed consistent with section 304 of this Act.

(3) TRANSMITTAL OF LIST.—No later than one year after the date of enactment of this title, the Secretary shall transmit to the Congress the list of priority coastal wetlands restoration projects required by paragraph (1) of this subsection. Thereafter,

Reports.

the list shall be updated annually by the Task Force members and transmitted by the Secretary to the Congress as part of the President's annual budget submission. Annual transmittals of the list to the Congress shall include a status report on each project and a statement from the Secretary of the Treasury indicating the amounts available for expenditure to carry out this title.

(4) LIST OF CONTENTS.—

(A) AREA IDENTIFICATION; PROJECT DESCRIPTION.—The list of priority coastal wetlands restoration projects shall include, but not be limited to—

(i) identification, by map or other means, of the coastal area to be covered by the coastal wetlands restoration project; and

(ii) a detailed description of each proposed coastal wetlands restoration project including a justification for including such project on the list, the proposed activities to be carried out pursuant to each coastal wetlands restoration project, the benefits to be realized by such project, the identification of the lead Task Force member to undertake each proposed coastal wetlands restoration project and the responsibilities of each other participating Task Force member, an estimated timetable for the completion of each coastal wetlands restoration project, and the estimated cost of each project.

(B) PRE-PLAN.—Prior to the date on which the plan required by subsection (b) of this section becomes effective, such list shall include only those coastal wetlands restoration projects that can be substantially completed during a five-year period commencing on the date the project is placed on the list.

(C) Subsequent to the date on which the plan required by subsection (b) of this section becomes effective, such list shall include only those coastal wetlands restoration projects that have been identified in such plan.

(5) FUNDING.—The Secretary shall, with the funds made available in accordance with section 306 of this title, allocate funds among the members of the Task Force based on the need for such funds and such other factors as the Task Force deems appropriate to carry out the purposes of this subsection.

(b) FEDERAL AND STATE PROJECT PLANNING.—

(1) PLAN PREPARATION.—The Task Force shall prepare a plan to identify coastal wetlands restoration projects, in order of priority, based on the cost-effectiveness of such projects in creating, restoring, protecting, or enhancing the long-term conservation of coastal wetlands, taking into account the quality of such coastal wetlands, with due allowance for small-scale projects necessary to demonstrate the use of new techniques or materials for coastal wetlands restoration. Such restoration plan shall be completed within three years from the date of enactment of this title.

(2) PURPOSE OF THE PLAN.—The purpose of the restoration plan is to develop a comprehensive approach to restore and prevent the loss of, coastal wetlands in Louisiana. Such plan shall coordinate and integrate coastal wetlands restoration

projects in a manner that will ensure the long-term conservation of the coastal wetlands of Louisiana.

(3) INTEGRATION OF EXISTING PLANS.—In developing the restoration plan, the Task Force shall seek to integrate the "Louisiana Comprehensive Coastal Wetlands Feasibility Study" conducted by the Secretary of the Army and the "Coastal Wetlands Conservation and Restoration Plan" prepared by the State of Louisiana's Wetlands Conservation and Restoration Task Force.

(4) ELEMENTS OF THE PLAN.—The restoration plan developed pursuant to this subsection shall include—

(A) identification of the entire area in the State that contains coastal wetlands;

(B) identification, by map or other means, of coastal areas in Louisiana in need of coastal wetlands restoration projects;

(C) identification of high priority coastal wetlands restoration projects in Louisiana needed to address the areas identified in subparagraph (B) and that would provide for the long-term conservation of restored wetlands and dependent fish and wildlife populations;

(D) a listing of such coastal wetlands restoration projects, in order of priority, to be submitted annually, incorporating any project identified previously in lists produced and submitted under subsection (a) of this section;

(E) a detailed description of each proposed coastal wetlands restoration project, including a justification for including such project on the list;

(F) the proposed activities to be carried out pursuant to each coastal wetlands restoration project;

(G) the benefits to be realized by each such project;

(H) an estimated timetable for completion of each coastal wetlands restoration project;

(I) an estimate of the cost of each coastal wetlands restoration project;

(J) identification of a lead Task Force member to undertake each proposed coastal wetlands restoration project listed in the plan;

(K) consultation with the public and provision for public review during development of the plan; and

(L) evaluation of the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana.

(5) PLAN MODIFICATION.—The Task Force may modify the restoration plan from time to time as necessary to carry out the purposes of this section.

(6) PLAN SUBMISSION.—Upon completion of the restoration plan, the Secretary shall submit the plan to the Congress. The restoration plan shall become effective ninety days after the date of its submission to the Congress.

(7) PLAN EVALUATION.—Not less than three years after the completion and submission of the restoration plan required by this subsection and at least every three years thereafter, the Task Force shall provide a report to the Congress containing a scientific evaluation of the effectiveness of the coastal wetlands restoration projects carried out under the plan in crea- Reports.

ting, restoring, protecting and enhancing coastal wetlands in Louisiana.

(c) COASTAL WETLANDS RESTORATION PROJECT BENEFITS.—Where such a determination is required under applicable law, the net ecological, aesthetic, and cultural benefits, together with the economic benefits, shall be deemed to exceed the costs of any coastal wetlands restoration project within the State which the Task Force finds to contribute significantly to wetlands restoration.

(d) CONSISTENCY.—(1) In implementing, maintaining, modifying, or rehabilitating navigation, flood control or irrigation projects, other than emergency actions, under other authorities, the Secretary, in consultation with the Director and the Administrator, shall ensure that such actions are consistent with the purposes of the restoration plan submitted pursuant to this section.

(2) At the request of the Governor of the State of Louisiana, the Secretary of Commerce shall approve the plan as an amendment to the State's coastal zone management program approved under section 306 of the Coastal Zone Management Act of 1972 (16 U.S.C. 1455).

(e) FUNDING OF WETLANDS RESTORATION PROJECTS.—The Secretary shall, with the funds made available in accordance with this title, allocate such funds among the members of the Task Force to carry out coastal wetlands restoration projects in accordance with the priorities set forth in the list transmitted in accordance with this section. The Secretary shall not fund a coastal wetlands restoration project unless that project is subject to such terms and conditions as necessary to ensure that wetlands restored, enhanced or managed through that project will be administered for the long-term conservation of such lands and waters and dependent fish and wildlife populations.

(f) COST-SHARING.—

(1) FEDERAL SHARE.—Amounts made available in accordance with section 306 of this title to carry out coastal wetlands restoration projects under this title shall provide 75 percent of the cost of such projects.

(2) FEDERAL SHARE UPON CONSERVATION PLAN APPROVAL.—Notwithstanding the previous paragraph, if the State develops a Coastal Wetlands Conservation Plan pursuant to this title, and such conservation plan is approved pursuant to section 304 of this title, amounts made available in accordance with section 306 of this title for any coastal wetlands restoration project under this section shall be 85 percent of the cost of the project. In the event that the Secretary, the Director, and the Administrator jointly determine that the State is not taking reasonable steps to implement and administer a conservation plan developed and approved pursuant to this title, amounts made available in accordance with section 306 of this title for any coastal wetlands restoration project shall revert to 75 percent of the cost of the project: *Provided, however,* that such reversion to the lower cost share level shall not occur until the Governor has been provided notice of, and opportunity for hearing on, any such determination by the Secretary, the Director, and Administrator, and the State has been given ninety days from such notice or hearing to take corrective action.

(3) FORM OF STATE SHARE.—The share of the cost required of the State shall be from a non-Federal source. Such State share shall consist of a cash contribution of not less than 5 percent of

the cost of the project. The balance of such State share may take the form of lands, easements, or right-of-way, or any other form of in-kind contribution determined to be appropriate by the lead Task Force member.

(4) Paragraphs (1), (2), and (3) of this subsection shall not affect the existing cost-sharing agreements for the following projects: Caernarvon Freshwater Diversion, Davis Pond Freshwater Diversion, and Bonnet Carre Freshwater Diversion.

SEC. 304. LOUISIANA COASTAL WETLANDS CONSERVATION PLANNING. 16 USC 3953

(a) DEVELOPMENT OF CONSERVATION PLAN.—

(1) AGREEMENT.—The Secretary, the Director, and the Administrator are directed to enter into an agreement with the Governor, as set forth in paragraph (2) of this subsection, upon notification of the Governor's willingness to enter into such agreement.

(2) TERMS OF AGREEMENT.—

(A) Upon receiving notification pursuant to paragraph (1) of this subsection, the Secretary, the Director, and the Administrator shall promptly enter into an agreement (hereafter in this section referred to as the "agreement") with the State under the terms set forth in subparagraph (B) of this paragraph.

(B) The agreement shall—

(i) set forth a process by which the State agrees to develop, in accordance with this section, a coastal wetlands conservation plan (hereafter in this section referred to as the "conservation plan");

(ii) designate a single agency of the State to develop the conservation plan;

(iii) assure an opportunity for participation in the development of the conservation plan, during the planning period, by the public and by Federal and State agencies;

(iv) obligate the State, not later than three years after the date of signing the agreement, unless extended by the parties thereto, to submit the conservation plan to the Secretary, the Director, and the Administrator for their approval; and

(v) upon approval of the conservation plan, obligate the State to implement the conservation plan.

(3) GRANTS AND ASSISTANCE.—Upon the date of signing the agreement—

(A) the Administrator shall, in consultation with the Director, with the funds made available in accordance with section 306 of this title, make grants during the development of the conservation plan to assist the designated State agency in developing such plan. Such grants shall not exceed 75 percent of the cost of developing the plan; and

(B) the Secretary, the Director, and the Administrator shall provide technical assistance to the State to assist it in the development of the plan.

(b) CONSERVATION PLAN GOAL.—If a conservation plan is developed pursuant to this section, it shall have a goal of achieving no net loss of wetlands in the coastal areas of Louisiana as a result of development activities initiated subsequent to approval of the plan.

exclusive of any wetlands gains achieved through implementation of the preceding section of this title.

(c) ELEMENTS OF CONSERVATION PLAN.—The conservation plan authorized by this section shall include—

(1) identification of the entire coastal area in the State that contains coastal wetlands;

(2) designation of a single State agency with the responsibility for implementing and enforcing the plan;

(3) identification of measures that the State shall take in addition to existing Federal authority to achieve a goal of no net loss of wetlands as a result of development activities, exclusive of any wetlands gains achieved through implementation of the preceding section of this title;

(4) a system that the State shall implement to account for gains and losses of coastal wetlands within coastal areas for purposes of evaluating the degree to which the goal of no net loss of wetlands as a result of development activities in such wetlands or other waters has been attained;

(5) satisfactory assurances that the State will have adequate personnel, funding, and authority to implement the plan;

(6) a program to be carried out by the State for the purpose of educating the public concerning the necessity to conserve wetlands;

(7) a program to encourage the use of technology by persons engaged in development activities that will result in negligible impact on wetlands; and

(8) a program for the review, evaluation, and identification of regulatory and nonregulatory options that will be adopted by the State to encourage and assist private owners of wetlands to continue to maintain those lands as wetlands.

(d) APPROVAL OF CONSERVATION PLAN.—

(1) IN GENERAL.—If the Governor submits a conservation plan to the Secretary, the Director, and the Administrator for their approval, the Secretary, the Director, and the Administrator shall, within one hundred and eighty days following receipt of such plan, approve or disapprove it.

(2) APPROVAL CRITERIA.—The Secretary, the Director, and the Administrator shall approve a conservation plan submitted by the Governor, if they determine that—

(A) the State has adequate authority to fully implement all provisions of such a plan;

(B) such a plan is adequate to attain the goal of no net loss of coastal wetlands as a result of development activities and complies with the other requirements of this section; and

(C) the plan was developed in accordance with terms of the agreement set forth in subsection (a) of this section.

(e) MODIFICATION OF CONSERVATION PLAN.—

(1) NONCOMPLIANCE.—If the Secretary, the Director, and the Administrator determine that a conservation plan submitted by the Governor does not comply with the requirements of subsection (d) of this section, they shall submit to the Governor a statement explaining why the plan is not in compliance and how the plan should be changed to be in compliance.

(2) RECONSIDERATION.—If the Governor submits a modified conservation plan to the Secretary, the Director, and the Administrator for their reconsideration, the Secretary, the

Director, and Administrator shall have ninety days to determine whether the modifications are sufficient to bring the plan into compliance with requirements of subsection (d) of this section.

(3) APPROVAL OF MODIFIED PLAN.—If the Secretary, the Director, and the Administrator fail to approve or disapprove the conservation plan, as modified, within the ninety-day period following the date on which it was submitted to them by the Governor, such plan, as modified, shall be deemed to be approved effective upon the expiration of such ninety-day period.

(f) AMENDMENTS TO CONSERVATION PLAN.—If the Governor amends the conservation plan approved under this section, any such amended plan shall be considered a new plan and shall be subject to the requirements of this section; except that minor changes to such plan shall not be subject to the requirements of this section.

(g) IMPLEMENTATION OF CONSERVATION PLAN.—A conservation plan approved under this section shall be implemented as provided therein.

(h) FEDERAL OVERSIGHT.—

(1) INITIAL REPORT TO CONGRESS.—Within one hundred and eighty days after entering into the agreement required under subsection (a) of this section, the Secretary, the Director, and the Administrator shall report to the Congress as to the status of a conservation plan approved under this section and the progress of the State in carrying out such a plan, including and accounting, as required under subsection (c) of this section, of the gains and losses of coastal wetlands as a result of development activities.

(2) REPORT TO CONGRESS.—Twenty-four months after the initial one hundred and eighty day period set forth in paragraph (1), and at the end of each twenty-four-month period thereafter, the Secretary, the Director, and the Administrator shall, report to the Congress on the status of the conservation plan and provide an evaluation of the effectiveness of the plan in meeting the goal of this section.

SEC. 305 NATIONAL COASTAL WETLANDS CONSERVATION GRANTS. 16 USC 3954.

(a) MATCHING GRANTS.—The Director shall, with the funds made available in accordance with the next following section of this title, make matching grants to any coastal State to carry out coastal wetlands conservation projects from funds made available for that purpose.

(b) PRIORITY.—Subject to the cost-sharing requirements of this section, the Director may grant or otherwise provide any matching moneys to any coastal State which submits a proposal substantial in character and design to carry out a coastal wetlands conservation project. In awarding such matching grants, the Director shall give priority to coastal wetlands conservation projects that are—

(1) consistent with the National Wetlands Priority Conservation Plan developed under section 301 of the Emergency Wetlands Resources Act (16 U.S.C. 3921); and

(2) in coastal States that have established dedicated funding for programs to acquire coastal wetlands, natural areas and open spaces. In addition, priority consideration shall be given to coastal wetlands conservation projects in maritime forests on coastal barrier islands.

(c) CONDITIONS.—The Director may only grant or otherwise provide matching moneys to a coastal State for purposes of carrying out a coastal wetlands conservation project if the grant or provision is subject to terms and conditions that will ensure that any real property interest acquired in whole or in part, or enhanced, managed, or restored with such moneys will be administered for the long-term conservation of such lands and waters and the fish and wildlife dependent thereon.

(d) COST-SHARING.—

(1) FEDERAL SHARE.—Grants to coastal States of matching moneys by the Director for any fiscal year to carry out coastal wetlands conservation projects shall be used for the payment of not to exceed 50 percent of the total costs of such projects: except that such matching moneys may be used for payment of not to exceed 75 percent of the costs of such projects if a coastal State has established a trust fund, from which the principal is not spent, for the purpose of acquiring coastal wetlands, other natural area or open spaces.

(2) FORM OF STATE SHARE.—The matching moneys required of a coastal State to carry out a coastal wetlands conservation project shall be derived from a non-Federal source.

(3) IN-KIND CONTRIBUTIONS.—In addition to cash outlays and payments, in-kind contributions of property or personnel services by non-Federal interests for activities under this section may be used for the non-Federal share of the cost of those activities.

(e) PARTIAL PAYMENTS.—

(1) The Director may from time to time make matching payments to carry out coastal wetlands conservation projects as such projects progress, but such payments, including previous payments, if any, shall not be more than the Federal pro rata share of any such project in conformity with subsection (d) of this section.

(2) The Director may enter into agreements to make matching payments on an initial portion of a coastal wetlands conservation project and to agree to make payments on the remaining Federal share of the costs of such project from subsequent moneys if and when they become available. The liability of the United States under such an agreement is contingent upon the continued availability of funds for the purpose of this section.

Texas

(f) WETLANDS ASSESSMENT.—The Director shall, with the funds made available in accordance with the next following section of this title, direct the U.S. Fish and Wildlife Service's National Wetland Inventory to update and digitize wetlands maps in the State of Texas and to conduct an assessment of the status, condition, and trends of wetlands in that State.

16 USC 1955

SEC. 306. DISTRIBUTION OF APPROPRIATIONS.

(a) PRIORITY PROJECT AND CONSERVATION PLANNING EXPENDITURES.—Of the total amount appropriated during a given fiscal year to carry out this title, 70 percent, not to exceed $70,000,000, shall be available, and shall remain available until expended, for the purposes of making expenditures—

(1) not to exceed the aggregate amount of $5,000,000 annually to assist the Task Force in the preparation of the list required under this title and the plan required under this title, including preparation of—

(A) preliminary assessments;
(B) general or site-specific inventories;
(C) reconnaissance, engineering or other studies;
(D) preliminary design work; and
(E) such other studies as may be necessary to identify and evaluate the feasibility of coastal wetland restoration projects;

(2) to carry out coastal wetlands restoration projects in accordance with the priorities set forth on the list prepared under this title;

(3) to carry out wetlands restoration projects in accordance with the priorities set forth in the restoration plan prepared under this title;

(4) to make grants not to exceed $2,500,000 annually or $10,000,000 in total, to assist the agency designated by the State in development of the Coastal Wetlands Conservation Plan pursuant to this title.

(b) COASTAL WETLANDS CONSERVATION GRANTS.—Of the total amount appropriated during a given fiscal year to carry out this title, 15 percent, not to exceed $15,000,000 shall be available, and shall remain available to the Director, for purposes of making grants—

(1) to any coastal State, except States eligible to receive funding under section 306(a), to carry out coastal wetlands conservation projects in accordance with section 305 of this title; and

(2) in the amount of $2,500,000 in total for an assessment of the status, condition, and trends of wetlands in the State of Texas.

(c) NORTH AMERICAN WETLANDS CONSERVATION.—Of the total amount appropriated during a given fiscal year to carry out this title, 15 percent, not to exceed $15,000,000, shall be available to, and shall remain available until expended by, the Secretary of the Interior for allocation to carry out wetlands conservation projects in any coastal State under section 8 of the North American Wetlands Conservation Act (Public Law 101-233, 103 Stat. 1968, December 13, 1989).

SEC. 307. GENERAL PROVISIONS.

16 USC 3956.

(a) ADDITIONAL AUTHORITY FOR THE CORPS OF ENGINEERS.—The Secretary is authorized to carry out projects for the protection, restoration, or enhancement of aquatic and associated ecosystems, including projects for the protection, restoration, or creation of wetlands and coastal ecosystems. In carrying out such projects, the Secretary shall give such projects equal consideration with projects relating to irrigation, navigation, or flood control.

Irrigation.
Navigation.
Flood control.

(b) STUDY.—The Secretary is hereby authorized and directed to study the feasibility of modifying the operation of existing navigation and flood control projects to allow for an increase in the share of the Mississippi River flows and sediment sent down the Atchafalaya River for purposes of land building and wetlands nourishment.

SEC. 308. CONFORMING AMENDMENT.

16 U.S.C. 777c is amended by adding the following after the first sentence: "The Secretary shall distribute 18 per centum of each annual appropriation made in accordance with the provisions of

section 777b of this title as provided in the Coastal Wetlands Planning, Protection and Restoration Act: *Provided*, That, notwithstanding the provisions of section 777b, such sums shall remain available to carry out such Act through fiscal year 1999.".

Great Lakes Oil Pollution Research and Development Act.

"TITLE IV—GREAT LAKES OIL POLLUTION RESEARCH AND DEVELOPMENT

33 USC 2701 note.

"SEC. 4001. SHORT TITLE.

"This title may be cited as the "Great Lakes Oil Pollution Research and Development Act".

"SEC. 4002. GREAT LAKES OIL POLLUTION RESEARCH AND DEVELOPMENT.

"Section 7001 of the Oil Pollution Act of 1990 (Public Law 101-380) is amended as follows:

Ante, p. 559.

"(1) GREAT LAKES DEMONSTRATION PROJECT.—In subsection (c)(6), strike "3" and insert "4", strike "and" after "California,", and insert "and (D) ports on the Great Lakes," after "Louisiana,".

"(2) FUNDING.—In subsection (f) strike "21,250,000" and insert "22,000,000" and in subsection (f)(2) strike "2,250,000" and insert "3,000,000".".

Approved November 29, 1990.

LEGISLATIVE HISTORY—H.R. 5390 (S. 2244):

SENATE REPORTS No 101-523 accompanying S. 2244 (Comm. on Environment and Public Works).

CONGRESSIONAL RECORD, Vol 136 (1990):
Oct. 1, considered and passed House.
Oct 26, considered and passed Senate, amended, in lieu of S. 2244.
Oct. 27 House concurred in Senate amendment.

WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 26 (1990):
Nov 29 Presidential statement.

Statement on Signing the Bill on Wetland and Coastal Inland Waters Protection and Restoration Programs
November 29, 1990

Today I am signing H.R. 5390, "An Act to prevent and control infestation of the coastal inland waters of the United States by the zebra mussel and other nonindigenous aquatic nuisance species, to reauthorize the National Sea Grant College Program, and for other purposes." This Act is designed to minimize, monitor, and control nonindigenous species that become established in the United States, particularly the zebra mussel; establish wetlands protection and restoration programs in Louisiana and nationally; and promote fish and wildlife conservation in the Great Lakes.

Title III of this Act designates a State official not subject to executive control as a member of the Louisiana Coastal Wetlands Conservation and Restoration Task Force. This official would be the only member of the Task Force whose appointment would not conform to the Appointments Clause of the Constitution.

The Task Force will set priorities for wetlands restoration and formulate Federal conservation and restoration plans. Certain of its duties, which ultimately determine funding levels for particular restoration projects, are an exercise of significant authority that must be undertaken by an officer of the United States, appointed in accordance with the Appointments Clause, Article II, sec. 2, cl. 2, of the Constitution.

In order to constitutionally enforce this program, I instruct the Task Force to promulgate its priorities list under section 303(a)(2) "by a majority vote of those Task Force members who are present and voting," and to consider the State official to be a nonvoting member of the Task Force for this purpose. Moreover, the Secretary of the Army should construe "lead Task Force member" to include only those members appointed in conformity with the Appointments Clause.

George Bush

The White House,
November 29, 1990.

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Summary of the Public Involvement Program

Exhibit 2

PUBLIC INVOLVEMENT

THE CITIZEN PARTICIPATION GROUP

The Task Force also established a Citizen Participation Group to provide general input from the diverse interests across the coastal zone: local officials, landowners, farmers, sportsmen, commercial fisherman, oil and gas developers, navigation interests, and environmental organizations. The Citizen Participation Group was formed to promote citizen participation and involvement in formulating Priority Project Lists and the restoration plan. The group meets at its own discretion, but may at times meet in conjunction with other CWPPRA elements, such as the Technical Committee. The purpose of the Citizen Participation Group is to maintain consistent public review and input into the plans and projects being considered by the Task Force and to assist and participate in the public involvement program. The membership of the Citizen Participation Group is shown in Table 1.

Table 1
Membership of the Citizen Participation Group

Gulf Coast Conservation Association	Concerned Shrimpers of America
Coalition to Restore Coastal Louisiana	Gulf Intracoastal Canal Association
Lake Pontchartrain Basin Foundation	Louisiana Association of Soil and Water Conservation Districts
Louisiana Farm Bureau Federation, Inc.	Louisiana Landowners Association
Louisiana League of Women Voters	Louisiana Nature Conservancy
Louisiana Oyster Growers and Dealers Association	Louisiana Wildlife Federation, Inc.
Midcontinent Oil and Gas Association	New Orleans Steamship Association
Oil and Gas Task Force (Regional Economic Development Council)	Police Jury Association of Louisiana
Organization of Louisiana Fishermen	

INVOLVEMENT OF THE SCIENTIFIC COMMUNITY

While the agencies sitting on the Task Force possess considerable expertise regarding Louisiana's coastal wetlands problems, the Task Force recognized the need to incorporate another invaluable resource: the state's scientific community. The Task Force therefore retained the services of a scientific advisor, who selected a team of scientists to work with the basin teams in the preparation of the 2nd Priority Project List.

In 1994, the Task Force will establish and fund a formally constituted group representing the academic community. This group will help ensure that the

evaluation, selection, and design of priority projects is based on the best scientific information available, and that the Task Force is kept apprised of newly emerging predictive tools.

INVOLVEMENT OF THE PUBLIC AT LARGE

Even with its widespread membership, the Citizen Participation Group cannot represent all of the diverse interests affected by Louisiana's coastal wetlands. The CWPPRA public involvement program provides an opportunity for all interested parties to express their concerns and opinions and to submit their ideas concerning the problems facing Louisiana's wetlands.

The first step in the program comprised two series of scoping meetings held by the Task Force in October and November 1991--one series for coastal zone parish officials and another series for the general public. The purpose of these scoping meetings was to identify wetland loss problems throughout the coastal zone and potential solutions to those problems. Literally hundreds of ideas were submitted to the Task Force through the scoping meetings. (Exhibit 3 is a compendium of those proposals.) All of the ideas presented in those meetings have been evaluated during the planning process; many of them have been incorporated into the Restoration Plan. The schedule of scoping meetings is shown in Table 2 (for the general public) and Table 3 (for parish officials).

The public involvement program has continued with a series of public meetings held each summer, since 1992, to aid in the development of the basin plans and the Priority Project List to be submitted in that year. Meetings for the 2nd PPL were held in June of 1992. At these meetings, the conceptual plans which had been developed for each basin were presented to the public, along with the candidate projects for the 2nd Priority Project List. This series of meetings provided the first opportunity for review of the conceptual plans and were held as shown in Table 4.

In 1993 meetings were held in late July through mid-August, as shown in Table 5. These meetings were held in conjunction with the state of Louisiana's Wetlands Conservation and Restoration Authority, providing an additional level for public input. The purpose of the meetings was to present the candidate projects for the 3rd Priority Project List and to accept comments and recommendations. The meetings also provided a preview of the Draft Restoration Plan, which was released for NEPA public review on July 16, 1993. The formal public hearing for the draft plan was held in New Orleans on August 11, 1993. However, comments on the Draft Restoration Plan were accepted at all the meetings.

Table 2
Public Scoping Meetings

Date	Location
October 21, 1991	Lake Charles, La.
October 22, 1991	Abbeville, La.
October 24, 1991	Houma, La.
October 28, 1991	Mandeville, La.
November 6, 1991	Belle Chasse, La.
November 7, 1991	New Orleans, La.

Table 3
Parish Scoping Meetings
(for Parish Officials)

Date	Location	Parishes
October 8, 1991	Crowley, La.	Calcasieu Parish Cameron Parish Iberia Parish Vermilion Parish
October 16, 1991	New Orleans, La.	Jefferson Parish Orleans Parish Plaquemines Parish St. Bernard Parish St. Charles Parish
October 16, 1991	New Orleans, La.	Livingston Parish St. James Parish St. John the Baptist Parish St. Tammany Parish Tangipahoa Parish
October 17, 1991	Thibodaux, La.	Ascension Parish Assumption Parish Lafourche Parish St. Martin Parish St. Mary Parish Terrebonne Parish

Table 4
Public Meetings
(2nd Priority Project List and Conceptual Basin Plan)

Date	Location	Hydrologic Basins
June 16, 1992	Morgan City	Atchafalaya, Teche/Vermilion
June 18, 1992	Belle Chasse	Barataria, Breton Sound, Mississippi River Delta
June 23, 1992	Houma	Terrebonne
June 25, 1992	Lake Charles	Mermentau, Calcasieu/Sabine
June 30, 1992	New Orleans	Pontchartrain

Table 5
Public Meetings
(3rd Priority Project List and Draft Restoration Plan)

Date	Location	Hydrologic Basins
July 27, 1993	Larose	Barataria
July 28, 1993	Belle Chasse	Breton Sound, Mississippi River Delta
July 29, 1993	New Orleans	Pontchartrain
August 9, 1993	Houma	Terrebonne
August 10, 1993	Morgan City	Atchafalaya and Teche/Vermilion
August 11, 1993	New Orleans	Formal Public Hearing on the Draft Restoration Plan and EIS
August 12, 1993	Cameron	Calcasieu/Sabine and Mermentau

DEVELOPING THE PLANS

The October-November 1991 scoping meetings were the first stage in the process identifying coastal wetlands problems and developing basin-by-basin solutions . The process continued with a series of basin plan formulation meetings, held in February through May 1992. These meetings were attended by representatives of the Task Force agencies, members of the scientific community, representatives of the Citizen Participation Group, parish officials, private consultants, and members of the general public.

These meetings were intense planning sessions, consisting of four three-day meetings with a two-day follow up for each. Each set of meetings began with a description of the geology, hydrology, and biological resources of the basins followed by projections for the future. Finally, the coastal wetlands problems and their causes were discussed in detail, and strategies were developed for dealing with those problems on a basin-by-basin basis. These strategies were molded into conceptual plans that would serve as a guide in selecting and evaluating projects both for Priority Project Lists and for the Restoration Plan.

During these meetings, many of the ideas submitted in the 1991 scoping meetings were integrated into the conceptual plans. The basin teams refined the conceptual plans over the next year to produce the comprehensive restoration plan presented in this report. The meetings followed the schedule shown in Table 6.

Table 6
Plan Formulation Meetings

Date	Location	Hydrologic Basins
February 4-6, 1992	Baton Rouge	Pontchartrain
February 12-13, 1992 (follow up)	New Orleans	
March 17-19, 1992	St. Francisville	Barataria, Breton Sound, Mississippi R. Delta
March 25-26, 1992 (follow up)	New Orleans	
April 7-9, 1992	Baton Rouge	Terrebonne, Atchafalaya, Teche/Vermilion
April 15-16, 1992 (follow up)	New Orleans	
April 28-30, 1992	Abbeville	Mermentau, Calcasieu/Sabine
May 6-7, 1992 (follow up)	New Orleans	

CONTINUING EVOLUTION OF THE PUBLIC INVOLVEMENT PROGRAM

The Task Force recognizes the need to increase the outflow of information and input from the public as it proceeds with implementation of the CWPPRA. To meet this need, the Task Force is developing a public outreach strategy. An outline of this strategy, which has not yet been approved by the Task Force, is presented below.

1. Improve dissemination of information on CWPPRA activities to the public.

   - Establish a mailing list of elected officials and participating Federal, State, and local agencies; interested citizens (people who have attended past CWPPRA pubic meetings); local, state, and national environmental organizations; libraries; and news media.
   - Publish a periodic four- or eight-page newsletter containing:
     Reports on the status of priority list projects form lead agencies
     Status of basin plans from basin captains
     Financial report (funds spent on planning vs. funds spent on projects)
     (The newsletter could be published by contract services.)

2. Publicize individual CWPPRA projects.

   - Invite media to groundbreakings and project completion ceremonies. Also hold media tours of projects under construction.
   - Prepare project maps and graphics that are usable by print and electronic media.

3. Mark annual progress.

   - Hold briefings for news media in New Orleans, Baton Rouge, Houma/Morgan City, Lafayette, and Lake Charles for news media when each year's priority project list is finalized.
   - Prepare and update annually a traveling exhibit to depict CWPPRA activities and work in progress.
   - Prepare annual briefings for higher authorities of all Task Force agencies and the congressional delegation.
   - In later years, publish a color brochure showing completed projects.

4. Hold annual public meetings on Priority Project Lists and Long-term Plan status.

   - Involve Public Affairs in early planning for public meetings to ensure effective public involvement.
   - Prepare public notices and news releases well in advance of public meetings.
   - Train all Task Force members participating in public meetings in public involvement and facilitation skills.

5. Conduct a Speakers' Bureau Program.

- Identify groups and organizations as potential audiences for CWPPRA speakers.
- Solicit and coordinate speaking engagement invitations.
- Maintain a current slide show so Task Force speakers can make presentations with minimal preparation.

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Summary and Status of the Priority Project Lists

Exhibit 3

DEVELOPMENT OF PRIORITY PROJECT LISTS

Section 303(a) of the CWPPRA directs the Task Force to submit to Congress annually a Priority Project List "of coastal wetlands restoration projects in Louisiana . . . that can be substantially completed during a five-year period commencing on the date the project is placed on the list." To date, the Task Force has submitted three such lists to Congress.

THE FIRST PRIORITY PROJECT LIST

In accordance with the CWPPRA, the first Priority Project List was due to Congress on 29 November 1991--ten months after the first meeting of the Task Force. As a consequence of this restrictive time frame, the list was composed of projects for which most of the planning had already been done by one of the Task Force agencies. Thirty-five of these "off-the-shelf" projects were considered. The Task Force selected 14 for the priority list based on the procedures outlined below.

Because the act requires a ranking of projects in order of cost-effectiveness, the Task Force established a consistent means of assessing project costs and benefits. The lead agency for each project prepared a cost estimate and submitted it to the Engineering Work Group of the Task Force. The work group reviewed the estimates for accuracy and consistency by reviewing quantity estimates and unit prices for project features. In addition, the work group reviewed the design of the projects to ensure that the method of construction was appropriate and the design was feasible.

The cost component of the cost-effectiveness criterion was based on the following procedures and assumptions:

a. Average annual costs represent the sum of direct and known indirect construction and operating costs, discounted over time.

b. Construction or first costs include engineering and design, inspection, contingencies, real estate (land, easements, rights-of-way, and relocations), and administration, as well as direct building costs.

c. Operating costs for a project include monitoring, replacement or closure, and induced dredging, as well as direct operation and maintenance costs. (However, operating costs are not counted if they are part of an existing program which is not expanded because of the project.) Operating costs extend through 20 years from the base, which is also the time when first costs are considered fully amortized. Costs (and benefits) beyond 20 years are not considered.

d. The discount rate used to account for the time value of money was $8^1/_2$ percent.

e. The funding requirements for each project were based on the current dollar value of the construction and operating costs, except that costs paid by sources other than the CWPPRA were not included. Whereas average annual costs assume no inflation over time, the calculation of funding

requirements does include an inflation adjustment of 3.5 percent to 4.7 percent per year.

Ensuring a consistent benefit evaluation was less straightforward. To this end, the Task Force adapted the U.S. Fish and Wildlife Service's Habitat Evaluation Procedure (HEP), a standard means of evaluating habitat quality to determine mitigation requirements. The Environmental Work Group modified the HEP to produce a methodology applicable strictly to wetland habitats--the Wetland Value Assessment (WVA). The Task Force used the WVA to calculate project benefits in terms of Average Annual Habitat Units (AAHU's). AAHU's provide a measure of the amount and quality of habitat which on the average would be found in a project area during the project life. When compared to the annual cost of a project, they give a means of determining the relative effectiveness of various projects in creating, protecting, restoring, or enhancing wetlands.

The stream of economic costs for each project was brought to present value and annualized at the current discount rate, based on a 20-year project life. Beneficial environmental outputs were annualized at a zero discount rate and expressed as AAHU's. These data were then used to rank each plan based on cost per AAHU produced. Where appropriate, individual plans were scaled and optimized to minimize cost per AAHU.

The lead agency for each project developed a fact sheet for that project. The fact sheet contained a description of the wetlands problems in the study area, a description of the proposed project and its purpose, a cost estimate, and a summary of the WVA analysis.

The final selection of projects for the first Priority Project List was based primarily on the criterion of cost-effectiveness, with consideration given to secondary criteria such as strong public support, addressing of critical needs, and the potential for providing new information regarding construction techniques or project impacts. The projects inculded on the first Priority Project list are summarized in Table 1.

THE 2ND PRIORITY PROJECT LIST.

The 2nd Priority Project List was submitted to Congress in November 1992. The expanded time frame allowed the Task Force to consider projects which had been proposed during the scoping meetings of October and November 1991 and the plan formulation meetings in February-May 1992. As a result of public input during these meetings, there were hundreds of potential projects available for consideration, some of which were little more than indistinct concepts.

The interagency basin teams that were established to develop the restoration plan were called upon to evaluate project proposals, flesh out those which were too sketchy but merited further work, and screen the scores of projects in each basin down to a few candidates. To give some form to the screening process, the Planning and Evaluation Subcommittee developed two tools: a Preliminary Evaluation Sheet (PES) and a Screening Information Sheet (SIS).

The PES constituted the first level of screening, and was designed to evaluate a proposal's fitness for the CWPPRA overall and the 2nd Priority Project List in particular. If the purpose of the project was not for the long-term benefit of coastal wetlands, or the project did not meet the objectives set for its particular basin at the

plan formulation meetings, the project was dropped from consideration. The PES also screened out projects which could not be constructed within the five-year time frame prescribed by the CWPPRA for priority list projects. Any project which was judged capable of meeting the timing criterion was evaluated according to whether it: possessed local support; served as a critical project in the overall restoration strategy for its basin; provided a significant opportunity to preserve, improve, or build coastal wetlands; and had regional impacts or was a small demonstration project. Projects which met at least three of these criteria were elevated to the next level of evaluation.

The SIS was used as the next step in the screening process. Each Task Force agency made a rough estimate of the cost of the projects for which it was responsible and acres to be created, protected, or enhanced. A weight was assigned to these acres according to their value. The cost per weighted acre, served as the main criterion used by each basin team to select four to six projects for further evaluation.

The Planning and Evaluation Subcommittee reviewed the recommendations of the basin teams and selected a list of 36 candidate projects for detailed evaluation. These candidate projects were presented during the June 1992 public meetings, following which some revisions were made to the candidate list in response to the views of the public. Thirty seven candidate projects were evaluated in detail in a process similar to that which was done for the first Priority Project List. Again, selection of the 2nd Priority Project List was based largely on cost-effectiveness, with due consideration given to secondary criteria such as public support. Table 2 summarizes the projects selected for the second Priority Project List.

THE 3RD PRIORITY PROJECT LIST

The 3rd Priority Project List was developed in a parallel effort to this restoration plan report. Its development followed a procedure similar to that used for the second list: screening by the basin teams using the PES and SIS, nomination of candidates by the basin teams, selection of a draft candidate list by the Planning and Evaluation Subcommittee, presentation of the draft candidate list to the public, revision of the candidate list if appropriate, detailed analysis of the candidate projects, and final selection of the list through review and evaluation of the candidates by the Technical Committee and the Task Force.

The PES constituted the first level of screening, and was designed to evaluate a proposal's fitness for the CWPPRA and a Priority Project List. If the purpose of the project was not long term protection, restoration, enhancement, or creation of coastal wetlands, or the project did not meet the objectives set for its particular basin as outlined in the Draft Restoration Plan, the project was dropped from consideration. The PES also screened out projects which could not be constructed within the five year time frame prescribed by the CWPPRA for priority list projects. In addition, because of the time constraints involved with developing the Restoration Plan and the 3rd list, projects that were not in the preliminary draft of the Restoration Plan as of February 17, 1993 or was not sufficiently developed to perform a Wetland Value Assessment by July, 1993, were not considered for the 3rd list. Any project which was judged capable of meeting the timing criterion was evaluated according to whether it: possessed local support; was a critical project in the overall restoration plan; did not present a cost over $10,000,000; provided a significant opportunity to preserve, improve, or build coastal wetlands; and had

regional impacts or was a small demonstration project. Projects which met the criteria were elevated to the next level of screening.

The SIS was again used as the next step in the screening process. Each Task Force agency made a rough estimate of the cost of the projects for which it was responsible. An estimate was also made of the acres to be created, protected, or enhanced by a project. The cost per acre was used to compare projects, serving as the main criterion each basin team used to select approximately four projects in each basin for further evaluation. The basin teams were responsible for doing preliminary evaluations of all projects submitted and making a recommendation to the Planning and Evaluation Subcommittee for candidate projects to be considered for the 3rd Priority Project List.

The Planning and Evaluation Subcommittee met on May 11, 1993, to hear the recommendations of the basin teams and develop the list of candidate projects for the 3rd Priority Project List. Each basin captain presented the results of his or her team's screening, recommending four projects (in most cases) for inclusion on the candidate list. The subcommittee decided to evaluate demonstration projects separately. Each agency was directed to develop fact sheets on their proposed demonstration projects and submit them for consideration at a later date.

The Planning and Evaluation Subcommittee met again on July 13, 1993, to evaluate the proposed demonstration projects. Each agency presented its projects to the subcommittee, outlining the critical project information, including what information would be learned by performing the demonstration and the need for such a project. A total of 12 projects were presented, but because of the time constraints in evaluating projects and a previous Task Force decision to limit spending on demonstration projects to approximately $2,000,000 per priority list, the subcommittee limited the number of projects to 5. Each agency ranked the projects, assigning a value of 5 to the most favored project and 1 to the least preferred. The subcommittee then put together a combined list of 41 candidate projects to be evaluated for the third list. These candidates were presented in the public meetings which took place in July and August of 1993.

On October 1, 1993 the Task Force met and selected the third Priority Project List. The list included 19 projects with 3 demonstration projects and 2 deferred projects. Table 3 summarizes these projects.

FUTURE PRIORITY PROJECT LISTS

The CWPPRA calls for two additional lists. Those lists and future lists that may result from a reauthorization of the CWPPRA will be drawn directly from--or, as a minimum, guided by--the Restoration Plan. The implementation section of the main report details the future use of the priority project procedure for the execution of the restoration plan. The priority list process will be a key tool for the phase one-short term implementation of the plan.

The Restoration Plan has already established its value in that regard. During development of the second priority list, the Task Force used basin conceptual plans as an important screening criterion for projects being considered for the list.

PROJECT IMPLEMENTATION

The 1st, 2nd and 3rd Priority Project Lists consist of 48 projects with an estimated fully funded cost of $123,280,000. The 48 projects encompass over 421,100 acres of

coastal wetlands in Louisiana. If protective measures were not taken, some 41,780 acres of these wetlands would have been lost over the next 20 years. More significantly, it is estimated that these 29 projects will turn this anticipated loss into a net gain of approximately 13,800 acres.

On April 17, 1993, the lead Task Force agencies signed cost sharing agreements with the Louisiana Department of Natural Resources for 11 priority list projects: BA-2 (GIWW to Clovelly) Unit 1, Vegetative Planting (West Hackberry and Dewitt-Rollover), Cameron-Creole Watershed Hydrologic Restoration, Bayou Sauvage Refuge, Cameron Prairie Refuge Shoreline Erosion Control, Sabine Wildlife Refuge Shoreline Erosion Control, Lower Bayou La Cache, Bayou La Branche Marsh Creation, Vermilion River Cutoff, and Isles Dernieres Barrier Island Restoration (Demonstration and Phase I). These cost share agreements will serve as models for future agreements between the State and the Federal Government, facilitating the implementation of additional projects.

Four projects have been given approval by the Task Force to proceed to construction: BA-2 (GIWW to Clovelly) Unit 1, Vegetative Planting (West Hackberry and Dewitt-Rollover), Cameron-Creole Watershed Hydrologic Restoration, and Cameron Prairie Refuge Shoreline Erosion Control. It is anticipated that construction will begin on these projects by the summer of 1993. The remaining projects are expected to be constructed within the five year limitation set forth in the CWPPRA.

As of November 28, 1993 contracts have been awarded for two CWPPRA projects. The first contract to be awarded was the West Hackberry Vegetative Planting project. The USDA, Soil Conservation Service is the lead agency for this project and work is expected to begin in December 1993. The second contract was awarded for the LaBranche Wetland Creation project sponsored by the U. S. Army Corps of Engineers. Construction is scheduled to begin in January 1994.

Table 1

Coastal Wetlands Planning, Protection and Restoration Act

1st Priority Project List

Project No.	Project	Basin	Lead Agency	Average Annual Acres	Affected Area (Acres)	Acres Created, Protected, and Restored	Area Loss w/o Project (Acres)	Avg Annual Cost/AAHU ($/AAHU)	Fully Funded Cost ($)[1]
XBA-68	Fourchon	Barataria	NMFS	146	2,020	160	100	21	252,000
BA-2	(GIWW to Clovelly)	Barataria	SCS	3,102	60,000	8,629	8,946	68	8,142,000
FCS-17	Cameron Creole Watershed	Calc/Sabine	USFWS	440	10,500	600	0	128	660,000
XPO-52a	Bayou Sauvage Refuge	Pontchartrain	USFWS	1,313	3,800	1,550	475	180	1,658,000
FCS-18	Sabine Refuge	Calc/Sabine	USFWS	2,207	13,000	5,542	7,008	253	4,895,000
TE-18, TE-17, FCS-19, ME-8	Vegetative Plantings (Demo)	Ter,Mer, C/S	SCS	385	2,575	633	752	282	922,000
FMR-3	West Bay Sediment Diversion	Miss Delta	USACE	5,329	12,910	9,831	0	305	8,517,000
BA-19	Barataria Bay Waterway	Barataria	USACE	219	510	445	0	449	1,759,000
TE-19	Lower Bayou La Cache	Terrebonne	NMFS	45	4,200	86	244	837	1,695,000
PPO-10	Bayou La Branche	Pontchartrain	USACE	205	487	203	0	2,369	4,461,000
ME-9	Cameron Prairie Refuge	Mermentau	USFWS	131	640	247	250	3,171	1,178,000
FTV-3	Vermilion River Cutoff	Teche/Verm	USACE	37	202	65	51	6,196	1,526,000
TE-20	Isle Dernieres (Demo)	Terrebonne	EPA	61	449	9	117	13,949	6,345,000
	Total			13,620	111,293	28,000	17,943		42,010,000

[1] Fully funded costs from the 1st priority list have been adjusted to include monitoring costs.

EPA Environmental Protection Agency
NMFS National Marine Fisheries Service
SCS Soil Conservation Service
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service
AAHU Average Annual Habitat Unit

Table 2

Coastal Wetlands Planning, Protection and Restoration Act

2nd Priority Project List

Project No.	Project	Basin	Lead Agency	Average Annual Acres	Affected Area (Acres)	Acres Created, Protected, and Restored	Area Loss w/o Project (Acres)	Avg Annual Cost/AAHU ($/AAHU)	Fully Funded Cost ($)
PAT-2	Atchafalaya Sediment Del	Atchafalaya	NMFS	1,267	4,248	2,232	30	113	908,000
ME-4/XME-21	Freshwater Bayou	Mermentau	SCS	523	14,381	1,593	1,679	128	2,770,000
XPO-52a	Bayou Sauvage	Pontchartrain	USFWS	841	5,475	1,280	503	185	1,452,000
PCS-27	Clear Marais	Calc/Sabine	USACE	677	4,637	1,067	1,029	193	1,741,000
BS-3a	Caernarvon Outfall Mgmt	Breton Sound	SCS	448	15,556	812	0	422	2,522,000
PCS-24	Mud Lake	Calc/Sabine	SCS	798	8,054	1,520	1,444	479	2,904,000
PBA-35	Jonathan Davis Wetland	Barataria	SCS	255	7,199	510	639	657	3,399,000
PTE-22/24	Point Au Fer	Terrebonne	NMFS	196	5,230	375	428	696	1,070,000
XAT-7	Big Island Mining	Atchafalaya	NMFS	944	3,400	1,560	342	933	4,136,000
PCS-25	Hwy 384	Calc/Sabine	SCS	79	650	150	142	1,023	701,000
PO-6	Fritchie Marsh	Pontchartrain	SCS	546	5,924	1,040	1,312	1,176	3,048,000
PTV-18/TV-9	Boston Canal/Vermilion	Teche/Verm	SCS	199	466	378	359	1,233	1,009,000
CS-9	Brown Lake	Calc/Sabine	SCS	152	2,794	282	85	2,223	3,223,000
PTE-27	West Belle Pass	Terrebonne	USACE	336	2,459	472	452	2,325	4,854,000
XTE-41	Isle Dernieres (Phase I)	Terrebonne	EPA	133	776	109	179	6,195	6,908,000
	Total			7,394	81,249	13,380	8,623		40,645,000

EPA Environmental Protection Agency
NMFS National Marine Fisheries Service
SCS Soil Conservation Service
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service,
AAHU Average Annual Habitat Unit

Table 3

Coastal Wetlands Planning, Protection and Restoration Act

3rd Priority Project List

Project No.	Project	Basin	Lead Agency	Average Annual Acres	Affected Area (Acres)	Acres Created, Protected, and Restored	Area Loss w/o Project (Acres)	Avg Annual Cost/AAHU ($/AAHU)	Fully Funded Cost ($)
XPO-71	MRGO Back Dike Marsh Pro	Pontchartrain	USACE	661	855	755	755	99	512,000
BA-4c	West Pt.-a-la-Hache Outfall Mgmt	Barataria	SCS	581	16,612	1,087	1,206	140	881,000
XMR-10	Channel Armor Gap Crevasse	Miss Delta	USACE	497	2,097	936	325	286	808,000
TV-4	Cote Blanche Hydro Rest	Teche/Verm	SCS	1,167	30,000	2,223	3,442	371	5,173,000
CS-4a	Cameron-Creole Maintenance	Calc/Sabine	SCS	716	54,076	2,602	1,462	378	3,720,000
XBA-65a	B. Perot/B. Rigolettes Marsh	Barataria	NMFS	642	4,255	1,065	1,644	380	1,835,000
MR-8/9a	Pass-a-Loutre Crevasse	Miss Dellta	USACE	636	1,869	1,043	101	439	2,858,000
XTE-67	E. Timbalier Restoration	Terrebonne	NMFS	664	23,621	1,013	2,745	686	2,047,000
XCS-47,48i, 48j, 48p	Replace Hog Island etc. Control Structures	Calc/Sabine	USFWS	495	42,247	953	1,320	753	4,582,000
BS-4a	White's Ditch Outfall Mgmt	Breton Sound	SCS	20	5,249	37	75	781	756,000
PTE-23	L. Chapeau Mrsh Crtn and HR	Terrebonne	NMFS	391	13,024	509	423	876	4,149,000
PTE-15bi	Whiskey Island Restoration	Terrebonne	EPA	837	4,926	1,239	909	921	4,844,000
PTE-26b	Brady Canal Hydro Rest	Terrebonne	SCS	156	7,653	297	380	1,017	4,718,000
PO-9a	Violet Freshwater Distribution	Pontchartrain	SCS	130	17,980	247	207	3,305	1,821,000
BA-15	L. Salvador Shore Prote Demo	Barataria	NMFS	88	4,070	176	196	586	1,445,000
PME-6	SW Shore White Lake Demo	Mermentau	SCS	9	25	16	22	1,850	126,000
XTE-43	Red Mud Demo	Terrebonne	EPA	----	3	3	0	----	350,000
	Total			7,690	228,562	14,201	15,212		40,625,000

EPA Environmental Protection Agency
NMFS National Marine Fisheries Service
SCS Soil Conservation Service
USACE U.S. Army Corps of Engineers
USFWS U.S. Fish and Wildlife Service
AAHU Average Annual Habitat Unit

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

List of Publicly Proposed Projects

Exhibit 4

Record	BASIN	CATEGORY	DESCRIPT
1	ATCH	FRSHWTR DIV	AVOCA ISLAND EXTENSION WITH FRESHWATER DIVERSION AND SEDIMENT DIVERSION (12)
2	ATCH	HYDRO REST	PLACE A LOCK IN BAYOU CHENE (11)
3	ATCH	SED DIV	DIVERSION STRUCTURE IN BAYOU SCHAFFER WITH AUX. STRUCTURE THRU LEVEE AT AVOCA I. TO DIVERT FRESH WATER INTO TERREBONNE PARISH
4	BARA	BARR ISL REST	BARRIER ISLANDS ARE MORE IMPORTANT TO INTERIOR WETLANDS THAN TO THE WETLANDS ON THE ISLAND (1)
5	BARA	BARR ISL REST	BARRIER ISLAND AND SHORELINE RESTORATION NEEDED BETWEEN BELLE PASS AND SANDY POINT (5)
6	BARA	BARR ISL REST	NOURISH GRAND ISLE AND GRAND TERRE ISLAND WITH SEDIMENTS DREDGED FROM NEARBY WATERWAYS & WATER BOTTOMS (10)
7	BARA	BARR ISL REST	IT IS ESSENTIAL TO PRESERVE GRAND ISLE FOR THE MANY FUNCTIONS IT SERVES (2A)
8	BARA	DREDGED MAT	FUND MITIGATION REQUIRED BY HIS PERMIT (MARSH CREATION WITH DREDGED MATERIAL) WITH CWPPRA FUNDS
9	BARA	DREDGED MAT	MARSH CAN BE CREATED WITH SEDIMENTS FROM A COMMERCIAL BOAT HARBOR ON GRAND ISLE (PERMIT- CARINADA BAY S2) (6)
10	BARA	DREDGED MAT	USE MATERIAL DREDGED FROM BAYOU DUPONT TO BUILD MARSH (11)
11	BARA	DREDGED MAT	PUMP DREDGED MATERIAL BEHIND FORT LIVINGSTON TO CREATE MARSH AND CREATE SHOREBIRD FEEDING HABITAT
12	BARA	DREDGED MAT	USE DREDGED MATERIAL FROM THE BARATARIA BAY WATERWAY TO BUILD AND PROTECT MARSH ON GRAND TERRE ISLAND
13	BARA	EROSION CONTR	EROSION CONTROL NEEDED ALONG LAKE SALVADOR SHORELINE FROM BAIE DU CABANAGE TO BAYOU DES ALLEMANDS
14	BARA	EROSION CONTR	SHORELINE EROSION CONTROL NEEDED ALONG EASTERN SHORE OF LAKE SALVADOR ESPECIALLY NEAR BAYOU SEGNETTE
15	BARA	EROSION CONTR	BANK STABILIZATION ALONG BAYOU LAFOURCHE AND AT THE INTERSECTION OF BAYOU LAFOURCHE AND THE GIWW (2)
16	BARA	EROSION CONTR	BANK STABILIZATION NEEDED ALONG BAYOU LAFOURCHE FROM SOUTH OF LAROSE TO SOUTH OF LEEVILLE (5)
17	BARA	EROSION CONTR	STABILIZE THE LAKE SALVADOR SHORELINE FROM BAIE CHACTAS SHELL BANK TO BAYOU DES ALLEMANDS WITH ROCK OR GABION
18	BARA	EROSION CONTR	CONSTRUCT A DEMONSTRATION BREAKWATER OF TIRES TO SLOW EROSION ON THE BANKS OF GRAND BAYOU
19	BARA	EROSION CONTR	USE TIRE STRUCTURE TO STABILIZE BANKS OF GRAND BAYOU BETWEEN WEST POINT A LA HACHE & PORT SULPHUR (2)
20	BARA	EROSION CONTR	EROSION IS OCCURRING ALL ALONG THE BARATARIA BAY WATERWAY (1)
21	BARA	EROSION CONTR	EROSION IS OCCURRING ALONG THE GIWW IN THE CROWN POINT AREA (2)
22	BARA	EROSION CONTR	SHORELINE STABILIZATION OF GRAND ISLE ESPECIALLY IN AREAS WHERE MARSH DESTRUCTION IS EVIDENT
23	BARA	EROSION CONTR	THE GIWW BANKS ARE ERODING FROM FLEMING CANAL WEST TO THE PARISH LINE. BANK PROTECTION IS NEEDED
24	BARA	EROSION CONTR	THE NORTHEASTERN SHORELINE OF THE PEN NEEDS A BARRIER TO ABSORB WAVE ENERGY TO PREVENT FURTHER EROSION AND TRAP SEDIMENTS
25	BARA	EROSION CONTR	THE WEST BANK OF THE BARATARIA WW. AT LAFITTE HAS SEVERE BANK EROSION. NEED TO PROTECT HOMES, DOCKS, ROAD, CEMETERY, CULTURAL SITES, ETC...
26	BARA	FRSHWTR DIV	SEDIMENT DIVERSION INTO THE UPPER BARATARIA BASIN, POSSIBLY HERO CANAL (8)
27	BARA	FRSHWTR DIV	STORM WATER RUNOFF TREATMENT FOR THE LAKE CATOUATCHE PUMPING STATION (16)
28	BARA	FRSHWTR DIV	DIVERT WATER FROM THE MISSISSIPPI RIVER DOWN BAYOU LAFOURCHE (1)
29	BARA	HYDRO REST	MARSH MANAGEMENT FOR THE AREA NORTH OF "THE PEN" NEAR LAFITTE, TIE IN WITH LAREUSSITE OR HERO CANAL DIVERSION PROJECTS (11)
30	BARA	HYDRO REST	REDUCE TIDAL FLUSHING ACTION IN THE BARATARIA BASIN BY CLOSING MAN-MADE CANALS, RE-ESTABLISHING N. TO S. FLOW (17)
31	BARA	HYDRO REST	LAFOURCHE PARISH SUPPORTS NMFS PROPOSED SPOIL IMPOUNDMENT RESTORATION FOURCHON (15)
32	BARA	HYDRO REST	WIDEN AND DEEPEN BAYOU LAFOURCHE AND CONSTRUCT LOCKS TO STOP SALT WATER INTRUSION (1A)
33	BARA	HYDRO REST	MANAGE WATER AND SEDIMENT OUTFLOW FROM DAVIS POND FRESHWATER DIVERSION TO MAXIMIZE BENEFITS
34	BARA	HYDRO REST	LAKE SALVADOR WATERSHED PROJECT - LARGE SCALE PROJECT TO MANAGE AN ENTIRE WATERSHED
35	BARA	HYDRO REST	CONSTRUCT A LOCK IN THE BARATARIA BAY WATERWAY AND FLOODGATES ON CARINADA PASS TO PREVENT SALTWATER INTRUSION, TIDAL SCOUR, ETC... (8)
36	BARA	HYDRO REST	RESTORE A CANAL PLUG OFF OF SCOFIELD BAYOU TO PREVENT TIDAL SCOUR. (5)
37	BARA	HYDRO REST	CONSTRUCT "LOW" LEVEES ALONG CANALS RUNNING BETWEEN PROTECTION LEVEES TO REDUCE SEDIMENT LOSS AND SALTWATER INTRUSION IN THE BARA. BASIN
38	BARA	MARSH MNGMNT	MANAGE THE AREA BETWEEN THE PEN AND HERO CANAL TO TRAP SEDIMENTS AND MAINTAIN THE INTEGRITY OF THE MARSH
39	BARA	MARSH MNGMNT	WATER MANAGEMENT AND FRESHWATER DIV. FOR THE AREA BETWEEN THE BARATARIA RIDGE AND THE RIGL. RIVER AND NORTH OF BAYOUS DUPONT AND TRAVERSE
40	BARA	OTHER	ELEVATED WATER LEVELS ARE A PROBLEM IN THE WACHERIE AREA (3)
41	BARA	WETLAND LOSS	EAST OF GOOSE BAYOU IN LAFITTE AROUND BAYOU DUPONT IS ERODING. CONSIDER USING DREDGED MATERIAL
42	BARA	WETLAND LOSS	THE MARSH SOUTHEAST OF LEEVILLE IS BEING LOST TO SALTWATER INTRUSION AND SOIL COMPACTION (4)
43	BARA/MISS	EROSION CONTR	SEE MR. PETROVICH'S PROJECTS THAT WERE PREPARED BY BROWN AND ROOT; THE TIRE SEDIMENT TRAP AND THE BREAKWATER ALONG GRAND BAYOU
44	BARA/MISS	FRSHWTR DIV	PROVIDE FOR ENRICHED SEDIMENT DIVERSION INTO GRAND PASS, TIGER PASS, AND BAPTISTE COLLETTE (9)
45	BRET	FRSHWTR DIV	INTRODUCE FRESHWATER TO PREVENT SALTWATER INTRUSION AT FLOODGATES AT BAYOU BIENVENUE & BAYOU DUPRE (3A)
46	BRET	FRSHWTR DIV	RESTORE RIVER FLOW THROUGH OAK RIVER (15)
47	BRET	FRSHWTR DIV	FRESHWATER INTRODUCTION AND DISTRIBUTION SYSTEM TO DISTRIBUTE WATER FROM THE VIOLET SIPHON INTO THE CENTRAL WETLANDS AND LAKE LERY WETLANDS
48	BRET	HYDRO REST	BUILD DOUBLE LOCKS AT BAYOU BIENVENUE & BAYOU DUPRE FLOODGATES TO REDUCE SALTWATER INTRUSION IN CENTRAL WETLANDS (3)
49	BRET	HYDRO REST	CONSTRUCT A LOW-LEVEL BARRIER BETWEEN POINT A LA HACHE AND THE MRGO TO REDUCE SALTWATER INTRUSION AND TIDAL SCOUR (7)
50	BRET	HYDRO REST	STABILIZE AND RESTORE THE MARSHES NORTH OF LAKE LERY (17)
51	BRET	HYDRO REST	BUILD A LOCK AT BAYOU BIENVENUE AND BAYOU DUPRE USING EXISTING FLOODGATES TO STOP SALTWATER FROM AFFECTING THE CENTRAL WETLANDS
52	BRET	SED DIV	BUILD LARGE-SCALE DIVERSIONS AT MYRTLE GROVE AND BOHEMIA TO REPLENISH MARSHES. ALSO, INCLUDE HYDROELECTRIC FACILITIES TO PAY FOR PROJECT
53	BRETON	OTHER	ISLAND CREATION ALONG THE EXISTING MARSH SHORELINE TO ACT AS BARRIERS TO MARSH EROSION AND PROVIDE WILDLIFE HABITAT
54	CALC	EROSION CONTR	CONSTRUCT "SOMETHING" TO PREVENT EROSION ALONG GIWW FROM CALCASIEU TO THE SABINE RIVER
55	CALC	EROSION CONTR	BREAKWATER OR ARTIFICAL REEF TO SLOW SHORELINE EROSION AT LOUISIANA POINT (12)
56	CALC	EROSION CONTR	EROSION OF A REMNANT DREDGED MATERIAL BANK WOULD ALLOW AN INCREASE OF EROSION ALONG MOSS LAKE. SUGGEST DREDGED MATERIAL OR ROCK DIKE (14)
57	CALC	EROSION CONTR	SHORELINE PROTECTION ALONG THE WEST SIDE OF THE CALCASIEU SHIP CHANNEL IN LONG POINT LAKE (2)
58	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE CALCASIEU SHIP CHANNEL, ESPECIALLY BETWEEN CALCASIEU LAKE AND THE GIWW (6)
59	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE GIWW FROM CALCASIEU TO SABINE RIVER, MOSTLY ON THE NORTH SIDE (5A)
60	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE GIWW W. OF THE SALT (ALKALI) DITCH (5)
61	CALC	EROSION CONTR	EROSION IS OCCURRING ALONG THE MERMENTAU RIVER NORTH OF THE GIWW (15)
62	CALC	EROSION CONTR	MAKE HOLES IN CALCASIEU JETTIES OR BAFFLES TO THE WEST OF THE JETTIES TO REDUCE EROSION ALONG THE LA COAST (8)
63	CALC	EROSION CONTR	PLACE AN EARTHEN LEVEE OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG PRIORITIZED SECTIONS OF THE NORTH GIWW BANK
64	CALC	EROSION CONTR	PLACE EARTHEN LEVEE OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG CALCASIEU SHIP CHANNEL TO PREVENT EROSION
65	CALC	EROSION CONTR	RIP-RAP EXISTING STRUCTURES ON HEBERT-PRECHT CANAL AND AT WELFARE BRIDGE TO PROTECT STRUCTURES
66	CALC	EROSION CONTR	RIP-RAP EXISTING WATER CONTROL STRUCTURES FOR THE CAMERON-CREOLE WATERSHED PROJECT TO PREVENT UNDERMINING
67	CALC	FRSHWTR DIV	REROUTE PUMPED STORM WATER INTO THE CAMERON CREOLE WATERSHED PROJECT(1A)
68	CALC	FRSHWTR DIV	DIVERT WATER FROM THE SABINE RIVER INTO BLACK BAYOU
69	CALC	HYDRO REST	PLACE ROCK WEIRS ACROSS EXCHANGE POINTS ALONG BLACK BAYOU BETWEEN GIWW AND SABINE RIVER
70	CALC	HYDRO REST	CLOSURE OF PETROLEUM ACCESS CANALS ALONG SABINE LAKE AND IN ADJACENT MARSHES TO REESTABLISH HISTORIC HYDROLOGY AND REDUCE WETLAND LOSS (2
71	CALC	HYDRO REST	DECREASE TIDAL FLUCTUATIONS AND SCOUR BY DECREASING THE CROSS SECTION OF OYSTER BAYOU (15)
72	CALC	HYDRO REST	REDUCE CROSS SECTION OF CALCASIEU PASS TO AUTHORIZED WIDTH TO REDUCE TIDAL EXCHANGE AND SALTWATER INTRUSION
73	CALC	HYDRO REST	REDUCE THE CROSS-SECTION OF KELSO BAYOU TO PREVENT TIDAL SCOUR AND SALT WATER INTRUSION (3)
74	CALC	HYDRO REST	SALT WATER BARRIER WEST OF HWY 27 AND EAST OF ALKALI (SALT) DITCH TO REDUCE SALT WATER INTRUSION AND TIDAL SCOUR (2)
75	CALC	HYDRO REST	SALTWATER INTRUSION UNDER HWY 384 IS THREATENING FRESH MARSH. PLUGS OR WATER CONTROL STRUCTURES NEEDED (22)

Record	BASIN	CATEGORY	DESCRIPT
76	CALC	HYDRO REST	A LOCK IS NEEDED ON THE GIWW, EAST OF THE HWY 27 BRIDGE AND WEST OF THE CALCASIEU RIVER TO PREVENT SALTWATER INTRUSION (5B)
77	CALC	HYDRO REST	INSTALL A LOCK AT THE MOUTH OF THE CALCASIEU SHIP CHANNEL TO REDUCE SALTWATER INTRUSION, ETC... (1)
78	CALC	HYDRO REST	MARSH MANAGEMENT IS NEEDED IN THE RUD LAKE AREA PERMIT: CAMERON PARISH WETLANDS 923 (12)
79	CALC	HYDRO REST	MARSH MANAGEMENT IS NEEDED IN THE OYSTER BAYOU AREA (11)
80	CALC	HYDRO REST	ROCK WEIRS SHOULD BE CONSTRUCTED ACROSS GAPS ALONG BLACK BAYOU FORM THE SABINE RIVER TO THE GIWW (22)
81	CALC	HYDRO REST	SALTWATER INTRUSION IS OCCURRING IN THE WETLANDS EAST OF HWY 38A (3)
82	CALC	HYDRO REST	STOP MAINTAINING THE CALCASIEU CHANNEL TO SAVE THE WETLANDS (2)
83	CALC	HYDRO REST	THERE IS A LACK OF WATER FLOW ALONG HWY 27 AT LITTLE CHENIER (4)
84	CALC	HYDRO REST	WATER MANAGEMENT IS NEEDED NORTH OF FOSS LAKE (10)
85	CALC	HYDRO REST	PLACE A SALT WATER BARRIER THAT ALLOWS NAVIGATION IN CALCASIEU PASS THAT A HIGH RISE BRIDGE COULD BE BUILT ON.
86	CALC	HYDRO REST	PLACE A SALTWATER BARRIER AT THE MOUTH OF BRANNON DITCH TO ALLOW RAINFALL RUNOFF FROM THE N. AND PREVENT SALTWATER FROM THE S.
87	CALC	HYDRO REST	CONSTRUCT A WATER CONTROL STRUCTURE IN BLACK BAYOU ADJACENT TO CALCASIEU LOCKS TO HELP RELIEVE MERMENTAU BASIN FLOOD FLOWS
88	CALC	HYDRO REST	CONSTRUCT LOCKS ON THE GIWW IN THE VICINITY OF ALKALI DITCH TO PREVENT SALTWATER CIRCULATION
89	CALC	HYDRO REST	BUILD LEVEE ON SOUTH SIDE OF MIAMI CORP. LAND TO ALLOW MARSH TO RECEIVE OVERBANK FLOW FROM THE NORTH AND PROTECT RESIDENTS
90	CALC	OTHER	ABSUMPTION OF OMA COSTS OF CAMERON-CREOLE WATERSHED PROJECT (17)
91	CALC	OTHER	DEAUTHORIZE THE LAKE CHARLES DEEPWATER CHANNEL SO THAT SALT WATER BARRIER OR FRESH WATER DIVERSION COULD BE BUILT INTO CHANNEL (23A)
92	CALC	OTHER	FLOODING OCCURS IN HACKBERRY AS A RESULT OF HYDROLOGIC RESTORATION (1)
93	CALC	OTHER	RESTORE BLACK LAKE'S SHORELINE TO PROTECT ADJACENT MARSHES AND RESTORE HYDROLOGY (4)
94	CALC	OTHER	USE HAY BALES AND ROLLS TO ENCOURAGE VEGETATION COLONIZATION OF AREA AND ACT AS WAVE DAMPENING DEVICES IN LAKE BOUDREAUX (27)
95	CALC	OTHER	FLOODING IS OCCURRING IN HACKBERRY AREA, REASONS SUGGESTED IN MARSH MANAGEMENT PROJECT (14)
96	CALC	WETLAND LOSS	RESTORE HYDROLOGY IN RUD LAKE MARSH TO REDUCE WETLAND LOSS (13)
97	CALC/MERM	EROSION CONTR	PLACE AN EARTHEN LEVEE OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG THE GIWW IN CALCASIEU, CAMERON, AND VERMILION PARISHES
98	CALC/MERM	MARSH MNGMNT	MARSH MANAGEMENT WITH STRUCTURES FOR THE COTEAU PLATEAU MARSH BETWEEN EAST CREOLE AND LITTLE CHENIER CHENIERS
99	CALC/MERM	OTHER	REINTRODUCE PRAIRIE BISON AND RED WOLVES TO BENEFIT THE ENTIRE PLANETARY ECOSYSTEM
100	CALC/MERM	WETLAND LOSS	EROSION IS OCCURRING ALONG THE GIWW FROM THE CALCASIEU RIVER TO LELAND-BOWMAN LOCK
101	MERM	EROSION CONTR	BREAKWATER OR ARTIFICAL REEF TO SLOW EROSION OF SHORELINE AT ROCKEFELLER WILDLIFE REFUGE (12A)
102	MERM	EROSION CONTR	EROSION OF GIWW DREDGED MATERIAL BANKS IS ALLOWING INCREASED WAVE ENERGY ON ADJACENT MARSHES (5)
103	MERM	EROSION CONTR	FRESHWATER BAYOU NEEDS BANK STABILIZATION FROM FRESHWATER BAYOU LOCK TO INTRACOASTAL CITY. AREAS HAVE BEEN PRIORITIZED & PERMIT ISSUED (1C
104	MERM	EROSION CONTR	INLAND WATERWAY'S (OLD GIWW) SHORELINE IS ERODING THREATENING ADJACENT MARSHES (9)
105	MERM	EROSION CONTR	LOWERING OF WATER LEVELS WOULD REDUCE WAVE INDUCED EROSION ALONG GRAND LAKE (6)
106	MERM	EROSION CONTR	LOWERING WATER LEVELS IN GRAND LAKE WOULD REDUCE SHORELINE EROSION (6A)
107	MERM	EROSION CONTR	REDUCE WATER LEVELS IN WHITE LAKE BY DIVERTING WATER UNDER HWY 82. WILL REDUCE EROSION AROUND WHITE LAKE & BENEFIT RECEIVING AREA
108	MERM	EROSION CONTR	LIMESTONE RIP-RAP ENTIRE SOUTH BANK OF GRAND LAKE AND PLANT WITH SMOOTH CORDGRASS
109	MERM	EROSION CONTR	LIMESTONE RIP-RAP ENTIRE SOUTH BANK OF WHITE LAKE AND PLANT WITH SMOOTH CORDGRASS
110	MERM	EROSION CONTR	EROSION IS OCCURRING ALONG THE OLD GIWW BETWEEN GRAND AND WHITE LAKES (13)
111	MERM	EROSION CONTR	SHORELINE OF WHITE LAKE IS ERODING (12)
112	MERM	EROSION CONTR	BUILD ROCK AND PILING EMBANKMENTS ALONG THE GULF SHORE TO TRAP SILT AND SAND TO PROTECT ROCKEFELLER REFUGE
113	MERM	EROSION CONTR	PLACE EARTHEN LEVEE OR NON-ERODABLE BREAKWATERS AND VEGETATIVE PLANTINGS ALONG CRITICAL SHORELINES OF GRAND AND WHITE LAKES
114	MERM	FRSHWTR DIV	FRESHWATER DIVERSION FROM GRAND AND WHITE LAKE BASINS UNDER HWY 82 TO DECREASE SALT WATER INTRUSION TO MARSHES S. AND E. OF HWY 82 (7)
115	MERM	HYDRO REST	THE HOG BAYOU AREA NEEDS A MANAGEMENT PLAN (20)
116	MERM	HYDRO REST	BUILD A LEVEE ON SOUTH BORDER OF MIAMI CORP. LAND TO ALLOW OVERBANK FLOODING TO ENTER BIG BURN MARSH AND PROTECT NEARBY RESIDENTS
117	MERM	HYDRO REST	CONSOLIDATE SAWMILL CANAL WATER CONTROL STRUCTURES INTO ONE UNIT AT INTERSECTION OF SAWMILL CANAL AND LITTLE PECAN BAYOU TO MAINTAIN MARSH
118	MERM	HYDRO REST	REPLACE EXISTING FLOODWATER CONTROL STRUCTURE ON HUMBLE CANAL TO MANAGE WATER LEVELS IN THE AREA OF BIG BURN
119	MERM	MARSH MNGMNT	A COMPREHENSIVE HYDROLOGIC PLAN TO PRESERVE AND RESTORE MARSH BETWEEN THE MERMENTAU RIVER AND ROCKEFELLER REFUGE
120	MERM	VEG PLANTINGS	PLANT SMOOTH CORDGRASS ALONG ENTIRE BANKS AND MARSH EDGE OF LITTLE PECAN BAYOU WATER SHED TO PREVENT EROSION FROM SALTWATER INTRUSION
121	MERM	VEG PLANTINGS	PLANT BALD CYPRESS SEEDLINGS ALONG THE GIWW FROM CALCASIEU LOCKS TO GRAND LAKE
122	MERM	WETLAND LOSS	EROSION IS OCCURRING IN THE GRAND & WHITE LAKE AREA (16)
123	MERM/VERM	EROSION CONTR	PLACE AN EARTHEN LEVEE AND/OR NON-ERODABLE BREAKWATER AND VEGETATIVE PLANTINGS ALONG FRESHWATER BAYOU TO PREVENT EROSION
124	MERM/VERM	OTHER	HERBICIDE USE IN GRAND & WHITE LAKE BASIN MAY BE HARMING WETLAND VEGETATION (9)
125	MERM/VERM	WETLAND LOSS	EROSION ALONG FRESHWATER BAYOU IS CRITICAL WHERE IT COMES CLOSEST TO VERMILION BAY (19)
126	MERM/VERM	WETLAND LOSS	MARSHES BETWEEN FRESHWATER BAYOU AND WHITE LAKE ARE BEING LOST (7)
127	MISS	DREDGED MAT	CREATE MARSH ISLANDS USING MATERIAL DREDGED FORM THE MISS. RIVER AND S.R.E.D. S CONSTRUCTED WITH TIRES
128	MISS	EROSION CONTR	USE OLD TIRES TO CONTROL EROSION ALONG GRAND BAYOU (13)
129	MISS	FRSHWTR DIV	INVESTIGATE WAYS TO LET NATURE MOVE HEAVY SEDIMENTS INTO THE WEST DELTA (4)
130	MISS	FRSHWTR DIV	DIVERT HEAVY SEDIMENTS FROM SOUTHWEST PASS INTO WEST DELTA (14)
131	MISS	OTHER	USE OLD TIRES TO TRAP AND RETAIN DISPOSED DREDGED MATERIAL FROM THE MISSISSIPPI RIVER & COMPLEMENT THE WEST BAY SEDIMENT DIVERSION (COE)(1
132	MISS	OTHER	USE OLD TIRES TO TRAP SEDIMENTS IN THE RIVERSIDE BAY AREA OF THE WEST DELTA (12)
133	OTHER	WETLAND ACQ	BUY AND PROTECT A WET BATTURE AREA ALONG THE MISSISSIPPI RIVER IN THE VICINITY OF WAWAWA, LA
134	PONT	DREDGED MAT	STABILIZE AND REBUILD THE BANKS OF THE GIWW BYPASS BY USING MATERIAL BORROWED FROM THE CHANNEL
135	PONT	DREDGED MAT	MARSH CREATION WITH DREDGED MATERIAL NORTH OF INTERSTATE 10 IN ST. CHARLES PARISH (5)
136	PONT	DREDGED MAT	PROPOSAL SIMILAR TO THE LABRANCHE WETLANDS PROJECT ON THE FIRST PROJECT LIST
137	PONT	DREDGED MAT	USE MATERIAL DREDGED FROM LAKE PONTCHARTRAIN TO BUILD MARSH IN LABRANCHE WETLANDS IN ADDITION TO THE FIRST PRIORITY PROJECT LIST
138	PONT	EROSION CONTR	BANK STABILIZATION ALONG THE LAKE PONTCHARTRAIN SHORELINE IN ST. CHARLES PARISH (4)
139	PONT	EROSION CONTR	PROTECT LAKE PONTCHARTRAIN SHORELINE WITH ROCK OR GABION IN AREA OF LABRANCHE WETLANDS
140	PONT	EROSION CONTR	BEACH EROSION IS OCCURRING E. AND W. OF THE MOUTH OF THE TCHEFUNCTE RIVER (4)
141	PONT	EROSION CONTR	NEED TO PROTECT CHENIER NEAR BAYOU CHINCHUBA TO PREVENT LAKE PONTCHARTRAIN FROM BREAKING THROUGH INTO FRESHER MARSH (1)
142	PONT	EROSION CONTR	PROTECT THE SHORELINE OF LAKE BORGNE FROM EROSION (18)
143	PONT	EROSION CONTR	SHORELINE PROTECTION NEEDED NEAR THE MOUTH OF THE TCHEFUNCTE RIVER
144	PONT	EROSION CONTR	PLACE STRUCTURES ALONG THE SOUTH SHORE OF LAKE PONT. TO REDUCE WAVE ENERGY TO ALLOW FOR SEDIMENTS TO ACCUMULATE AND BUILD MARSH
145	PONT	HYDRO REST &	RESTORE EASTERN PART OF EDEN ISLES TO WETLANDS
146	PONT	HYDRO REST	RESTORE THE UNDEVELOPED 2,700 ACRES ON THE EASTERN SIDE OF EDEN ISLES ON THE NORTH SHORE OF LAKE PONTCHARTRAIN
147	PONT	HYDRO REST	MARSH MANAGEMENT OF AREA BOUND BY LAKE BORGNE, LAKE ST. CATHERINE, CHEF MENTEUR PASS, AND ST. CATHERINE PASS, USING ROCK WEIRS, PLUGS, ET
148	PONT	HYDRO REST	CULVERTS UNDER HWY 51 & POSSIBLY THE RAILROAD ARE PREVENT WATER EXCHANGE BETWEEN LAPLACE AND PONCHATOULA (1)
149	PONT	HYDRO REST	THE WEIR AT THE WHITE RIVER DIVERSION CHANNEL NEEDS TO BE MAINTAINED (2)
150	PONT	HYDRO REST	DEAD END CANALS AT PORT LOUIS AREA CAUSING PROBLEMS. THE PORT IS NEARLY DEFUNCT AND NO MAINTENANCE IS BEING DONE. (2)

Record	BASIN	CATEGORY	DESCRIPT
151	PONT	HYDRO REST	FORMULATE AND IMPLEMENT A COMPREHENSIVE HYDROLOGIC PLAN TO PRESERVE AND RETURN HYDROLOGIC FLOW TO THE LOWER MAUREPAS BASIN
152	PONT	MARSH MGMNT	CREATE MARSH SYSTEMS AND BARRIER ISLANDS TO RETAIN AND TREAT STORM WATER RUNOFF
153	PONT	OTHER	LOOK AT ACQUIRING AND PRESERVING EDEN ISLE PROPERTY EAST OF INTERSTATE 10@HWAY 10 (3)
154	PONT	OTHER	MARSH CREATION FOR TREATMENT OF STORM WATER RUNOFF IN EAST JEFFERSON (15)
155	PONT	OTHER	FUND PROJECT SWALLOW WITH CWPPRA FUNDS (7)
156	PONT	OTHER	PRESERVE MARSHES SURROUNDING LAKE PONTCHARTRAIN, POSSIBLY PURCHASE OF LAND. (6)
157	PONT	OTHER	RE-ESTABLISH GRASS BEDS IN LAKE PONTCHARTRAIN (5)
158	PONT	OTHER	RELOCATE HUMANS LIVING SOUTH OF LAKE PONTCHARTRAIN TO THE NORTH SHORE THEN OPEN UP LEVEES ALONG THE RIVER TO REPLENISH MARSH
159	PONT	OTHER	RESTORE THE AREA OF EDEN ISLES TO THE EAST OF INTERSTATE 10 (10)
160	PONT	OTHER	ANALYZE THE BONNABEL CANAL CREATED WETLANDS TO DETERMINE THEIR EFFECTIVENESS IN TREATING STORMWATER RUNOFF
161	PONT	OTHER	ANALYZE THE EFFECTIVENESS OF THE DUNCAN CANAL CREATED WETLANDS IN TREATING STORMWATER RUNOFF
162	PONT	WETLAND LOSS	WETLAND LOSS AREAS: A.GOOSE POINT MARSH, B.FRITCHIE MARSH C.BETWEEN MACISONVILLE AND MANDEVILLE, D.EAW OF TCHEFUNCTE RIVER (SHORELINE)(4)
163	PONT	WETLAND LOSS	EROSION OF SWAMP AND MARSH BETWEEN BAYOU CHINCHUBA AND TCHEFUNCTE RIVER
164	PONT	WETLAND LOSS	INTERIOR EROSION OF NORTH SHORE AND FRITCHIE MARSHES
165	PONT	WETLAND LOSS	INTERIOR MARSH LOSS BETWEEN CANE BAYOU AND BAYOU LACOMBE
166	PONT/BARA	WETLAND LOSS	BANK STABILIZATION AND HYDROLOGIC RESTORATION IS NEEDED ALONG THE GIWW IN ORLEANS AND JEFFERSON PARISH (2)
167	PONT/BRET	EROSION CONTR	PROTECT THE SHORELINE OF LAKE BORGNE FROM EROSION (23)
168	PONT/BRET	EROSION CONTR	BANK STABILIZATION ALONG MRGO (1)
169	PONT/BRET	HYDRO REST	CLOSE THE MRGO AND USE CWPPRA FUNDS TO RELOCATE CONTAINER CARGO FACILITIES TO THE MISSISSIPPI RIVER
170	PONT/BRET	HYDRO REST	INSTALL A GATE OR LOCK ON THE MRGO TO REDUCE SALTWATER INTRUSION
171	PONT/BRET	HYDRO REST	NAVIGABLE WEIR OR GATE ON THE MRGO TO REDUCE SALTWATER INTRUSION (17)
172	PONT/BRET	HYDRO REST	PUT A NAVIGABLE LOCK ON THE MRGO (19)
173	PONT/BRET	HYDRO REST	RESTORE MARSHES IN CENTRAL WETLAND UNITS OF ST. BERNARD PARISH (16)
174	STATE	BARR ISL REST	HE SUBMITTED A LENGHTY DISCOURSE ON HOW TO USE OLD TIRES, BOUND TOGETHER WITH NYLON CORD, FOR EROSION CONTROL AND CAPTURING SEDIMENTS
175	STATE	BARR ISL REST	FAILURE TO PRESERVE BARRIER ISLANDS WILL MAKE EFFORTS TO SAVE INTERIOR WETLANDS FUTILE (3)
176	STATE	DREDGED MAT	USE DREDGED MATERIAL WHEN & WHERE EVER POSSIBLE (19)
177	STATE	DREDGED MAT	USE DREDGED MATERIAL BENEFICIALLY WHEN AND WHERE EVER POSSIBLE (10)
178	STATE	EROSION CONTR	THIS MAN'S COMPANY HAS A PRODUCT CALLED "BEACH BLOCKS" THAT THEY MARKET FOR EROSION CONTROL
179	STATE	EROSION CONTR	EROSION ALONG TYME GIWW IS AFFECTING WETLANDS OUTSIDE OF THE PROJECT RIGHT-OF-WAYS (6)
180	STATE	FRSHWTR DIV	PUMP RIVER SEDIMENTS INTO THE INFLOW CHANNELS OF THE FRESHWATER DIVERSION PROJECTS (9)
181	STATE	HYDRO REST	RECONVERT MARGINAL AGRICULTURAL LANDS TO WET-PRAIRIE (MARSH). HE ALSO SUBMITTED THIS PROPOSAL FOR THE STATE PLAN
182	STATE	HYDRO REST	REDUCE TIDAL FLUSHING AND SCOUR BY FILLING OR PLUGGING UNUSED CANALS (20)
183	STATE	HYDRO REST	CONSIDER PLUGGING AND BACKFILLING CUTS INTO MARSHES MADE BY OIL COMPANIES, THEY SHOULD BEAR THIS COST
184	STATE	HYDRO REST	REDUCE THE SIZE OF TIDAL PASSES ALON THE GULF SHORELINE TO REDUCE SALTWATER INTRUSION AND TIDAL SCOUR (7)
185	STATE	OTHER	CONSTRUCTION AND VEGETATION OF BERMS ALONG NAVIGATION CHANNELS TO PREVENT BANKLINE EROSION (24)
186	STATE	OTHER	WAVE DAMPENING AND VEGETATIVE PLANTINGS IN OPEN WATER AREAS (20). ALSO OTHER WETLAND PROTECTION/RESTORATION TYPE PROJECTS (21)
187	STATE	OTHER	ALLOCATE OR DEDICATE WATER IN THE MISS. RIVER FOR USE IN LA. (22)
188	STATE	OTHER	EXAMINE ALL NAVIGATION CHANNELS FOR SALTWATER INTRUSION AND EROSION PROBLEMS (12)
189	STATE	OTHER	SUBSIDENCE AND MARSH DETERIORATION HAS OCCURRED FROM PETROLEUM EXTRACTION. EXAMINE REINTRODUCTION OF PRODUCED WATER (13)
190	STATE	OTHER	USE YARD WASTE TO CREATE A BASE FOR WETLAND GROWTH IN FRESHWATER CANALS (21)
191	STATE	OTHER	SUPPORT PROJECTS LIKE EPA'S FALBOUT CANAL SOUTH WETLAND CREATION DEMONSTRATION (7)
192	STATE	OTHER	CONSIDER SEA LEVEL RISE WHEN PLANNING PROJECTS ALONG THE COAST (9)
193	STATE	OTHER	PERMITTING PROCESS IS TO LONG AND COMPLICATED (10)
194	STATE	OTHER	GIVE MARSH OWNERS THE RIGHT AND PERMITS TO LEVEE THEIR LANDS WITH FIVE FOOT LEVEES
195	STATE	OTHER	USE PRODUCTS DEVELOPED FROM DISCARDED TIRES TO PROTECT AND REBUILD MARSHES AND BARRIER ISLANDS
196	STATE	OTHER	STOP ALL DREDGING AND ENCOURAGE LAND AND OIL COMPANIES TO RESTORE LAND
197	STATE	OTHER	A PROJECT TO DETERMINE THE FEASIBILITY OF USING BEACH CONES SHOULD BE FUNDED (3)
198	STATE	OTHER	PLAN RESTORATION BY HYDROLOGIC BASINS INSTEAD OF BY UNASSOCIATED INDIVIDUAL PROJECTS (4)
199	STATE	TIDAL EXCHANG	DEMOLISH CATTLE WALKWAYS THAT INTERRUPT SHEET FLOW USING MILITARY EQUIPMENT TO BLOW THEM UP
200	STATE	VEG PLANTINGS	PLANTING OF DEEPWATER AQUATICS TO REDUCE EROSION AND WAVE FETCH (26)
201	STATE	VEG PLANTINGS	VEGETATIVE PLANTING EFFORTS SHOULD BE EXPANDED
202	STATE	VEG PLANTINGS	PLANT NATUAL VEGETATION ALONG THE COASTLINE TO RESTORE AND MAINTAIN BEACHES & SAND BANKS, ie TURTLE GRASS, MANGROVES, WILDFLOWERES, COCONU
203	TERR	BARR ISL REST	COMPLETE BARRIER ISLAND RESTORATION PLAN FOR TERREBONE PARISH (1)
204	TERR	BARR ISL REST	REBUILD BARRIER ISLANDS, PLANT VEGETATION, INSTALL ROCK JETTIES, AND STABILIZE NATURAL PASSES
205	TERR	BARR ISL REST	RESTORE ISLE DERNIERES CHAIN WITH MATERIAL FROM BAY SIDE, STRUCTURES TO SEDIMENTS ON GULF SIDE, AND REPAIRS TO BREAKS IN ISLANDS
206	TERR	DREDGED MAT	DREDGE BAYOU TERREBONNE AND USE DREDGED MATERIAL TO CREATE WETLANDS (8)
207	TERR	EROSION CONTR	MARSH CREATION AND BANK STABILIZATION ON THE WEST SIDE OF BAYOU LAFOURCHE AND AT BELLE PASS (4)
208	TERR	EROSION CONTR	STABILIZATION OF HOUMA NAVIGATION CANAL BANKS (4)
209	TERR	EROSION CONTR	CONSTRUCT ARTIFICAL REEF IN GULF OF MEXICO TO SLOW WAVE ACTION USING OLD CARS
210	TERR	EROSION CONTR	CONSTRUCTION OF LEVEES ALONG BAYOU PETIT CALLIOU & BAYOU TERREBONNE & UPGRADE ROAD SIDE ALONG HWY 56 S. OF BOUDREAUX CANAL
211	TERR	EROSION CONTR	PARISH WANTS BARRIER ISLAND PROJECTS
212	TERR	EROSION CONTRO	A LARGE BREACH HAS OCCURRED IN THE BANK OF THE GIWW ABOUT 3 MILES WEST OF BAYOU LAFOURCHE AND IS CAUSING WIDESPREAD LOSS OF FRESH MARSH
213	TERR	FRSHWTR DIV	DIVERT SEDIMENT AND FRESHWATER FROM THE ATCHAFALAYA RIVER AND OFFER FLOOD PROTECTION TO TERREBONNE PARISH (3)
214	TERR	HYDRO REST	ON POINT AU FER ISLAND, CLOSE AN EXISTING CANAL SYSTEM WITH PLUGS, AND FILL WITH DREDGED MATERIAL TO KEEP THE GULF FROM BREAKING THROUGH
215	TERR	HYDRO REST	ON POINT AU FER ISLAND, INSTALL THREE BULKHEADS IN ABANDONED ACCESS CANALS, SPECIFICALLY, IN THE AREA OF LOCUST BAYOU AND LAKE CHAPEAU
216	TERR	HYDRO REST	ON POINT AU FER ISLAND, REINSTALL TWO BULKHEADS THE HAVE FAILED IN A CANAL SYSTER CONNECTING MOSQUITO BAY AND BAY CASTAGNIER
217	TERR	HYDRO REST	PLACE A LOCK IN THE HOUMA NAVIGATION CANAL TO REDUCE HYDROLOGIC EXCHANGE AND PREVENT SALTWATER INTRUSION (12)
218	TERR	HYDRO REST	RESTORE LAKE HOUMA TO CYPRESS SWAMP (3)
219	TERR	HYDRO REST	CLOSE HOUMA NAVIGATION CANAL OR INSTALL LOCKS JUST NORTH OF FALBOUT CANAL
220	TERR	HYDRO REST	INSTALL TWO SALINITY REDUCTION CELLS IN HOUMA NAVIGATION CANAL JUST N. OF COCODRIE AND IN DULAC AREA
221	TERR	MARSH CREATION	MARSH CREATION WEST OF HOUMA AND NORTH OF GIWW (8)
222	TERR	OTHER	RE-ROUTE GIWW SOUTH OF HOUMA AND USE DREDGED MATERIAL TO BUILD A HURRICANE PROTECTION LEVEE (7)
223	TERR	OTHER	RELOCATE THE GIWW SOUTH OF COCODRIE
224	TERR	WETLAND LOSS	RESTORE MARSH ON POINT AU FER ISLAND. LAND OWNERS HAVE DIFFICULTY GETTING PERMITS AND FINANCING PROJECTS (8)
225	TERR/ATCH	EROSION CONTR	STABILIZE BANKS OF AVOCA ISLAND CUTOFF BAYOU DRAINAGE CANAL AND THE GIWW IN TERREBONNE PARISH

Record	BASIN	CATEGORY	DESCRIPT
226	TERR/ATCH	HYDRO REST	CLOSE OFF THE NORTHERN SEGMENT OF BAYOU CHENE (2)
227	TERR/ATCH	OTHER	INVESTIGATE BOTH WETLAND RESTORATION AND PROTECTION, AND FLOOD PROTECTION. (BARRIER PLAN - BAYOUS CHENE, BOEUF, AND BLACK) (10)
228	TERR/BARA	BARR ISL REST	RESTORE AREAS WEST OF BAYOU LAFOURCHE AND EAST OF TIMBALIER (9)
229	TERR/BARA	BARR ISL REST	RESTORE BARRIER ISLANDS IN BOTH TERREBONNE AND BARATARIA BASINS (6)
230	TERR/BARA	BARR ISL REST	PLACE MAN-MADE REEFS NEAR OR OUTSIDE BARRIER ISLANDS TO REDUCE WAVE ENERGY AND PREVENT EROSION (13)
231	TERR/BARA	BARR ISL REST	PLACE ROCKS IN BREACHES OF BARRIER ISLANDS TO PREVENT FURTHER EROSION (9)
232	TERR/BARA	BARR ISL REST	USE OYSTER SHELL AND SAND TO NOURISH BEACH AND BUILD STRUCTURES ON THE GULFSIDE OF THE ISLANDS FOR PROTECTION
233	TERR/BARA	DREDGED MAT	DREDGE ALL OF BAYOU LAFOURCHE AND USE DREDGED MATERIAL TO CREATE MARSH
234	TERR/BARA	EROSION CONTR	STUDY USE OF BEACH COMBS TO SLOW EROSION OF BARRIER ISLANDS (1A)
235	TERR/BARA	FRSHWTR DIV	DIVERT WATER FROM BAYOU LAFOURCHE INTO WESTERN LAFOURCHE AND TERREBONNE BASIN
236	TERR/BARA	FRSHWTR DIV	REROUTE PUMPED OUTFALL WATER THROUGH ADJACENT MARSHES
237	TERR/BARA	HYDRO REST	PLACE 3-4 SILLS IN BAYOU LAFOURCHE TO REDUCE SALINITY
238	TERR/BARA	OTHER	CONNECT BAYOU TERREBONNE AND BAYOU LAFOURCHE WITH A CHANNEL (8A)
239	VERM	EROSION CONTR	STABILIZE EASTERN END OF MARSH ISLAND WITH SEDIMENT RETENTION DIKES AND DREDGED MATERIAL
240	VERM	EROSION CONTR	BREAKWATER, ARTIFICAL REEF, OR VEGETATIVE PLANTINGS BETWEN MUD POINT AND POINT CHAMPLAIN IN VERMILION BAY (16)
241	VERM	EROSION CONTR	EROSION OF VERMILION RIVER SHORELINE AT LIVE OAK PLANTATION IS THREATENING ADJACENT WETLANDS (19)
242	VERM	EROSION CONTR	POSSIBLE BREAKWATER &/OR ARTIFICAL REEF TO SLOW COASTLINE EROSION (11)
243	VERM	EROSION CONTR	BANKS OF BAYOU CARLIN ARE ERODING. POSSIBLE WAVE STILLING FENCES OR VEGETATIVE PLANTING (19)
244	VERM	EROSION CONTR	BANKS OF BAYOU PETIT ANSE ERODING FROM VERMILION BAY TO AVERY ISLAND POSSIBLE VEGETATIVE PLANTINGS AND WAVE STILLING FENCES (18)
245	VERM	EROSION CONTR	BANKS OF FRESHWATER BAYOU ARE ERODING (1)
246	VERM	EROSION CONTR	EROSION IS OCCURRING ALONG THE GULF SHORELINE FORM SOUTHWEST PASS TO THE WEST (16)
247	VERM	EROSION CONTR	EROSION IS OCCURRING NORTH OF LITTLE VERMILION LAKE IN THE AREA AROUND OLD BAYOU CHENE (14)
248	VERM	EROSION CONTR	FOUR-MILE CUT NEEDS EROSION CONTROL ON THE WEST SIDE (2)
249	VERM	EROSION CONTR	VERMILION BAY- MUD POINT TO CYPREMONT POINT NEEDS EROSION PROTECTION POSSIBLE VEGETATIVE PLANTINGS (3)
250	VERM	EROSION CONTR	MM WITH STRUCTURES, LEVEE REPAIRS, AND PLANTINGS. AREA IS S. OF GIWW, N. OF VERMILION BAY, E. OF 4 MILE CUT & W. OF BOSTON BAYOU
251	VERM	EROSION CONTR	EROSION ALONG GIWW IN VERMILION AND IBERIA PARISHES (40)
252	VERM	EROSION CONTR	EROSION IS OCCURRING ALONG AVERY CANAL (5)
253	VERM	EROSION CONTR	ISOLATE FRESHWATER BAYOU FROM VERMILION BAY WITH AN EARTHEN LEVEE AND ROCK BREAKWATERS
254	VERM	HYDRO REST	RESTORE PIPELINE PLUGS AROUND VERMILION BAY TO PREVENT WETLAND LOSS (15)
255	VERM	VEG PLANTINGS	VEGETATIVE PLANTINGS ALONG SHORELINE OF EAST AND WEST COTE BLANCHE BAYS (11)
256	VERM	WETLAND LOSS	FROM VERMILION RIVER EAST TO IBERIA PARISH LINE MARSHES ARE BEING LOST (11)
257	VERM	WETLAND LOSS	WETLAND LOSS BETWEEN VERM. PAR. LINE ON THE W., NEW IBERIA DRAINAGE CANAL ON THE E., TRUNKLINE PIPELINE ON THE N., AND GIWW ON THE S.
258	VERM	WETLAND LOSS	WETLANDS BEING LOST BETWEEN PECAN ISLAND AND GULF. POSSIBLE FRESHWATER INTRODUCTION FROM ATCHAFALAYA RIVER (6)
259	VERM	WETLAND LOSS	MARSH IS BEING LOST BECAUSE OF SALTWATER INTRUSION NORTH OF GIWW IN THE VICINITY OF THE LELAND-BOWMAN LOCK (8)
260	VERM/ATCH	FRSHWTR DIV	REROUTE OUTFALL WATER THROUGH ADJACENT MARSHES TO ENHANCE MARSHES AND IMPROVE WATER QUALITY IN EAST AND WEST COTE BLANCHE BAYS (10)

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

CWPPRA Monitoring Program and Protocols

Exhibit 5

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EXECUTIVE SUMMARY

Louisiana's coastal wetland loss, estimated at 79.5 km^2/year, has drawn national attention. In response, the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) was created to provide the guidance and means to develop and implement a project-oriented program to combat this coastal wetland loss. The CWPPRA requires a monitoring program be established to evaluate the effectiveness of these projects.

Projects developed under this program range from massive freshwater and sediment introduction to small scale vegetative plantings. Currently, there is no available standardized method for monitoring variables that can determine success or failure of wetland restoration projects. Consequently, data collected by Federal, State, and local entities within the coastal zone of Louisiana have not been comparable, and thus of limited use. The committee charged with the development of this monitoring program felt it was imperative to develop standardized protocols that could be used to judge project success or failure. Over 100 Federal and State restoration projects are currently being planned, and with standardized protocols, usable and comparable information will be generated, aiding in resource management and future planning and design.

These monitoring protocols were developed in response to the mandate for procedures that would evaluate the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana. Specifically, this mandate requires that a scientific evaluation be conducted to test the effectiveness of these projects in creating, restoring, protecting, and enhancing coastal wetlands in Louisiana.

These monitoring protocols broadly categorize project types, goals, and biological variables, and standardize data collection methodologies using a matrix design. This organization provides accessibility to three levels of information: project type, category of variable, and variable. These three levels are cross-referenced and ranked to guide personnel in the development of appropriate monitoring plans.

The goal of the monitoring protocols is to provide a guidance document that can be used to develop project-specific and basin-wide monitoring plans and monitoring cost estimates. In addition, the protocol should help determine the minimum monitoring standards necessary to provide sufficient information to determine whether project-specific goals are met.

Monitoring protocols were developed by subgroups of technical experts for seven categories of monitoring variables: water quality, hydrology, soils and sediments, vegetative health, habitat mapping, wildlife, and fisheries. Some variables were identified as a monitoring priority by more than one subgroup, but only one subgroup will describe specific methodologies and costs (Table 1). The results of each subgroup are represented in the following sections of this document. Each section described protocol design, cost estimates, priority rankings, and existing data bases. Following is a general overview of the monitoring protocols each monitoring subgroup developed.

Table 1. Monitoring subgroup responsibilities based on project type and variables measured. VEG=vegetative health; WQ=water quality; HYD=hydrology; FISH=fisheries; SED=soil/sediments; HAB=habitat mapping.

Project type	Freshwater diversion	Sediment diversion	Marsh manage-ment	Hydrologic restoration	Dredge material	Shoreline protection	Barrier island restor.	Vegetative planting	Sediment/ nutrient trapping
Salinity temperature	WQ		WQ	WQ				WQ	
Physical variables	WQ		WQ	WQ					
Nutrients	WQ		WQ	WQ					WQ
Trace metals				WQ					
Synthetic organics				WQ					
Species composition	VEG	VEG	VEG	VEG	VEG		VEG	VEG	VEG
Relative abundance	VEG	VEG	VEG	VEG	VEG		VEG	VEG	VEG
Above-ground biomass	VEG		VEG	VEG				VEG	
Herbivory								VEG	
Precipitation	HYD		HYD	HYD				HYD	
Soil salinity					HYD				
Wind speed direction	HYD		HYD			HYD	HYD		
Water level	HYD	HYD	HYD	HYD					
Bathymetry		HYD	HYD	HYD	HYD	HYD	HYD		HYD
Topography		HYD	HYD	HYD	HYD	HYD	HYD		HYD
Discharge	HYD	HYD	HYD	HYD					
Suspended sediments	HYD	HYD, WQ			WQ		WQ	WQ	WQ
Oyster growth, recruitment, and survival	FISH		FISH	FISH					
Fish density, size, biomass, and species richness	FISH		FISH	FISH					
Accretion	SED	SED	SED	SED	SED	SED	SED	SED	SED
Subsidence	SED	SED	SED	SED	SED				SED
Organic matter	SED	SED	SED	SED	SED			SED	SED
Bulk density	SED	SED	SED	SED	SED			SED	SED
Water content	SED	SED	SED	SED	SED			SED	SED
Grain size		SED					SED		SED
Soil redox	SED	SED	SED	SED	SED			SED	
Habitat mapping	HAB	HAB	HAB	HAB	HAB	HAB	HAB	HAB	HAB

Water Quality

The water quality monitoring subgroup identified physical variables, salinity, temperature, nutrients, and priority pollutants as essential in designing a water quality monitoring plan for CWPPRA projects. Sampling methodologies vary widely in degree of sophistication as well as frequency (instantaneous, continuous recorder, realtime). The water quality monitoring subgroup feels that specification of sampling frequency is premature at this time and that sampling frequency will vary according to the availability of preexisting data, size of the project area, type of restoration project, and cost. Costs were estimated on a per sample basis and are illustrated by project type in Table 2.

Hydrology

The hydrologic monitoring subgroup identified variables to be monitored that would assist in determining project success as well as design of future projects. The variables are precipitation, evaporation, wind speed and direction, water level, bathymetry, topography, salinity, discharge, suspended sediment, ground water, and soil salinity. A majority of these variables can be monitored on a single data collection platform to provide realtime data, reduce maintenance costs, and minimize data loss. Cost estimates will vary according to frequency of data collection and number of sampling stations (Table 2).

Soil and Sediments

The soil and sediments monitoring subgroup identified variables that can be measured in the field to evaluate the success of CWPPRA projects in promoting soil development. The variables are organic matter content, bulk density, water content, grain size, soil redox, soil nutrients, soil contaminants, vertical accretion, subsidence, and soil erosion or creation. Vertical accretion and subsidence measurements can use three different methodologies depending on monitoring intensity: feldspar markers, sediment erosion table or radionuclide dating for accretion and carbon-14 dating, global positioning systems (GPS), and extensometers for subsidence. Estimates of total will vary tremendously depending on monitoring intensity and frequency as illustrated in Table 2.

Vegetative Health

The vegetative health monitoring subgroup determined that the following four variables were essential in evaluating vegetative health responses to CWPPRA projects: species composition, relative abundance, aboveground biomass, and herbivory. It was recommended that the Braun-Blanquet method be used for quantifying shifts in community compositions and abundances; that the clip-plot method be used for quantifying aboveground biomass; and that exclusion techniques be used to estimate the impacts of herbivory. Project-specific goals and available resources will dictate what and how frequently vegetative health variables will be monitored. Cost estimates by project type are illustrated in Table 2.

Habitat Mapping

The habitat mapping subgroup developed a two-phased monitoring approach. At the first level, basin-wide mapping at a scale of 1:100,000 is proposed. Data at this level could provide a quick

Table 2. Cost estimates based on priority (ranking 1 and 2) variables to be monitored.

Project type	Costs per project (annual)				Costs per sample		
	Hydrology[a]	Vegetative health[b]	Habitat mapping[c]	Wildlife[d]	Water quality[e]	Soil and sediments[f]	Fisheries[g]
Freshwater diversion	$39,200-235,200	$2,250-9,000	$12,250-18,600	$0	$50-400	$2,575-15,325	$150-200
Sediment diversion	$46,200-92,400	$2,000-4,000	$12,250-18,600	$0	$222-260	$2,675-15,425	$0
Marsh management	$23,600-96,400	$2,250-6,750	$12,250-18,600	$0	$50	$2,575-15,325	$150-200
Hydrologic restoration	$23,600-96,400	$2,250-6,750	$12,250-18,600	$0	$250-850	$2,575-15,325	$150-200
Dredge material	$10,500-21,000	$2,000	$12,250-18,600	$0	$222-660	$2,575-15,325	$0
Shoreline protection	$6,000-11,000	$0	$12,250-18,600	$0	$0	$250-1,000	$0
Barrier island restoration	$11,000-21,000	$2,000-4,000	$12,250-18,600	$0	$222-260	$350-1,000	$0
Vegetative planting	$2,500-8,000	$2,250-4,500	$12,250-18,600	$0	$208	$575-1,325	$0
Sediment/ nutrient trapping	$6,000-33,100	$2,000	$12,250-18,600	$0	$222-296	$2,600-14,600	$0

[a]Hydrology cost estimates will vary depending on the number of data collection platforms (DCP's) in the project area.
[b]Vegetative health cost estimates will vary depending on the number of field days to conduct monitoring and the number of samples taken.
[c]Habitat mapping cost estimates will vary depending on the size of the project area.
[d]Wildlife monitoring will use existing data bases, therefore, no additional cost.
[e]Water quality cost estimates are only for discrete samples. Continuous samples for many variables could be obtained by using DCP's installed by the hydrologic monitoring subgroup.
[f]Soil and sediment cost estimates vary tremendously depending on whether an extensometer is used ($14,000).
[g]Fisheries cost estimates are only for the use of throw traps.

land and water classification to assess wetland trends for large restoration projects and entire hydrologic basins. The second level mapping is at scales ranging from 1:6,000 to 1:12,000. The Cowardin et al. classification is used for those restoration projects that require a greater level of detail. Habitat mapping will be conducted on all projects and will be prioritized based on project implementation timetables. Cost estimates by project type are illustrated in Table 2.

Wildlife

The wildlife monitoring subgroup recognized that wildlife populations are secondary to full recovery and conservation of coastal wetlands. The subgroup further recognized that wildlife populations are influenced by a broad range of factors, many of which are external and unrelated to basin-wide habitat conditions. For these reasons, the subgroup felt strongly that project evaluation should be based on monitoring variables that are expected to respond directly to restoration projects, namely water quality, hydrological, and vegetative variables. The subgroup agreed that, over the long term, recovery of coastal wetlands would benefit wildlife populations in the region. Wildlife populations or the effects of herbivores on vegetation will have to be monitored in case of herbivore demonstration projects.

Fisheries

The fishery monitoring subgroup determined that monitoring should target juvenile fish and crustaceans with emphasis placed on the collection of quantitative samples using high catch-efficiency gear. In addition to measuring animal density as an indicator of project area or habitat value, information on animal size, biomass, and species richness should also be collected. For oysters, measurements of growth, survival, and spat settlement should be collected. The gear type selected for sampling is throw traps. Sampling intensity and frequency depend on size of project area, number of different habitats present, and cost. Cost estimates by project type are illustrated in Table 2.

The standardized monitoring protocols developed in this document will provide statistically defensible, scientific procedures for monitoring those variables critical for determining project success or failure. It provides the framework and flexibility to develop basin-wide and project-specific monitoring plans while at the same time identifies the degree of effort and resources needed to accomplish this monitoring.

I. INTRODUCTION

Wetland loss in Louisiana has been caused in part by subsidence and natural delta senescence (Boesch et al. 1983), channelization of the Mississippi River (Frazier 1967), saltwater intrusion (van Beek and Meyer-Arendt 1982), and canal dredging along with other mineral exploration and extraction activities (U.S. Environmental Protection Agency 1987; Craig et al. 1979). Reductions in freshwater and sediment inputs caused by changes in wetland hydrologies have been key to this substantial loss.

Louisiana is experiencing the most critical coastal wetland erosion and land loss problem in the United States, accounting for nearly 80% of the nation's coastal marsh loss (U.S. Army Corps of Engineers 1987a). Shoreline erosion rates exceed 6 m/year in more than 80% of the Louisiana coastal zone and can reach up to 50 m/year in areas impacted by hurricanes (Suter et al. 1989). Continually impacted by a combination of natural forces and human activity, Louisiana coastal marshes lose an estimated 79.5 km^2/year (Dunbar et al. 1990).

The need for comprehensive, large-scale restoration action has been documented by state and federal agencies in several reports (U.S. Army Corps of Engineers 1987b; U.S. Environmental Protection Agency 1987; State of Louisiana 1988—Appendix A). In Louisiana, efforts of State and Federal agencies are currently underway to develop a comprehensive wetland conservation and restoration plan. This and other restoration efforts require that informed decisions be made in order to implement successful projects. In their action agenda, the National Wetlands Policy Forum (1988) specifically stated that "the ability to evaluate restoration efforts is severely limited because readily usable, accurate techniques for measuring or monitoring functions do not exist."

In response to accelerated wetland loss in Louisiana, Act 6 of the 2nd Extraordinary Session of the Louisiana State Legislature in 1989 and the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) of 1990 were created to conserve, restore, create, and enhance Louisiana coastal wetlands. The agencies responsible for designing and implementing coastal conservation and restoration projects include the Louisiana Department of Natural Resources, U.S. Department of Commerce, U.S. Department of Agriculture, U.S. Department of the Interior, U.S. Department of the Army, and the U.S. Environmental Protection Agency. The restoration plans developed pursuant to these acts specifically require an evaluation of the effectiveness of each coastal wetlands restoration project in achieving long-term solutions to arresting coastal wetlands loss in Louisiana. They necessitated the development of a monitoring program to adequately assess the success or failure of coastal restoration projects. The above agencies have a responsibility to the State of Louisiana, and to the nation, to develop a monitoring program that will effectively ensure the best use of State and Federal funds for the restoration and conservation of wetlands.

The CWPPRA created an interagency task force and charged it with the development and implementation of a comprehensive approach to the long-term conservation and restoration of coastal wetlands. Because in a broader context, the mission of the CWPPRA is to provide appropriate management plans for the Louisiana coastal zone over the next 50-100 years, monitoring protocols could be applied on a regional scale across the coastal zone to provide the data necessary for effective management planning at that scale. The CWPPRA requires that not less than 3 years after the completion and submission of the restoration plan, and at least every 3 years thereafter, a report shall be made to Congress containing a scientific evaluation of the effectiveness of the coastal wetlands restoration projects in creating, restoring, protecting, and enhancing coastal wetlands in Louisiana. Consequently, the purpose of this monitoring protocol is to evaluate the effectiveness of the projects

selected for inclusion in the plan in achieving their stated goals. To address these monitoring requirements, a monitoring work group was established under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee (Figure 1). This report represents the efforts of the monitoring work group.

II. OBJECTIVE

The monitoring work group consisted of representatives from Federal and State agencies, as well as academia. The specific responsibilities of the monitoring work group were 1) to develop a monitoring program to evaluate the effectiveness of each coastal wetland restoration project in achieving long-term solutions to arresting coastal wetland loss in Louisiana, 2) to document the effectiveness in reports to the U.S. Congress and Louisiana legislature, and 3) to make recommendations to the CWPPRA Task Force for the allocation of monitoring funds properly.

To accomplish these responsibilities, the following goals were established: 1) to develop standardized protocols for monitoring variables, 2) to develop statistical review procedures, and 3) to develop quality assurance and quality control procedures. All three goals will lead to detecting change between the pre-project condition and the post-project condition in Louisiana wetlands. This will help determine if the project is working and whether midcourse corrections are necessary.

In pursuit of these goals, group members envisioned a monitoring program that would consider

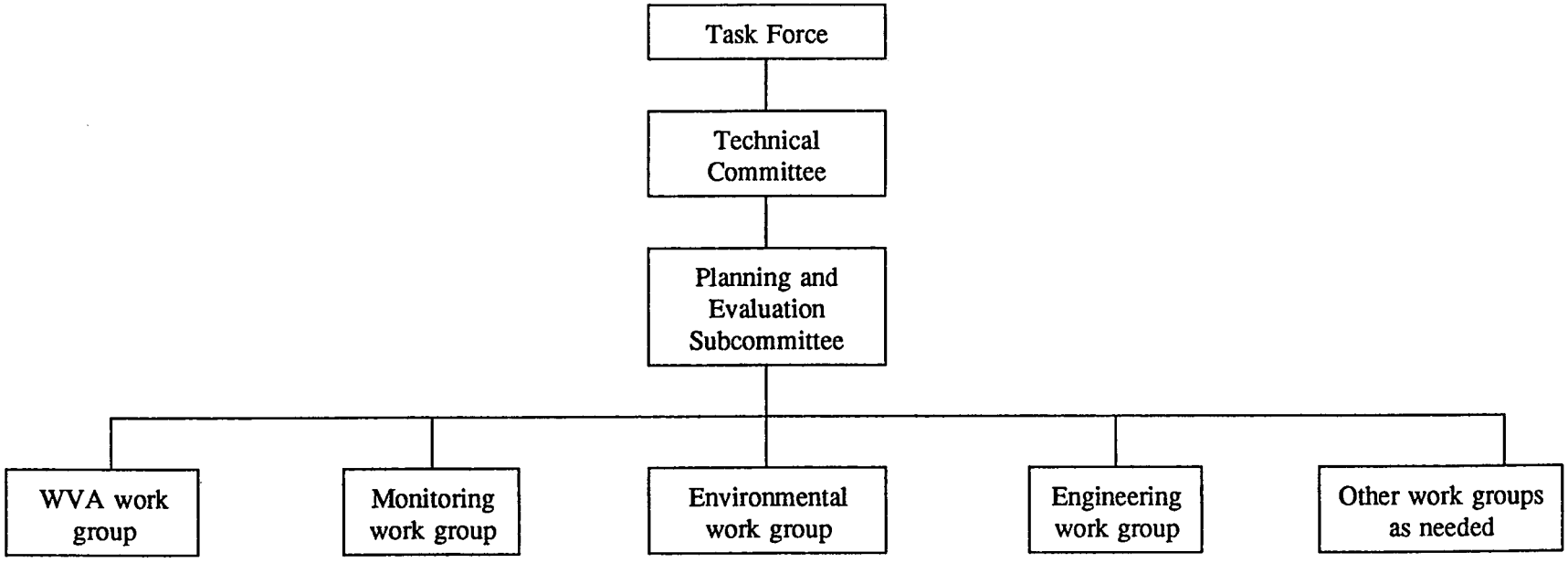
1) Nine types of restoration projects;
2) Project-specific goals (hypotheses);
3) Wetland values as determined by a wetland value assessment (WVA) procedure;
4) Site-specific as well as basin-level effects of projects; and
5) Existing monitoring activities occurring in coastal Louisiana.

Similar monitoring needs exist within and between each type of restoration project, and the development of standard protocols for these similarities are the backbone of the monitoring program. Monitoring methods and protocols for restoration projects were developed by technical experts for seven categories as follows:

1) Water quality
2) Hydrology
3) Soil and sediments
4) Vegetative health
5) Habitat mapping
6) Wildlife
7) Fisheries

The protocol design was developed to broadly categorize project types, goals, ecological variables, and data collection methodologies.

Figure 1. A hierarchial chart of the Coastal Wetlands Planning, Protection, and Restoration Act.



III. DESIGN

Restoration Project Types

Under Act 6 and the CWPPRA, all projects were categorized into nine types: freshwater introduction and diversions, sediment diversions, marsh management, hydrologic restoration, beneficial use of dredged material, shoreline protection, barrier island restoration, vegetative planting, and sediment and nutrient trapping.

Freshwater introduction and diversion

Freshwater introduction and diversion projects are designed to introduce fresh water and alluvial material from available sources to shallow marsh estuaries. Areas targeted for freshwater diversion projects are characterized by saltwater intrusion, sediment subsidence, and shoreline erosion. The primary goal of these projects is to enhance wetlands by increasing the use of fresh water, nutrients, and sediments that will be provided by the freshwater diversions. Management of the outfall will route the fresh water through the wetlands and provide greater deposition of sediments in the marsh to offset subsidence, greater availability of nutrients to vegetation, and a more gradual release of fresh water to the benefit of wildlife, fish, and shellfish. Monitoring freshwater diversions will help to determine if any changes or modifications are needed in the operation.

Sediment diversion

Sediment diversions are projects that increase deposition of river-borne sediment in shallow bay areas that cannot keep pace with subsidence through sediment accretion. A small-scale sediment diversion project is designed around the concept of natural crevasse splay development, where a breach occurs in the bank of a river, sediment infilling begins within the surrounding distributary bays, and crevasse splay sediments eventually become subaerial and established with marsh vegetation. Large-scale sediment diversions on the Mississippi River are designed to be similar to the large natural crevasses such as the one at Baptiste Collette, LA. The primary goal of the project is to create and manage crevasses through the natural levee ridges of rivers and major distributary channels so that the natural land-building process can create emergent and submergent aquatic communities critical to the overall productivity of the deltaic systems. Monitoring of sediment diversions will help to determine the management of the crevasses.

Marsh management

In marsh management projects, structures actively manipulate local hydrology to control water levels and salinity and while at the same time allowing ingress and egress of marine organisms. Marsh management plans generally incorporate existing canal spoil banks, the construction of short levees to connect these spoil banks, the installation of water control structures, and/or the construction of pump and other control structures to introduce fresh water into the managed area and keep out saline water. The main goals of marsh management are to minimize the loss of emergent and submergent plant communities by reducing salinities, stabilizing water levels, and restricting tidal exchange. Monitoring of marsh management projects will help determine operation schedules for pumps and structures.

Hydrologic restoration

Hydrologic restoration projects typically try to reestablish former hydrologic pathways and flow regimes, with the goal of redistributing fresh water to influence water levels and salinity. These manipulations of the local hydrology will aid in the reestablishment of emergent and submergent plant communities. Monitoring will help determine hydrologic effects on vegetative growth.

Beneficial use of dredged material

Open water bodies and navigational channels are often sources of dredged sediment material that could be beneficially used to create vegetated wetlands or to restore areas of deteriorating marsh. Sediments can be pumped into confined or unconfined areas to a height conducive to marsh development. Once the dredged material settles, growth of emergent vegetation can be promoted. Monitoring will help determine the applicability of this technique for marsh creation.

Shoreline protection

Shoreline protection projects use structural and nonstructural measures such as breakwaters, bulkheads, revetments, longyard tubes, wave-dampening fences, and levees to reduce wave energies and erosive action. Critical shoreline areas threatened with hydrological breaches could be protected to prevent wave erosion and water exchange from jeopardizing the physical integrity of the shoreline and adjacent marshes. Vegetation could also be incorporated into the shoreline protection design to create habitat as well as an additional erosion buffer. Monitoring will help determine the effectiveness of different shoreline protection techniques in reducing wave erosion and in creating wetland habitat.

Barrier island restoration

Barrier islands provide protection to back-barrier bays, estuaries, and marshes. This protection includes reduction of erosional effects and wind and wave energies, dissipation of storm surges, and prevention of saltwater intrusion. Over the last century, Louisiana's barrier islands have been reduced by approximately 40 percent, resulting in loss of habitat and protection for the coastal mainland. Barrier island restoration projects are needed to reestablish this natural protective zone. Barrier island restoration projects include creation of barrier islands or augmentation of existing islands. The objectives of these projects are to increase the height and width of the barrier island and close any shoreline breaches by using dredged materials and vegetation. Monitoring will help determine the effectiveness of restoration and creation techniques.

Vegetative planting

Vegetative planting projects are designed to introduce suitable plant species into deteriorating marsh areas and along eroding shorelines to provide a buffer against erosive wave action. Vegetative plantings also provide many other functions such as sediment stabilization, sediment trapping, and habitat value. Monitoring will help determine the success and effectiveness of different vegetative planting techniques in reducing wetland erosional loss and in creating wetland habitat.

Sediment and nutrient trapping

Sediment and nutrient trapping projects use structural devices such as brush fences or earthen berms to reduce wave energies, promote the deposition of suspended sediments, and increase water clarity. The goals are to reduce erosion of windward marsh edges, promote the growth of emergent vegetation, and increase the overall productivity of the area. Monitoring will help determine the effectiveness of different sediment and nutrient trapping techniques.

Project-Specific Goals

A critical step in establishing a successful monitoring program is to define the goals of conducting the monitoring. If the goals are poorly defined, there will be no guidance in the establishment of protocols. The CWPPRA requires an evaluation of the effectiveness of each project in achieving its specific goals directed towards creating, restoring, protecting, or enhancing coastal wetlands. For example, a project using dredged material may be built to reduce wave energies and consequent physical erosion or develop a new soil and sediment base at a proper elevation to restore or maintain vegetated marsh. Each of these projects begin with a hypothesis or set of hypotheses related to the expected change in physical, biological, or chemical variables of the project area. These hypotheses then guide the monitoring program as to which variables will be monitored and how frequently.

Control Areas

The importance of using appropriate control areas cannot be over emphasized. Monitoring on both project and control areas provides a means to achieve statistically valid comparisons, and is, therefore, the most effective means of evaluating project success.

Selection of a control area should ideally be done before project initiation. Controls should be ecologically similar to the project area yet located far enough away so as to not be influenced by the project. Potential control areas can be selected by use of WVA methods or through more basic comparisons of structural and functional attributes. To ensure the selection of appropriate controls, an interagency team of experts should be convened. If there is any question concerning the similarity of the control and project areas, more than one control area should be selected.

It is recognized that in many areas of Louisiana, appropriate controls cannot be identified. In addition, the extent of wetland modification (both planned and unplanned) occurring in this region often results in the loss of control areas before monitoring efforts are completed. We also recognize that occasionally, especially in the case of very large projects (e.g., sediment diversions and freshwater diversions from the Mississippi River or watershed projects) it may be difficult to select control areas that adequately reflect the same marsh type and function as those being affected by the project. In these cases, two strategies could be adopted:

(1) Monitoring before and after project implementation. The disadvantages of this strategy include delay in project implementation, temporal variability, and the inability to clearly identify cumulative impacts of the project in comparison to unaffected areas. In addition, before and after monitoring cannot ensure that the same events are being monitored for comparison; therefore, interpretation of the results will be difficult. However, such monitoring would provide some indication of project performance and impact.

(2) Baseline data collection. This may be especially important in areas where controls cannot be selected for monitoring. As a "once only" data collection program, it would not delay project implementation as much as full-scale monitoring before implementation (as in (1) above). It would provide a datum against which changing biological variables could be compared. In some cases, existing data bases might be considered appropriate as baseline data. If this were to occur, an interagency team of experts or their scientific advisors should be convened to evaluate the suitability of the existing data bases for this purpose.

Although before and after monitoring and baseline data collection provide valuable information, they do not necessarily provide a statistically valid evaluation of projects.

Statistical Design

The size of the project area, the number of different habitats present, and the heterogeneity within those habitats should define the number of statistical strata necessary for an analysis.

Before sampling is initiated, it is important to determine the desired statistical power for the analysis (Fairweather 1991). This procedure involves using a variance estimate to calculate the number of samples required to detect a percentage difference between two means. Initially, the sample size required to achieve this power can be estimated from sample variances reported in the literature, and these estimates can be refined by using data collected in the control area selection process. It should be recognized that this power will often improve with the use of data transformations and more complex analysis of variance (ANOVA) designs.

Data analysis for a project may include a two-way ANOVA with area and habitat as main effects. In the most basic design, the null hypothesis to be tested is whether the mean value for some variable is equal between the project area and the control area(s) or between the pre-project and post-project condition. The alternate hypothesis should be whether the mean value for that variable at the project area is greater or less than in control areas or whether the pre-project condition is greater or less than the post-project condition. It is important to determine whether the mean value for the variable increased or decreased because of the project, taking into consideration other outside influences. If the alternate hypothesis is limited to only whether the variable increased, negative effects will be indistinguishable from no effects.

Wetland Value Assessment Methodology

The Wetland Value Assessment (WVA) methodology was developed as a uniform and quantitative habitat-based assessment methodology for use in prioritizing project proposals submitted for funding under the CWPPRA. The WVA quantifies changes in wetlands quality and quantity that are expected from a proposed project.

The WVA was developed by the environmental work group assembled under the Planning and Evaluation Subcommittee of the CWPPRA Technical Committee. It is strictly designed for use in ranking proposed CWPPRA projects, and it is not intended to provide a detailed, comprehensive methodology for establishing baseline conditions within a project area. In addition, it was developed for application to the following coastal Louisiana wetland types: fresh marsh (including intermediate marsh), brackish marsh, saline marsh, and cypress-tupelo swamp.

The WVA operates under the assumptions that optimal conditions for a coastal wetland can be characterized, and that any existing or predicted condition can be compared to that optimum to provide an index of wetland quality. The quality component of a wetland is estimated or expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of 1) a set of variables that are considered important in characterizing the particular wetland type, 2) a suitability index graph for each variable, which defines the assumed relationship between wetland quality and the variable, and 3) a mathematical formula that combines the quality value (habitat suitability index or HSI) for each variable into a single value for overall wetland quality.

The variables chosen to describe wetland quality in each of the marsh types are

V_1 - Percent of wetland covered by persistent emergent vegetation;
V_2 - Percent of open water area dominated by aquatic vegetation;
V_3 - Marsh edge and interspersion;
V_4 - Water duration in relation to marsh surface;
V_5 - Open water depth in relation to marsh surface;
V_6 - Mean high salinity during the growing season; and
V_7 - Aquatic organism access.

Predictions are then made as to how these model variables will change through time under two scenarios: with the proposed project in place and without the proposed project. A numerical representation of habitat quantity and quality is derived and compared between the two scenarios. Net benefits attributable to the project can then be compared to the net benefits from other projects in order to rank all proposed projects.

In most instances, variables measured in the monitoring program will provide data that can be used in the WVA models. Post-project WVA analyses utilizing these data can be compared with the results of WVA scores derived during priority project rankings in order to verify or refine the WVA. Such comparisons should not be used to judge project success or failure in achieving goals.

The monitoring work group recognizes the WVA as a planning tool and is therefore looking beyond the WVA in terms of monitoring variables. However, the WVA process can provide invaluable baseline information that may aid in the development of project-specific monitoring plans and/or the selection of appropriate control areas.

IV. APPROACH

The monitoring work group developed a broad-based, standardized approach for monitoring different variables. Each technical expert was asked to assemble a subgroup in order to

1) identify variables
2) develop a standard method or protocol for measuring each variable;
3) develop options for accurately and reliably measuring that variable over time;
4) develop options for accurately and reliably measuring that variable over space;
5) determine how the protocol, time, or space sampling might differ for each of the nine types of projects;
6) address a plan for statistical review;
7) address quality assurances;

8) develop generalized costs of monitoring option; and
9) determine existing monitoring efforts.

In addition to the above tasks, each monitoring subgroup was requested to complete a priority ranking for all variables to be sampled within their monitoring protocol. Each variable was assigned a numerical value of 1 for the highest priority through 4 for the lowest priority. This prioritization is according to the suitability of each variable in evaluating the various types of CWPPRA projects. For example, the highest ranking of 1 corresponds to the importance of a variable in determining if the primary objectives of a project are met. These rankings will provide a mechanism for selecting variables to be monitored according to the availability of funds.

The monitoring categories that comprise the following sections of this document are water quality, hydrology, soil and sediments, vegetative health, habitat mapping, wildlife, and fisheries. Each section establishes procedures that can guide personnel in the development of appropriate monitoring protocols.

I. TITLE: WATER QUALITY MONITORING IN COASTAL LOUISIANA

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IV. INTRODUCTION

The charge to the water quality monitoring subgroup was to develop a protocol documenting the approach the monitoring work group should use in establishing a water quality monitoring design. This design will provide data for the assessment of the different types of restoration projects on area water quality, and yet be consistent enough to allow for comparison of data between projects. The monitoring design must consider possible water quality effects on waters receiving discharge from restoration projects. The subgroup also felt that the protocol should be flexible in design to allow for successful monitoring of the many different types of restoration projects that will likely be attempted. It should be emphasized that many of the topics addressed by the water quality subgroup are directly related to the charges assigned to the hydrology, vegetative, and soil and sediment subgroups. Our subgroup recognizes the potential of fecal bacterial contamination by some CWPPRA projects; however, active monitoring programs by the Louisiana Departments of Health and Hospitals and Environmental Quality already address this issue. Frequency and intensity of collection of data for monitoring water quality are directly related to or influenced by the needs of these other subgroups.

V. GENERAL DISCUSSION

Pre-project Selection Considerations

The first recommendations of the water quality subgroup are that prior to actual selection of projects, the CWPPRA Planning and Evaluation Subcommittee must consider and perform the following tasks for each possible project:

1. Identify all superfund sites and sites proposed for superfund activities and landfills.

2. Identify all active and past oil and gas activities.

3. Identify any water quality problems existing in the basin.

4. Identify current and historical sources of water quality information.

5. Identify potential sources of water and bottom material to be used for restoration. Also, perform chemical analyses of these sources.

6. Evaluation of hazardous toxic radioactive waste by the U.S. Army Corps of Engineers (USACE).

If the above tasks are not considered for proposed restoration projects, then the potential monitoring costs may be quite high, and the possibilities for incursion of other nonrestoration- related costs could be extremely high. For example, if contaminated dredge material is used to reestablish a wetland, then the agency that performed the work may be responsible for clean-up of the site. Further, recent studies by Demas and Demcheck (1989) and Johnson and Leenheer (1992) have demonstrated remobilization of synthetic organic compounds from bottom material in saltwater environments on exposure to freshwater. Also, trace metals are known to be released from sediments under reducing conditions. Given these potential chemical reactions, it is quite possible that contaminants could be further dispersed within a project area unless the proper documentation of chemical concentrations within a restoration area has been made. Clean-up, in many cases, may be several times more costly than the actual cost of the project or the value of the area restored.

If no current data exist for a proposed restoration project, then it is recommended that the Planning and Evaluation Subcommittee consider that the following tasks may need to be accomplished prior to final selection of the project for restoration:

1. Randomly collect water and bottom material throughout the project area for analyses of priority pollutants. Stratify sampling such that potential contaminant sources are visited.

2. Depending on project objectives, document current conditions that the project is designed to mitigate, including such variables as specific conductance and salinity, suspended sediment, dissolved oxygen, pH, nutrients, total organic carbon, etc.

Variable Selection

Our subgroup recommends that the matrix in Table 3 be used in determining the water quality design variables that need to be monitored for those projects for which tasks 1-6 have already been performed. The variables to be monitored are listed in the priority of sampling necessary for the successful monitoring of potential changes in water quality, achievement of project goals, and the availability of funds.

The water quality monitoring subgroup feels that specification of sampling frequency is premature at this time, and that sampling frequency will vary according to the availability of preexisting data, size of project area, and the type of restoration project attempted. The subgroup feels quite strongly that the other protocols are all interrelated and that monitoring programs designed for specific projects consider these interrelationships in their design.

Table 3. Recommended prioritization of water quality variables for CWPPRA.

Project type	Salinity/ temperature	Physical, dissolved oxygen, pH, specific conductance	Nutrients, nitrogen, phosphorus	Trace metals	Synthetic organic compounds	Soil/suspended sediment			
						Nutrients	Trace metals	Synthetic organics	Size fraction analyses
Freshwater introduction and diversion	1[a]	2	2	4,2[b]	4,2	4,2	4,2	4,2	3,N
Sediment diversion	4	4	3	4	4	2	3	3	2,N
Marsh management	1	2	2	4,2	4,2	3	4	4	4,N
Hydrologic restoration	1	2	2	2,4	2,4	3	4	4	4,N
Beneficial use of dredged material	4	4	4,1	4,1	4,1	2	3,1	3,1	2,N
Shoreline protection	4	4	4	4	4	4	4	4	N
Barrier island restoration	4	4	4,1	4,1	4,1	2	3,1	3,1	2,N
Vegetative plantings	1	3	3	4	4	2	3,2	3,2	3,N
Sediment and nutrient trapping	3	3	1	4,1	4,1	2	3,2	3,2	3,N

[a]Priorities:

1 = Primary objective
2 = Secondary objective
3 = Tertiary objective - long term evaluation
4 = Lower priority - long term evaluation
N = As needed, unique to a specific project

[b]For columns that have two numbers listed, the first number indicates the priority of that variable(s) for projects where information for tasks 1-6 are available. The second number indicates the priority of the monitoring task for projects lacking information for tasks 1-6.

VI. METHODOLOGY

The above grouping of variables can be implemented by using a variety of methods varying widely in degree of sophistication, frequency of collection, and cost. The methods selected for use in monitoring water quality and the frequency of collection is dependent upon the goals of the project (that is, the type of restoration project), the variability of the aquatic environment to be monitored, and the funds available.

Methods available for the collection of data for the grouping of variables, their relative costs, and the environments for which they are best suited are listed below. It should be noted that the costs for installation of a data collection platform (DCP) are based on the assumption that the other monitoring subgroups have not already installed one. If, on the other hand, a DCP already exists for other monitoring variables (e.g., directional velocity meter), then cost of additional probes to measure desired water quality variables is greatly reduced.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Salinity/ temperature	Data collection platform	$20k instrumentation, $6-8k maintenance, $2k installation[a]	5-30 min	Highly variable, tidal situation
	Fixed monitors paper punch or digital recorder (hydrolab, mini monitor)	$4-6k maintenance	5-30 min	Highly variable, tidal situation
	Non-fixed data sonde (hydrolab)	$4-6k	5-30 min	Highly variable, tidal situations, remote areas
	Fixed bottle collector (ISCO)	$4-5 instrumentation	30 min-24 hr	Highly variable to stable
	Daily observer	$840 collection, $2k analysis	Daily	Stable(Mississippi River)

[a]Installation cost if platform and transmitter are already installed.

Salinity and temperature data need quality control and assurance information in the form of duplicate samples, calibration checks, standards, and field checks.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Other physical measurements-pH, dissolved oxygen, specific conductance, ORP (oxidation reduction potential), turbidity	Data collection platform	$20k instrumentation, $2-4k installation[a], $6-8k maintenance	5-30 min	Highly variable, tidal areas
	Fixed recorder paper punch or digital recorder	$4-8 maintenance	5-30 min	Highly variable, tidal areas
	Non-fixed data sonde (Hydrolab)	$4-6k	5 min-2 hr	Highly variable, tidal situations, remote areas

[a]Installation cost if platform and transmitter are already installed.

These methods need quality control and assurance information in the form of duplicate samples, calibration checks, standards, and field checks. Dissolved oxygen probes may need frequent servicing during certain seasons to prevent biofouling.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Nutrients: total and dissolved nitrogen spp, phosphorus spp, (ortho P, NH_4, NO_2, NO_3, Organic)	Fixed sampler requires chilling to 4°C	$20k instrumentation, $10-35k including analysis	1 hr - daily	Highly variable, tidal situations
	Fixed probes for NH_4, NO_3	$8-20k instrumentation, $2-3k installation[a], $3-4k maintenance, including analysis	5-15 min	Highly variable, tidal situations, nutrient-sensitive areas
	Daily observer	$8k-collection and analysis	Daily	Stable areas

[a]Installation cost if platform and transmitter already installed.

Samples need to be chilled to 4°C upon collection and treated upon collection and analyzed within 7 days of collection according to accepted methods (the current edition of the U.S. Geological Survey, U.S. Environmental Protection Agency or Standard Methods for the examination of water and wastewater). This grouping of variables needs quality control and assurance information in the form of duplicate samples, calibration checks, standards, and field blanks.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Trace metals As, Be, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Pb, Zn, Ag, Ni, Se	Fixed sampler	$240k (instrumentation and analysis)	Daily	Highly variable and sensitive areas
	Daily observer	$220k collection and analysis	Daily	Highly variable and sensitive areas
	Instantaneous	$200-800 variable dependent	NA	Unknown basin

Samples need to be fixed at time of collection. Holding times are less critical; however, possibility for sample contamination is much greater. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, calibration checks and blanks from laboratory, standards, and field blanks.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Synthetic organic (VOC's, pesticides-herbicides, insecticides, triazines, carbamates, semi-volatile priority pollutants, PCB's, dioxins)	Fixed sampler	$560k (instrumentation and analysis)	Daily	Highly variable and sensitive areas
	Daily observer	$550k collection and analysis	Daily	Highly variable and sensitive areas
	Instantaneous	$200-1,500 variable and analytical technique dependent	NA	Unknown basin

Costs of monitoring can be greatly decreased by employing gas chromatograph-flame ionization scans for those compounds extractable with methylene chloride, and by using portable gas chromatographs for volatile organic compounds and immuno-assay kits for triazine herbicides. Confirmation of detections by any of these methods must be performed by using quantitative gas chromatograph-mass spectrometer.

Samples need to be chilled or fixed and chilled at time of collection. Holding times are critical, depending upon class of compounds to be analyzed. The possibility of sample contamination is a concern. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, surrogate recovery, blanks from laboratory, field spikes, and field blanks. Data should be reported with percent recoveries for the compounds analyzed.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soils/sediment nutrients	Instantaneous, includes collection and analysis	$200	NA	NA

All samples should be chilled to 4°C immediately upon collection. Samples should be analyzed according to accepted methods. Quality control and assurance information need to be collected including duplicate analyses and laboratory standard and blank information.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soils/sediment trace metals	Instantaneous, includes collection and analysis	$400-1,400[a]	NA	NA

[a] Cost is per sample. Cost of sample analysis is dependent upon the number and kinds of elements requested and the amount of ancillary data (TOC, grain size, surface area, etc.) needed.

Samples need to be chilled at the time of collection. Holding times are less critical; however, possibility for sample contamination is much greater. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, and spikes and blanks from the laboratory.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soils and sediment synthetic organic compounds, insecticides, PCB's, semi-volatile priority polluntants	Instantaneous, includes collection and analysis	$440-3,000 sample-compound class dependent	NA	NA

Samples need to be chilled at the time of collection. Holding times may be critical depending upon class of compounds to be analyzed. Possibility for sample contamination is a concern. Analyses should be done according to accepted methods. This grouping of variables needs quality control and assurance information in the form of duplicate samples, surrogate recovery and blanks from laboratory, and field spikes. Data should be reported with percent recoveries for the compounds analyzed.

Grouping of variables	Instrument	Cost	Frequency of record	Environment
Soil and sediment grain size	Instantaneous, analyses only	$22-60	NA	NA

Table 4 lists sampling frequency and priority of variables based on the perceived needs of the different kinds of restoration projects and the variable priorities listed in Table 3.

The water quality monitoring subgroup has the following equipment and sampling comments on each type of restoration project in addition to the above matrix:

Freshwater Diversion

The type of recorder installed and readout will be determined by whether the structure is "managed" or simply stage activated. Managed projects should have DCP's installed. Further, sampling of nutrients, trace metals, synthetic organic compounds, and turbidity is project dependent and greatly influenced by the availability of historical and recent data. Secondary objectives of projects, such as enhancement of fishery resources may require monitoring of turbidity on a realtime basis. Initially, the water quality monitoring subgroup recommends instantaneous (that is, only one initial sample) samples for the chemical variables listed for both water and sediments. If, however, abnormal concentrations of any compounds are detected, then sampling frequency will need to be increased to account for potential water quality effects on the project area and any areas impacted by waters exiting the project area.

Table 4. Sampling frequency and priority of variables.

Project type	Salinity/ temperature	Physical, dissolved oxygen, pH, specific conductance	Nutrients, nitrogen, phosphorus	Trace metals	Synthetic organic compounds	Soil/suspended sediment			
						Nutrients	Trace metals	Synthetic organics	Size fraction analyses
Freshwater introduction and diversion	R[a]	R2[b]	I2N	I4,2N	I4,2N	I4,2	I4,2N	I4,2N	I3N
Sediment diversion	4N	4N	I3N	I4,2N	I4,2N	I2N	I3N	I3N	I2N
Marsh management	R	R2N	I2N	I4,2N	I4,2N	I3N	I4N	I4N	I4N
Hydrologic restoration	R	R2N	I2N	I2,4N	I2,4N	I3N	I4N	I4N	I4N
Beneficial use of dredged material	I4	I4	I4,1N	I4,1N	I4,1N	I2N	I3,1N	I3,1N	I2N
Shoreline protection	I4N	I4N	I4N	I4N	I4N	I4N	I4N	I4N	N
Barrier island restoration	I4N	I4N	I4N	I4N	I4N	I2N	I3N	I3N	I2
Vegetative plantings	I1	I3N	I3	I4	I4	I2	I3,2	I3,2	I3
Sediment and nutrient trapping	I3	I3	I1	I4,1	I4,1	I2	I3,2	I3,2	I3

[a]Frequency of collection
I = Instantaneous
R = Realtime

[b]Priorities:
1 = Primary objective
2 = Secondary objective
3 = Tertiary objective - long term evaluation
4 = Lower priority - long term evaluation
N = As needed, unique to a specific project

Sediment Diversion

Because sediment diversion projects do not require active management, realtime data are not required except for specific projects (should match up with the flow monitoring requirements identified by the hydrology monitoring subgroup). The water quality monitoring subgroup recommends one initial set of samples for the chemical variables listed for both water and sediments be collected from the source water body and the receiving water body if recent chemical data are unavailable.
If, however, abnormal concentrations of any compounds are detected, then sampling frequency will need to be increased to account for potential water quality effects on the project area and any areas impacted by waters exiting the project area.

Marsh Management

Salinity and temperature data need to be collected on a continuous basis for these kinds of projects. DCPs need to be installed for control structures, but digital recorders can suffice for areas out in the marsh. Collection of dissolved oxygen and other physical variables on a realtime basis is dependent upon secondary objectives of the project; otherwise it should be collected whenever any site visits are made. For example, enhancement of fisheries resources would require monitoring of dissolved oxygen on a continual basis.

Frequency of water and soil and sediment chemistry sampling will be project dependent. Soil chemistry should be sampled at least once annually to provide information on factors that might affect plant growth.

Hydrologic Restoration

Salinity and temperature data need to be collected on a continuous basis for these kinds of projects. Installation of DCP's depend on the specifications of the hydrologic monitoring subgroup. Collection of dissolved oxygen and other physical variables on a realtime basis is dependent upon secondary objectives of the project; otherwise data should be collected whenever any site visits are made. For example, enhancement of fisheries resources would require monitoring of dissolved oxygen on a continual basis.

Frequency of water and soil and sediment chemistry sampling will be project dependent and based on availability of historical data. If, however, abnormal concentrations of any compounds are detected, then sampling frequency will need to be increased to account for potential water quality effects on the project area and any areas impacted by waters exiting the project area.

Beneficial Use of Dredged Material

The water quality monitoring subgroup recommends that standard elutriate tests be performed on source material prior to its dredging and dispersal. If the source material has been recently tested, then elutriate tests do not need to be performed; however, some chemical testing at the outfall pipe is advised.

Shoreline Protection

These kinds of projects are not expected to have any impacts on water quality; however, specific projects may require chemical samples from water and sediments before and after the project is completed.

Barrier Islands

These kinds of projects are not expected to have any impacts on water quality; however, specific projects may require chemical samples from water and sediments before and after the project is completed.

Vegetative Plantings

The water quality monitoring subgroup recommends that an initial synoptic sampling of the project area be completed (unless recent historical data exists) prior to initiation of the project. Sampling, especially soil and sediments, is recommended if problems are observed in the growth of the targeted plant species. Areas receiving agricultural runoff, especially herbicides, may need seasonally targeted sampling to determine factors effecting the success of the project.

Sediment and Nutrient Trapping

The water quality monitoring subgroup recommends that an initial synoptic sampling of the project area be completed (unless recent historical data exists) prior to initiation of the project. Additional yearly samples may be required to determine the effectiveness of an individual project. It should be noted that only those compounds identified during the initial synoptic sampling need to be reanalyzed.

VII. HISTORICAL DATA

Inventory of Existing Data

Maps and an inventory of current and historical U.S. Geological Survey (USGS) chemical and monitoring sites are on file with the monitoring work group. Nutrients, trace metals, pesticides, PCB's, and major ions in water and nutrients, trace metals, pesticides, and PCB's in sediments have been collected at most of the sites plotted on the map. Many of the current sites have suspended sediment and discharge collected on routine basis. Volatile organic compounds (VOCs), triazine herbicides, and semi-volatile priority pollutant data have not been collected at any USGS sites with the exception of the Mississippi, Calcasieu, and Mermentau Rivers.

A listing of the Louisiana Department of Environmental Quality (LDEQ) water quality stations also is on file with the monitoring work group. The LDEQ does not analyze for synthetic organic compounds on a routine basis at any of their sites with the exception of VOC's on the Mississippi River. The LDEQ does have synthetic organic compound data for the Calcasieu River system.

A listing of all stations in the U.S. Environmental Protection Agency STORET system also is on file with the monitoring work group. A total of 2,922 stations are listed for the Louisiana coast and inland to Interstate 10.

A listing of all USACE water quality sites is available from the water quality monitoring subgroup.

Also on file with the monitoring work group is a listing of all current RCRA and CERCLA sites in Louisiana. As previously stated, location of these sites should be considered by the CWPPRA Planning and Evaluation Work Group prior to project selection.

Potential Upgrading of Existing Sites

All federal agencies should be willing to increase the variables at existing sites to meet the needs of specific restoration projects if funds are provided to cover the additional costs of collection and analyses.

VIII. DATA STORAGE

The water quality monitoring subgroup recommends that all agencies that collect water quality data store that data electronically, review it for quality control prior to entry into data storage systems, enter data in a timely fashion, and have the capability of transferring data to the appropriate agencies.

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IV. INTRODUCTION

The primary purpose of hydrologic monitoring is to collect data required for the scientific evaluation of completed projects. In this evaluation, the success of a completed project will be measured by the number of acres of wetlands saved or created. This effort is intended by all involved—Federal, State, and local governments and private citizens alike—to be successful and have a positive, lasting effect in coastal Louisiana and to either preserve or create a measurable impact on our marshes and coastline. To measure the degree to which these activities and projects are being successful, physical variables must be quantified in the beginning, during construction, after completion, and for posterity. These variables will define the problem, define human impact, measure progress, suggest midcourse changes, improve design and performance of future projects, and ultimately justify our efforts and direction.

The second purpose of monitoring is to determine changes in hydrologic variables to assist in the design of future projects. The third purpose of monitoring is to determine how the selected design criteria and wetland values used for assessment interact to define the degree of success for each project type. The fourth ranking purpose is to develop a coastal network of hydrologic monitoring stations. The four purposes make up a ranking system against which the need for hydrologic data collection can be assessed.

V. GENERAL DISCUSSION

Precipitation

In the evaluation of many of the CWPPRA projects, the duration and volume of water in a wetland area are important variables for determining the quality of the wetland. Precipitation augments the volume and duration of water. For example, retention of local rainfall because of poor drainage contributes to long duration flooding and increases the quantity of shallow open water. The quality of the wetland is decreased. Because precipitation is a source of fresh water, it influences the quantity of fresh water needed to improve circulation, reduces salinity levels, and promotes growth of vegetation. Precipitation is a source of water contributing to overland and channel flow and will affect any flow measurements in the wetland and adjacent channels. Drought, the absence of precipitation, dries up the wetland and lowers water levels, which in turn increases the likelihood of saltwater intrusion. Precipitation is also a source of groundwater recharge.

Evaporation

Evaporation and transpiration reduce the quantity of water actually reaching the soil surface. They are indicative of changes in the moisture deficiency of a basin and affect the volume and duration of water. In areas of high evaporation, a larger volume of water is needed to maintain open water areas. Rates of evaporation vary depending on meteorological factors and the nature of the evaporating surface.

Wind Speed and Direction

Winds affect water levels, drive tides, and push large quantities of gulf waters into or out of the marshes. Such wind tides can increase salinity levels and depths. Winds affect wave height and cause erosion of lake and bay shoreline and barrier islands. Winds can cause set up in open water bodies, increasing volume of water entering adjacent wetlands. Wind speed and direction data indicate the presence and timing of frontal passages, tropical disturbances, and other weather types. Wind data can be used to develop wind fields, and make estimates of evaporation rate, flows, and surface currents.

Water Level

The volume and duration of water in a wetland area are important variables in determining the quality of the wetland. Excessive volume and duration of water can have an adverse effect on a wetland by stressing and drowning vegetation, increasing breakup of floating marsh, and increasing the vertical load forces on the wetland, which in turn increases settlement. Insufficient water can deprive a wetland of nutrients and foster growth of nonwetland vegetation. Water-level data are the primary indicators of hydrologic conditions in a wetland, of seasonal flooding, and of extreme events such as

floods and hurricanes. They are indicators of tidal exchanges and sea-level change. Water-level data are important in interpreting aerial photography and converting bathymetric and topographic data to a common datum. Additionally, the data are used in making decisions on regulating inflow and outflow in a water control project such as a marsh management project.

Bathymetry

Bathymetry can be used in conjunction with aerial photography in quantifying increases and decreases in open water areas in determining the success of a project. Bathymetry can be used to measure sediment deposition, subaqueous delta development, and scour. Bathymetry can also provide valuable information on water depths, location of channels and crevasses, and overall marsh bottom configuration that will affect different hydrologic measurement and management practices.

Topography

Topography can be used in conjunction with aerial photography in quantifying increases and decreases in wetland areas and barrier islands. The elevation of the ground in a wetland affects the type of vegetation present and the depth and duration of water. Topography can be used to measure sediment deposition, subaerial deltaic development, and subsidence. Topography can also provide valuable information on channel obstructions, natural and artificial banks and levees, and points of ingress and egress.

Salinity

It is important to quantify the salinity in a project area because of its influence on wetland habitat. Wetland habitats are characterized by salinity levels, i.e., fresh marsh and saline marsh. Saltwater intrusion is a major cause of loss of freshwater wetland habitat in areas such as the Mississippi River delta because of its adverse impact on freshwater vegetation. Project types such as marsh management, freshwater diversion, and hydrologic restoration are geared toward regulation of salinity levels in a project area to reduce wetland loss.

The main body of information on this variable can be found in the report on water quality monitoring.

Discharge, Velocity, and Direction

Discharge, velocity, and direction data are important in defining circulation patterns and tidal characteristics within a project area. Circulation affects the presence and variability of nutrients in a wetland; estuarine organisms; and turbidity, salinity, and other water quality variables. Water exchange is an important variable in the quality of cypress-tupelo swamps. Discharge can be correlated with suspended sediment to quantify the amount of sediment available for deposition. Discharge measurements can be used to "rate" a structure to determine the volume of flow entering or exiting a water control structure, such as freshwater diversion or hydrologic restoration structures given certain headwater and tailwater conditions. Velocity and direction data can assist refuge managers in determining when to open or close a structure and for how long.

Suspended Sediment

Sediment is the building block of a wetland creation project. Too much sediment can change a

wetland into upland; not enough sediment to counteract subsidence and erosion can result in open-water areas. Sediment replenishes the existing soil, providing nutrients to the vegetation. The quantity of sediment entering a wetland area is important to maintain a diverse habitat and a healthy wetland. Suspended sediment data can be used to determine the quantity and gradation of sediment available for deposition into the coastal zone. Suspended sediment data can also be used with other data to determine where scour and deposition will occur and why aggradation or degradation has taken place in an area.

Groundwater

Groundwater level and duration may affect the health of a wetland through waterlogging or drainage. Waterlogging may be evidenced by groundwater levels even when surface water levels are down. Some project types, such as marsh management and hydrological restoration, are intended in part to reduce water levels at certain times, e.g., by draw downs or by increasing drainage to decrease waterlogging. In these circumstances, measurement of groundwater levels would augment information obtained from surface water-level measurements and would support evaluation of the effectiveness of water management techniques.

Soil Salinity

Changes in hydrology that allow regular or intermittent saltwater intrusion can increase soil salinity (the salinity of interstitial water trapped within the sediment). Limited by a relatively low rate of exchange between interstitial water and overlying surface water, soil salinities can persist beyond the time when surface water salinities are apparent, even when saltwater intrusion is intermittent. Soil salinities can affect marsh vegetation and can thus affect wetland health. For projects in which salinity mitigation is an objective, principally freshwater diversions but perhaps also marsh management projects, the measurement of soil salinities would contribute to interpreting expected responses of vegetation. While soil salinities are not currently proposed for monitoring by the soils and sediments monitoring subgroup, it would be efficient to link measurement of soil salinity with that effort because the soils monitoring subgroup will already be equipped to collect soil cores.

Common Datum

Semi-permanent bench marks should be set at each project location. Many of these projects will require a common datum be established by ordinary leveling, global positioning system (GPS), or as a last resort, water level ties. Technical experts will provide information on an acceptable bench mark (e.g., a 35-foot brass rod) at each project location.

The datum of a gauge may be a recognized datum, such as NGVD, a local datum related to project or research activities, or an arbitrary datum selected for expediency or convenience. Normal practice is to select a recognized datum; however, cost may be a determining factor.

A permanent datum must be maintained so that only one datum for gauge height record is used for the life of a data collection station. To maintain a permanent datum at each gauging station requires at least two or three reference marks that are independent of the gauge structure. Reference marks are independent auxiliary datum references used to verify or reestablish the gauge datum. All gauges should be periodically checked by running levels or GPS and by using the reference marks to maintain a fixed datum.

A common datum for all the gauges in the coastal zone would be beneficial. A common datum allows for the comparison of data within the project area and throughout the coastal zone. However, this may prove to be cost prohibitive or infeasible. Reference marks may use a common datum such as NGVD but will contain different adjustments to the datum.

The costs to establish a datum for a water-level gauge has not been included in the cost of the gauge presented in this report. Costs will vary depending on the location of the gauge. A baseline of levels has been established by the U.S. Army Corps of Engineers (USACE) along the Mississippi River into Southwest Pass. Levels have also been run for the Lower Atchafalaya River. To tie into these baselines may be expensive; the cost of the Mississippi River levels was $40,000 for 20 miles of levels. GPS has been used in the Lake Verret-Atchafalaya area very successfully. The field work and post processing costs were approximately $26,000. More than 10 gauge datums were verified with the GPS method; the cost per gauge is therefore reasonable. In using GPS, consideration should be given to grouping gauges in a geographical area to reduce costs.

Ongoing Programs

The USACE has a gauging program to evaluate the effectiveness of their projects. The gauges are located predominantly along rivers, channels, and bayous. The networks, type of gauge, and parameters measured were designed for projects such as navigation, flood control, and water supply. Because many of the gauges are continuous recording or realtime, they can provide valuable information for the CWPPRA projects in the vicinity. Use of USACE gauges can minimize the cost o the CWPPRA monitoring program.

The USACE also installs gauges for data collection during the design phase of their projects. Although the data collection is short term and often uses an arbitrary datum, it can provide information on pre-project conditions in the coastal zone.

The USACE and U.S. Geological Survey (USGS) have a cooperative stream-gauging program with many gauges in the coastal zone. Again, the gauges are located predominantly along rivers, channels, and bayous and were installed mainly for flood control purposes.

The USGS and the Louisiana Department of Natural Resources have a cooperative program to monitor state wetland restoration projects in the coastal zone. The collection of stage, precipitation, salinity, wind speed and direction, and velocity data are primarily in realtime.

The U.S. Fish and Wildlife Service has installed some gauges in several of their refuge areas to monitor water levels, salinity, and tidal characteristics. The gauges collect realtime data.

The National Ocean Survey and the National Geodetic Survey have placed tide recorders and related equipment in the coastal zone. Data from these equipment are available to establish base conditions in some projects locations.

Data protocols are usually in ASCII format or are convertible to ASCII. The use of these data will minimize costs to establish base conditions and monitor project hydrology.

VI. METHODOLOGY

Precipitation

Precipitation is measured on the basis of the vertical depth of water that would accumulate on a level surface if the precipitation remained where it fell. Recording precipitation gauges are recommended when continuous records of precipitation are required. The tipping bucket continuous recording gauge is used with Handar equipment for realtime transmission. Other recording gauges include the weighing type gauge and the float type gauge. Precipitation is accrued on an hourly or more frequent basis until the gauge is reset. Standard rain gauges are used when continuous records are not required. These gauges need to be read daily and emptied. Precipitation is reported on a daily basis. The units of measure for precipitation data are generally inches.

Precipitation measurements are subject to various errors. Individually, the errors are small but cumulatively they could be significant. Errors are smaller for standard rain gauges than recording gauges. In rainfall of 5-6 inches per hour, the bucket of a tipping bucket gauge tips every 6-7 seconds. About 0.3 seconds is required to complete the tip, during which some water is still pouring into the already filled compartment. The resulting recorded rate may be 5 percent too low; however, the water is all caught in the gauge reservoir and can be measured independently of the recorder. The difference can be prorated through the period of excessive rainfall. The most serious error is the deficiency of measurements caused by wind; consequently, wind shields are recommended to reduce the error.

Methodology recommended for a project will depend on the uses for which the precipitation data are intended and the site at which the gauge will be located. Where accumulated volume of overland flow is of interest, the depth of rainfall measured by standard rain gauges should be adequate if the site is accessible on a daily basis. Recording precipitation gauges reduce the need for daily visits and can be serviced during the project site visits. Recording gauges also provide hourly or more frequent data. The use of tipping bucket gauges takes advantage of the Handar equipment used to transmit other hydrologic variables in realtime. For high priority projects, the standard protocol recommended is the use of tipping bucket gauges at water level or water quality sampling sites. This practice allows for continuous data collection and realtime transmission. The cost of a Handar 444a tipping bucket rain gauge is low, about $800. Installation costs are included in the cost of installing the other equipment. Data of good quality can be obtained by establishing a system of quality control that includes not only periodic inspection of stations and maintenance or repair of equipment, but preliminary checking of data by internal consistency checks. Maintenance costs should be no more than $500 per year, including analysis of the data for quality control.

Precipitation should be recorded continuously by using the same recording periods as the National Weather Service. Hourly incremental precipitation data can be determined from the data collected. Monthly and annual totals can be computed from the data with adjustments for periods of high intensity.

The uses for which the precipitation data are intended should determine network density. A relatively sparse network of stations would suffice for determining annual averages over large areas. In general, sampling errors, in terms of depth, tend to increase with increasing areal mean precipitation and decrease with increasing network density, duration of precipitation, and size of area. Average errors

tend to be greater for summer than for winter precipitation because of the greater spatial variability. The minimum density of precipitation network recommended for general hydrometeorological purposes for flat regions of tropical zones is 230-350 mi^2 per station.

For lower priority projects, records from nearby precipitation stations may be sufficient. Gauges should be added, if necessary, to achieve a good spatial density. The cost to purchase and install a recording rain gauge is approximately $1,400 with maintenance costs around $1,000. Tipping bucket gauges can also be installed at existing realtime stage recording sites; the cost to purchase and install this equipment is approximately $800 for the gauge and $1,000 to install. Maintenance costs should be no more than $500 per year but will include some analysis of the data for quality control.

Evaporation

The pan is the most widely used evaporation instrument. The operation of a pan station is relatively inexpensive and should provide good estimates of annual evaporation. Water levels in the pan are measured, and the evaporation, in inches, is computed as the difference between observed levels, adjusted for any precipitation recorded. Three types of exposures are employed for pan installation: sunken, floating, and surface. Burying the pan tends to eliminate boundary effects such as radiation on the side walls and heat exchange between the atmosphere and the pan, but causes observational problems.

In the coastal zone, there are currently no evaporation pans from which evaporation rates can be determined. For projects where precipitation and evaporation are high priorities, one evaporation pan should be installed in the hydrologic basin along with a precipitation gauge for continuous data collection and realtime transmission. Purchase costs will be approximately $800 for the pan. Installation and maintenance costs will be included in the cost of the precipitation gauge.

Evaporation should be recorded continuously by using the same recording periods as the National Weather Service. Annual, seasonal, and monthly evaporation rates can be determined from the data collected. One evaporation pan per hydrologic basin should be sufficient spatial density.

Wind Speed and Direction

Wind speed is measured with anemometers. Both cup and propeller anemometers are commonly used. A wind vane measures the direction from which the wind is blowing. Surface winds are generally reported in miles per hour, meters per second, or knots. Surface wind directions are generally reported in degrees to the nearest 10 degrees.

Reported wind speed above 3 kn is nominally accurate to plus or minus 1.5 kn under steady-state conditions. Wind vanes are constructed to indicate direction within plus or minus 5 degrees.

Ideally, surface-wind sensing equipment should be placed 20 ft above the ground on a freely exposed tower over terrain that is relatively level and free from obstructions to wind flow.

For high-priority projects, the standard protocol recommended is to use automatic wind-speed and direction equipment linked to the Handar communication equipment for realtime data collection. Wind-speed and direction equipment would be installed at each water level and water quality data

collection station with a data collection platform. The advantages are continuous realtime collection of data and reduced maintenance costs of on-site equipment. This protocol is really the only effective way to measure data of this type. Cost to purchase the equipment is about $600. Installation costs are included in the cost for a water-level or water-quality gauge. Maintenance of wind equipment should be performed at specified intervals to ensure continuity of data to prevent malfunctions. Maintenance costs should be no more than $500 per year. Maintenance costs include some analysis of the data for quality control.

The recommended frequency for wind-speed and direction data collection is continuous. In many cases, the dynamics of the wind data may be more important than the actual data. The same reporting periods at the National Weather Service--hourly, daily and monthly summations--should be adopted.

Spatial distribution of wind-speed and direction equipment will be dependent on the use of the data collected and the complexity of the project area. As data collection efforts move east across the coastal zone, wind data become more important. Wind gauges are important in the Barataria Bay, Breton Sound, Atchafalaya floodway, and Lake Pontchartrain hydrologic basins. Wind gauges should be distributed closer than a 50-mi radius in these basins because large-scale wind cells and circulation patterns develop in them. Wind gauges become less important in the Terrebonne and Teche-Vermilion river basins, and are generally not important in the Mermentau and Calcasieu-Sabine river basins. Because land breezes are different from sea breezes, data at airports should be only cautiously used in the coastal zone. Fewer wind gauges are needed if the data are to be used in conjunction with a wind-field model.

Where data collection is a lower priority, continuous records from a second site within a 40-mi radius are sufficient if this second site has similar hydrologic and hydraulic characteristics. Wind-speed and direction gauges should be installed at existing realtime stage recording sites to achieve a good spatial distribution. The purchase and installation costs at each site are approximately $600 to purchase and $500 to install, but installation costs will be lower where precipitation gauges are also installed. Maintenance costs should be no more than $500 per year, including analysis of the data for quality control. Purchase and installation of recording wind gauges without realtime capabilities should cost approximately $3,600. Maintenance costs should be no more than $1,000 per year.

Water Level

Stage is a measure of water-level surface in a body of water. Stage can be measured discretely or continuously over a period of time. Depending on the measurement device, accuracy limitations will range from 0.01 to 0.1 ft.

Stage measurements can be made by using several different devices. A staff gauge is the simplest of stage measurement devices. Water-level measurements are made by visual inspection of a vertical graduated staff. Water-level measurements can also be measured with a continuous stage recorder. The water levels are determined by using a tape-float system or pressure transducer. Readings are recorded on a regular time interval on digital recorders, graphic recorders, or electronic data recorders. Electronic data recorders are devices such as basic data recorders where the stage values are stored in memory and downloaded into a computer during field inspections or into data collection platforms that transmit the data via satellite, radio, or telephone on a realtime basis.

Stage recorders can be temporary or built to last over a long period of time and under various environmental and climatological conditions. Cost can range from $200 for a staff gauge to $20,000 for some data collection platforms. Some of this equipment can be rented.

Where cost is not a major issue and where water-level data are a high priority variable data collection platforms are recommended as the standard protocol. Data collection platforms have a high equipment and installation cost for the stage recorders but reduce the cost of collecting other variables such as water temperature, dissolved oxygen, and precipitation because the equipment that measures the other variables can also use the data collection platform. Data collection platforms reduce maintenance costs; maintenance personnel can see when a gauge is not functioning properly and can perform maintenance on a less frequent basis than without the data collection platform. Because maintenance is performed immediately rather than on a scheduled basis, periods of bad or missing data are reduced. Equipment costs will be $5,000 and installation costs $3,000. Maintenance costs will range from $3,000 to $6,000 per year ($5,000 will be used for estimating purposes), including analysis of the data for quality control.
The measurement of stage over time can be from one reading at a site to whatever interval is required, such as daily, hourly, or less over a determined period.

Measurement of stage at one location can be compared to other water levels within a certain range of the gauge in common hydrologic areas. Spatial distribution of water level gauges will depend on the project type and the hydrologic characteristics of the project area.

At many project areas, existing stage recorders or realtime data collection platforms in the vicinity will suffice. At some locations, an observer may be hired to daily record stage from a staff gauge; a paid observer usually receives about $365 per year. Purchase and installation of the staff gauge would be about $1,100, with annual maintenance costs about $500 per year. Some sites can be monitored continuously for a short time, i.e., 30 to 180 days to determine the relationship of stage at the project to a nearby permanent location. Other sites can have a staff gauge installed, which would be read during the site visits. Purchase and installation would be approximately $1,100. These protocols are best suited for projects where collection of water-level data is a low priority.

There will be some projects where the level of the water is not as important as the forces of the waves and littoral transport. Directional wave gauges may be necessary to determine these forces. Wave gauges are placed in deep and shallow water near the area of interest. Data are gathered for a 2-3 year period and used to develop a wave model. The wave model predicts the near-shore wave climate based on the deep water wave gauge data. The model then replaces the shallow water gauges. Wave gauges cost about $20,000 each. Installation and maintenance costs are similar to the realtime data collection platforms.

The National Oceanic and Atmospheric Administration (NOAA) has several wave gauging stations in the Gulf of Mexico as do many of the oil companies. Use of these gauging stations may be more reliable and less expensive than installing additional deep water gauges.

Bathymetry

Bathymetric surveying is the measurement of depths of water bodies. Bathymetry is generally measured from a boat by using positioning equipment and a fathometer. Range lines are laid out to be surveyed on a routine basis. Positioning is usually recorded in x-y coordinates; depth is recorded in

feet. Data can be recorded electronically and even transmitted over telephone hookups.

Costs for bathymetry data collection will vary according to the size of the area to be surveyed and the depth of water. Some shallower water bodies may have to be surveyed by using topographic land surveying techniques. Costs will also depend on desired survey accuracy. Costs for a bathymetric survey have been included in the costs for a topographic survey because most of the project sites will probably require a combination of the two types.

For projects where this variable is a high priority, bathymetry should be measured once before project implementation and at least once during each 3-year reporting period. Frequency, methodology, and survey coverage will be project and priority dependent. Spot elevations should be taken annually in conjunction with aerial photography to provide supplemental information.

Topography

Topographic surveying is the measurement of the elevation of land. Topographic surveys can be taken by using three different methods. (1) A surveyor can "walk" an area, recording horizontal location and vertical elevation. A survey that uses the water surface as a base and measures elevations with a rod is less expensive than a survey that uses positioning equipment and a fathometer. The accuracy of such a survey is about 0.5-1.0 ft. (2) Surveying with GPS equipment should be used when some error in measurement is acceptable. With GPS equipment, the use of range lines to determine location is unnecessary. Data can be recorded electronically. (3) Conventional equipment is used when horizontal and vertical accuracy is critical. Range lines are laid out to be surveyed on a routine basis. Positioning is usually recorded in x-y coordinates; depth is recorded in feet.

Costs for topographic surveying will vary according to the size of the area to be surveyed, its accessibility, and the ground conditions. Survey costs can range from $5,000-$10,000 per square mile for a "rod" survey or GPS type survey, to $30,000-$60,000 per square mile for a conventional survey. Depending on the project area characteristics and the presence of permanent bench marks, these costs could be double or higher.

For projects where the magnitude of yearly accretion on an existing wetland is measured in millimeters, traditional topographic surveying techniques are not suitable. Three different methods can be used to measure accretion of this type. First of all, soil cores can be taken to determine mineral contents. Generally, the presence of minerals in an organic layer indicate accretion. Second, direct measurement can be made by using feldspar marker horizons at intervals from the edge of streambanks. Soil cores are taken to measure accretion. Problems can arise with this method if the existing surface is porous and spongy; the feldspar can diffuse through a zone for several centimeters. A third method is the use of experimental sediment trapping devices. Problems can arise with animals digging in the vicinity of the traps and throwing additional sediment into the traps. All three methods were used in a recently completed monitoring program for a small-scale freshwater diversion project on the Mississippi River. This type of topographic monitoring would also be suitable for a vegetative planting, marsh management, sediment trapping, and hydrologic restoration projects. Costs for the materials and evaluation of the cores should be less than $1,000 per year. During the site visits, cores could be taken and sediment traps emptied.

For projects such as sediment diversion, barrier island restoration, dredged material, and shoreline protection, where this variable is a high priority, topographic surveys should be taken once before

project implementation and at least once during the 3-year reporting period. Frequency, methodology, and survey coverage will be project and priority dependent. Spot elevations should be taken annually in conjunction with aerial photography to provide supplemental information. For the other project types, measuring accretion by using soil cores, feldspar marker horizons, and sediment trapping devices is recommended.

Salinity

Salinity is a measure of dissolved mineral in sea water in units of parts per thousand. Salinity is typically measured by using electric resistance meters.

Water samples can be collected on a regular basis and analyzed for some projects. Recording salinity or conductivity meters can be installed on those projects needing frequent salinity data.

There are water-level gauges such as the Endeco 1159 that also measure temperature and salinity in addition to stage. Hydrolab H_2O equipment is another gauge that measures all three variables. Both can be used with data collection platforms. Costs for the equipment vary between $8,700 and $10,500. Maintenance costs should be around $2,000 per year. Where water level, salinity, and water temperature are high priorities, this is the recommended standard protocol. The advantages are the ability to acquire realtime data in hourly increments. The disadvantage is mainly in the cost of the equipment. In fresh and intermediate marshes, salinity levels in the growing season, from March through November, are important. In the interests of cost, monitoring could be realtime during the growing season and monthly for the remainder of the year.

Where salinity is a lower priority, monthly collection is recommended in conjunction with site visits. Salinity can be measured during the site visits by using a field instrument such as a YSI 3800, which measures water temperature, salinity, and dissolved oxygen, among other things. The cost of this equipment is about $5,000. Existing data collection platform equipment can also be upgraded to measure and record salinity. Purchase and installation costs will be about $3,100. Maintenance costs should be no more than $500. Further information on methodology, recommended protocol, cost, and frequency of data collection can be found in the water quality monitoring subgroup report.

Discharge, Velocity, and Direction

Discharge is the measurement of volume of water passing a given point within a given period of time. Units of measurement for discharge are typically cubic feet per second.

To determine discharge, a measurement of velocity and cross-sectional area is necessary. Velocities are usually measured with mechanical velocity meters, electromagnetic velocity meters, and acoustical velocity meters. Some of these meters can measure only in one direction, while some can measure bi-direction, and others in any direction. The measurement of area is made with physical sounding of depth or by using electronic depth finders.

Discharge measurements are instantaneous measurements, that is, measured at one point in time. Some projects require that the discharge rate be known over a period of time. Typically, discharge over a period of time is determined by using a stage-discharge relationship. A series of discharge measurements is made at different stage elevations and a relationship between stage and discharge is determined. Unfortunately, this stage-discharge relationship does not apply to tide-affected areas.

Another method to determine continuous discharge is to measure continuous velocity and to develop a relationship between velocity and discharge.

Discharge measurements are typically made from bridges, boats, or even by wading the channel. Discharge measurements typically cost around $800 for 20 measurements in small channels. Costs will vary depending on site location and hydrologic conditions.

Some projects need only velocity and direction measurements to determine the movement of water instead of the volume of water moved. Velocity and direction measurements can also be used to monitor the tidal inflow and outflow through gaps and openings in the barrier islands. Tides can transport sediments into and out of the barrier island area. Velocity and direction recorders that interface with the data collection platforms are available. This equipment costs around $5,100. Installation costs are around $500. Maintenance costs are approximately $4,000. Maintenance costs include the cost to compute discharge.

The standard protocol for data collection will vary with project type and location. For example, large scale uncontrolled diversions will require discharge measurements to be taken from a boat on a routine basis. Conventional measurements should be taken where cross-sectional geometry fluctuates and where the relation between velocity and discharge will vary over time. Velocity and direction measurements can be taken where the cross section does not appreciably change over time and where the direction of flow is more important than the volume of flow. Frequency and spatial distribution of discharge measurements will also be project dependent. Discharge measurements could be taken during the project visits.

Suspended Sediment

Sediment is solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water. It includes chemical and biochemical precipitates and decomposed organic material such as humus. Suspended sediment is the sediment that at any time is maintained in suspension by the upward components of turbulent currents or that exists in suspension as colloid. Suspended sediment is expressed in parts per million (ppm) or milligrams of dry sediment per liter of water sediment mixture (mg/L).

Suspended sediment samples can be collected in several ways. In moving water, samples can be collected by using a number of different types of point samplers. Samples are collected at different points in a vertical profile and combined for analysis or analyzed individually. Suspended sediment samples can be collected in low velocities with wide-mouth samplers. Suspended sediment samples can also be collected by using a pump system to collect the sample. Automatic samplers are also available to provide unattended sampling at the frequency desired. Sediment sample costs will vary depending on the number of samples taken. A typical sampling program would cost about $1,800 for data collection and lab analysis of around 20 stations on small channels. A DH59 sampler costs about $500. Additional information is provided in the water quality monitoring subgroup report.

Where sediment sampling is a high priority, channel measurements taken with a point sampler should be made or an automatic sampler should be installed. Channel measurements generally require a discharge or velocity measurement for correlation. Automatic samplers require implementation of a good quality control system that includes routine visits for maintenance. The frequency of measurements will be project and site dependent. Sampling should be performed a minimum of six

times per year. Sampling could be done during the site visits.

Groundwater

Probably the easiest technique to measure groundwater is to install a shallow piezometer at the same time soil cores are initially taken. The piezometer would be slotted PVC and would need some type of fine-gravel pack to minimize siltation, an upper casing, and a protective cap. Height of groundwater could be measured by using a simple ruler from the top of the casing during site visits, or any other data collection event.

Piezometers to monitor groundwater are relatively inexpensive; they cost a few hundred dollars each. Piezometer monitoring could be done during site visits or when personnel are in the field for other monitoring.

Piezometers can probably be installed at a cost of a $200 to $400 each. Actual monitoring costs will be minimal since the monitoring will occur during other visits to the project area and take only a few minutes. Data collation and analysis will also be minimal. Estimated costs are $5 for collection and $10 for collation, quality control, and analysis per piezometer.

Soil Salinity

Soil salinities can be measured by extracting interstitial water from a surface sediment sample by centrifuge. In many cases, freezing and defrosting a segment of sediment will disrupt sediment particle structure and allow settling. Separation of interstitial water can then be measured by a conductivity probe. Titration is accurate, but time consuming and therefore expensive in terms of labor. A refractometer is quick and inexpensive, but measurements are only accurate to approximately 1 ppt.

Soil salinities change slowly, and variation will be dampened compared to variation in salinity of the overlying water, which will change with tidal cycle as well as wind direction, seasonal changes to freshwater input, and climatic cycles. Thus soil salinities can be measured monthly for projects that rank this data collection a high priority, at least within the season when projects are most likely to affect salinity. For example, freshwater diversions are typically operated seasonally when fresh water is available and when biota are most sensitive to high salinity. When soil salinity monitoring is a medium priority, monitoring should be done monthly during times when projects are most likely to affect soil salinity. With those project types where soil salinity monitoring is a low priority, monitoring may be done infrequently or not at all.

Soil salinity samples can be collected with the soil-sediment sampling equipment and therefore will have no costs for initial sampling. Costs for analysis are unknown at this time. If annual soil samples are not collected, annual surface samples to determine soil salinity will cost about $10 to collect, assuming they are collected during some other monitoring event or a project visit.

If soil salinity sampling is coordinated with soil-sediment sampling, no additional equipment expense should be incurred. Cost of a conductivity probe for measuring salinity (e.g., a YSI 3800) is about $5,000.

VII. HYDROLOGIC DATA COLLECTION

Types of Projects Needing Hydrologic Monitoring

The monitoring work group has identified nine types of projects for which we are to develop hydrologic monitoring requirements. The types of projects are listed in Table 5 along with the priority of need for hydrologic monitoring. The priorities correspond to the four purposes of hydrologic monitoring discussed in the introduction of this report.

Table 5. Priority consensus of hydrologic monitoring projects.

Project type	Priority consensus
Freshwater diversion	1
Sediment diversion	1
Marsh management	1
Hydrologic restoration	1
Dredged material	4
Shoreline protection	4
Barrier island restoration	3
Vegetative plantings	2
Sediment and nutrient trapping	2

The hydrologic monitoring subgroup has further prioritized monitoring of variables within each project. Priorities agreed upon by subgroup members along with estimated costs are shown in Table 6.

Table 6. Monitoring matrix by priority[a] for hydrologic monitoring projects.

Project type	Precip.	Evap.	Wind speed direction	Water level	Bathymetry	Topography	Salinity	Discharge	Suspended sediment	Ground water	Soil salinity	Annual cost[b]
Freshwater diversion	1	3	1	1	3	3	1	1	1	4	4	$39,200
Sediment diversion	3	3	3	1	1	1	3	1	1	4	4	$46,200
Marsh management	1	3	1-3	1	2	2	1	2	3	4	2-3	$23,600
Hydrologic restoration	1	3	2-3	1	2	2	1	2	3	4	2-3	$24,100
Dredged material	4	4	4	3	1	1	4	4	4	4	1	$10,500
Shoreline protection	4	4	2[c]	3[d]	1	1	4	3	4	4	4	$6,000
Barrier island restoration	4	4	2[c]	3[d]	1	1	4	3	4	4	4	$11,000
Vegetative plantings	2	3	4	2-3	3	3	1	4	3	4	2-3	$8,000
Sediment and nutrient trapping	4	4	3	2-3	1	2	3	4	2-3	4	2-3	$33,100

[a]Key:
1 = Primary objective
2 = Secondary objective
3 = Tertiary objective (long term evaluation)
4 = Lowest objective (long term evaluation)

[b]Estimates include average annual equipment maintenance cost for one gauging station.

[c]Wind vectors may have a higher priority if needed to hindcast wave height and period.

[d]A directional wave gauge to determine the forces and littoral transport may have a high priority in determining failures.

VIII. HISTORICAL DATA

A table showing inventory of current and discontinued hydrologic data collection stations in Louisiana is on file with the monitoring work group. Equipment type varies, depending on location and the frequency of collection. Generally, realtime gauges use Handar GOES equipment. Water-level gauges may be electronic continuous recorders, strip charts, or bubbler gauges. Daily water levels are usually read from a staff gauge. Daily temperature and chloride data are from paid observers. Discharge measurements and sediment samples are taken 3-4 times per week to monthly from a boat; daily discharge and sediment loads are computed from rating curves. Lark rain gauges are used for hourly and daily rainfall records; standard rain gauges are used for daily records.

Maps showing the network of current hydrologic data collection stations in the Louisiana coastal zone, which can be incorporated into the hydrologic monitoring program are available from USACE.

Some of the realtime water-level stations can be upgraded with precipitation, salinity, water quality, velocity, and wind gauges. The cost to add a rain gauge is about $800 for the equipment, $1,000 for installation, and $500 per year for maintenance. Adding a wind-speed and direction gauge will cost around $600 for equipment, $1,000 for installation, and $500 per year for maintenance. A salinity upgrade will cost about $2,600 for equipment, $1,000 for installation, and $2,000 per year for maintenance. Temperature will also be measured with this equipment. The cost to add a velocity and direction gauge is about $5,000 for equipment, $1,000 for installation, and $1,000 per year for maintenance. Computing discharge from the velocity gauge will add about $3,000 per year to the annual maintenance costs for periodic discharge measurements and the computation of discharge. Adding water-quality probes, to determine aspects such as dissolved oxygen, would cost at least $5,000 for equipment, $1,000 for installation, and $3,000-$10,000 per year maintenance. All maintenance costs include analysis of data for quality control. Costs will vary on location and accessibility. Costs do not include replacement costs in the event of vandalism or theft.

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I. TITLE: MONITORING PROTOCOL FOR EXAMINATION OF THE IMPACTS OF CWPPRA PROJECTS ON SOIL DEVELOPMENT, SUBSIDENCE, AND MARSH ACCRETION

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IV. INTRODUCTION

Continued vertical development of marsh soils is critical to their survival in coastal Louisiana. Subsidence is recognized as one of the major processes causing coastal erosion and wetland loss. Subsidence of Mississippi deltaic plain and chenier plain sediments, combined with eustatic sea-level rise, has resulted in relative sea-level rise rates of over 1 cm/year in the delta plain and approximately 0.6 cm/year in the chenier plain (Penland and Ramsey 1990). If coastal marshes cannot increase surface elevation at the same rate as relative sea-level rise, marsh soils will become increasingly waterlogged. Chemical changes in the marsh soil resulting from such waterlogging can cause reduced growth and even die-back in wetland vegetation in both saline and fresh Louisiana coastal marshes (Koch et al. 1990). Insufficient accretion of the marsh surface to keep pace with relative sea-level rise is frequently termed a "sedimentation deficit."

The processes that contribute to accretion of the marsh surface can be summarized as follows:

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NVA = [Deposition on the marsh surface + belowground plant production] -
[erosion from the marsh surface + belowground decomposition].
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where NVA is net vertical accretion of the marsh surface. The processes that contribute to subsidence include geosynclinal downwarping, compaction of Pleistocene and Tertiary sediments, compaction of Holocene deposits, localized consolidation, tectonic activity, and fluid withdrawals. Consequently, the impact of projects implemented under the Coastal Wetlands Planning, Protection, and Restoration Act on marsh accretion and soil development can be dramatic in terms of their effect on depositional and erosional processes at the marsh surface and the production and decomposition of organic material within the soil, but rarely will the projects be able to impact the underlying causes of subsidence. However, the type of sediments composing the marsh soils, their grain size, and their chemical characteristics affect long-term stability, and these factors might also be impacted by projects aimed at marsh restoration. Therefore, we propose a monitoring plan that includes a broad spectrum of soil variables.

It is important to recognize that even if the stated goals of a particular project are achieved, there may be unintentional or indirect alterations to marsh ecosystem function that can have detrimental cumulative impacts on the ecosystem. Consequently, to fully evaluate the project it is necessary to monitor marsh soil variables other than those directly impacted by the project. Because of the delicate balance between marsh accretion and relative sea-level rise, it is important to monitor accretion in areas where accretionary processes are directly or indirectly impacted by the project, even if enhanced accretion is only a secondary goal for the project. For example, the stated goal of a marsh management project might be to increase vegetation growth, and this increased productivity may either increase or decrease net vertical accretion via its effect on organic accumulation, depending upon concomitant alterations in decomposition (see mass balance equation above). Monitoring of changes in soil type can also indicate the impact of vegetative or hydrologic changes on the stability and fertility of the soil substrate.

Some projects proposed for funding by CWPPRA do not involve the manipulation of marsh processes but seek instead to create marsh in areas where it does not now exist (e.g., projects on the beneficial use of dredged spoil or the back barrier marsh component of barrier island restoration). These projects aim to create marsh that functions naturally and can become self-sustaining in the long term. Given that these projects are developed in a subsiding coastal environment, natural accretionary processes

(involving the accumulation of both organic and inorganic material) must occur or the marshes will be gradually submerged and the vegetation subjected to waterlogging. In addition, an important aspect of marsh creation is the development of soil properties. The newly created marsh soil must attain adequate hydrologic function to prevent waterlogging and/or the accumulation of toxics while providing the necessary nutrients for vegetative growth.

In those projects that aim to stimulate accretionary processes or recreate natural marsh development processes, e.g., sediment diversions, monitoring of marsh vertical accretion and changing soil properties is essential to assessing the success of the project. On the basis of this assessment of the need for monitoring of soil development and accretionary processes in a variety of types of project, the proposed CWPPRA projects can be classified as follows:

> Class A. Those that aim to create new marsh by artificial means (e.g., use of dredged spoil) but do not manipulate marsh processes, and where subsequent accretion and soil development are essential for the longevity of the project.
>
> Class B. Those in which the manipulation of accretionary processes is a minor or secondary aim of the project, but where indirect affects on accretion and changes in soil type might occur (e.g., freshwater diversion, marsh management).
>
> Class C. Those that specifically aim to enhance accretionary processes in existing marsh or to create new viable marsh by the manipulation of existing processes (e.g., sediment diversion, crevasse splays).

In addition, the variables to be measured during monitoring have been ranked according to project type and their importance in assessing project goals.

V. GENERAL DISCUSSION

Rationale of Variables

The marsh soil is a result of the cumulative effect of marsh building processes that include the production, transport, and decomposition of organic matter and net influx of inorganic sediments. Depending upon the rate of soil development or marsh accretion, the soil can represent the cumulative impacts of these processes over years or decades. Consequently, monitoring changes in soil variables after project implementation can provide two types of information regarding the success of CWPPRA restoration projects:

(1) documentation of changes in soil composition, stability, structure or development that occur as a direct or indirect result of the project.

Variables:
- Organic matter
- Bulk density
- Water content
- Grain size
- Soil redox
- Soil nutrients
- Soil contaminants (trace metals, synthetic organics, etc.)

(2) documentation of continued development or accretion of the marsh soil that allow for the long-term survival of the marsh in the face of subsidence, sea-level rise, physical erosion, etc.

Variables: Soil vertical accretion
Subsidence
Soil erosion and creation (change in spatial extent)

Relationship to Ongoing Programs

1. The U.S. Soil Conservation Service has produced soil surveys of all coastal Louisiana parishes. These surveys can provide data about specific soil types and their distribution. General information is available concerning such soil variables as percentage of clay, percentage of organic matter, permeability, and moist bulk density. This information can provide a regional context for soil evaluations and may be of value to those responsible for the design and implementation of projects (e.g., levee construction for marsh management projects). The data bases used for soil characterization include specific measurements of soil physical variables and also pH, exchangeable cations, exchangeable aluminum, phosphorous, and particle size, and are available through Wayne Hudnall, Agronomy Department, Louisiana State University, for all Louisiana parishes for which soil surveys have been conducted since 1975.

2. Much of the existing data collection and monitoring efforts that concern soils and sediments are project specific. They include monitoring of individual marsh management plans and scientific research projects designed to either resolve particular management issues or increase understanding of marsh system function. The U.S. Geological Survey is presently participating in two such initiatives. The first involves detailed examination of the physical processes of wetland loss and includes measures of marsh soil bulk density, organic matter content and accretion, as well as field and modeling studies of the movements of freshwater and sediments through marsh areas. The second examines the impact of marsh management on marsh accretion and sedimentation and is being conducted in cooperation with the U.S. Fish and Wildlife Service. The project uses various approaches to the measurement of sediment deposition and marsh accretion and compares experimental marsh management areas, which are being actively managed, with control areas.

   Such studies, and the sampling strategies they develop, can provide data to be used as part of a plan to evaluate the success of CWPPRA projects, especially where they provide information on regional patterns or the character of various marsh types. An example of this use of existing information is in the evaluation of subsidence. The framework geology of an area is particularly important in determining its subsidence potential, and existing studies have identified broad differences in subsidence between the chenier plain and the deltaic plain, as well as more localized variations within hydrologic basins. Because of the purpose for which the data was originally collected, it may not be sufficiently specific to be used in the evaluation of individual projects. Other sources that can indicate subsidence potential (e.g., fault maps) may be available in a more detailed form. Such issues are reflected in the priority that individual variables are assigned in the monitoring matrix (Table 7).

Table 7. Monitoring matrix.

	Class	Accretion	Subsidence	Organic matter	Bulk density	Water content	Grain size	Soil redox	Erosion/ creation large scale (mapping)	Erosion/ creation small scale
Freshwater diversion	B[a]	2, 1a[bc]	2	1	1	1	3	2	3	N/A
Sediment diversion	C	1	1	1	1	1	1	2	1	N/A
Marsh Management	B	1	2	1	1	1	4	1	3	N/A
Dredged material	A	1	2	1	1	1	3	2	N/A	1D, 4M[d]
Barrier island restoration	A	1	3	3	3	3	2	4	N/A	1
Shoreline protection	B	2, 3c	4	3	3	3	3c	4	N/A	1
Vegetative plantings	B	2	4	2	2	2	3	2	N/A	1
Sediment and nutrient trapping	C	1	1 Basin	1	1	1	2	3	N/A	1
Hydrologic restoration	B	1	2	2	2	2	3, 2d	2	3	2 e

[a]A - Create new marsh by artificial means, not manipulate processes.
B - Manipulation of soil processes is a minor aim of project but impact on soil occurs.
C - Project aims to enhance accretionary processes or create new marsh using natural processes.

[b]1 - Primary objective
2 - Secondary objective
3 - Tertiary objective - long term evaluation
4 - Lowest priority - long term evaluation

[c]a - depending on the scale of monitoring for vegetative vigor/growth
b - higher priority of no previous information on soil quality available
c - higher priority if marsh creation is expected
d - if riverine sediment transport paths are affected
e - small scale monitoring required if marsh creation is expected

[d]D - importance at design stage
M - importance for monitoring
Basin - basin scale subsidence information only

3. The cost effectiveness of CWPPRA monitoring versus the use of existing data collection programs depends upon a variety of factors. If certain State or Federal agencies presently have personnel involved in data collection in the coastal zone, it may be appropriate, and cost effective, to incorporate them into a CWPPRA monitoring plan. However, the specific variables and the experimental design for CWPPRA monitoring should be determined independently of these programs in order to provide data that can be used in a statistically valid evaluation of the CWPPRA projects. Where these data collection efforts coincide with ongoing efforts, interagency cooperation is encouraged to increase cost effectiveness. If outside contractors are to be solicited to conduct monitoring efforts, they should be expected to make use of existing efforts and/or logistic support from agencies where appropriate.

VI. METHODOLOGY

Variables

The sediment and soil variables to be included in monitoring plans have been prioritized according to their suitability for evaluating the various types of CWPPRA projects (Table 7). The matrix in Table 7 distinguishes between large-scale and small-scale marsh erosion and creation variables. Large-scale monitoring variables are those that can be undertaken by mapping from aerial imagery, while small-scale monitoring variables are required where changes at a scale of meters are important to the project and must be determined on the ground.

Selection of Sampling Sites

Subsidence is a rapid, highly variable process throughout the Louisiana coastal zone, and all of the proposed CWPPRA projects will be constructed within environments experiencing subsidence. The rate of subsidence can have a dramatic effect on the success of a project. In projects designed to manipulate water and sediments for wetland restoration, the chances of success are greater in areas with lower subsidence rates. It is possible that in some areas subsidence rates are so high that the likelihood of project success is diminished. Because subsidence is an underlying problem for all projects, it is appropriate that it be addressed both at the basin and project specific levels to successfully plan for the management of the coastal zone, and for effective evaluation of project success.

To scientifically evaluate the success of projects, effective comparisons must be made between control and project areas. Certain criteria should be followed in control area selection:

* In projects that impact significant areas of existing vegetated marsh there will probably be gradients in marsh topography, soils and accretion between streamside areas, and back-marsh areas. Where this is the case, sampling sites should be selected consistently in either or both of these zones so that similar environments are being monitored.

* Differences in soil composition and the relative importance of organic and inorganic accretionary processes are also well established between marsh habitat (as defined by salinity and vegetation zones). If the project area includes sizeable areas of more than one marsh habitat comparisons between control and project areas should be made for each marsh habitat. This is necessary to ensure that comparisons are made between like environments.

* Control and project areas should be comparable in their vegetation (within marsh habitat), hydrology, and proximity to sediment sources. The amount of acceptable variability varies according to the number of control areas selected (see Experimental Design section).

* Control and project areas should be comparable in the thickness of the marsh soil. This provides the substrate for marsh growth and is the zone where changes resulting from project implementation will be identified. Previous studies by the U.S. Soil Conservation Service and Louisiana Geological Survey have noted some variations in the depth to the "clay horizon." In order to make effective comparisons between control and project areas, variations in the thickness of marsh soil must be examined before sampling sites are selected.

The validity of the comparisons made between project and control areas will depend upon the number of replicate samples that are taken. The project and control areas should be divided into marsh habitats and at least five replicate sample sites selected randomly within the areas. For instance, if the project area includes both brackish and saline marsh habitats and the study is to consider only back marsh locations, then five brackish-backmarsh-control, five brackish-backmarsh-project, five saline-backmarsh-control, and five saline-backmarsh-project sampling sites should be selected. It is necessary to ensure that control and project areas are comparable. If the project area is large, then sample size should be increased. It is essential that sampling sites are not chosen for logistic reasons but to represent the marsh area being studied. Boardwalks may be necessary to prevent unnecessary disturbance in areas where frequent access is necessary. In all cases, sampling on all areas should be conducted during as short a period as possible to prevent the confounding effects of unpredictable extreme events.

Marsh accretion and soil development are mediated by marsh hydrology and vegetative growth. If monitoring is to be conducted regarding hydrology and vegetation, the understanding of marsh function and the impact of the project will be greatly enhanced by coordination of sampling sites and frequencies. Indeed, the monitoring of marsh-water levels and vegetation productivity (aboveground and belowground), in particular, will enhance the understanding of project impacts gained from the monitoring of marsh accretion and soil development. Consequently, the overall monitoring strategy should allow for coordination between monitoring protocols. Preferably, the same agency or contractor should be responsible for these aspects of the monitoring, or a mechanism for cooperation should be established.

Sampling Design

The sampling matrix (Table 8) shows three strategies for sampling the different types of projects according to the frequency of sampling. The basic monitoring is for Class A projects; more detailed monitoring is proposed for Class B projects; and Class C projects require the most intensive monitoring as soils and sediments are included in the primary objectives of the projects. In addition, for projects where no control sites are available, pre-project monitoring of certain variables is proposed to provide baseline data. These are believed to be the minimum requirements necessary to meet the mandate of CWPPRA for scientific evaluation of project success.

Table 8. Sampling matrix.

	Basic class A	Better class B	Best class C	No control any class
Accretion				
Feldspar markers	A[a]	S	S	
Sediment-erosion table		A	S	
Radionuclide dating			Once only	Once only
Subsidence				
Carbon-14 dating	Once only			
GPS		C		
Extensometers			C	
Organic matter content	A	S	S	Pre-project
Bulk density	A	S	S	Pre-project
Water content	A	S	S	
Grain size	A			Pre-project
Soil redox	A	S	S	Pre-project
Erosion/creation large scale	A			
Erosion/creation small scale	A			
Nutrients	Once only	A		Pre-project
Pollutants	Once only	A		Pre-project

[a] A = Annual
S = Seasonal
C = Continuous

Methods

Soil properties - organic matter content, dry bulk density, water content, grain size

Core samples should be taken from the marsh for the evaluation of these variables.[1] The technique used for coring the marsh is important because inappropriate techniques can cause compaction of marsh sediments and particularly inaccurate measurements of dry bulk density and water content. The best method, which works in all marsh habitats (saline through fresh) and with minimum disturbance to the marsh surface, is cryogenic coring. This involves the freezing of the marsh onto a copper tube and the extraction of a small diameter (5 cm) core without compaction (Knaus and Cahoon 1990). The cores can be sliced into 1 cm or larger segments while still frozen. This method is more field intensive than other methods involving coring devices, but the frozen cores allow easier laboratory analysis for bulk density than other standard practices (e.g., Procedure 4A in U.S. Department of Agriculture, Soil Conservation Service 1984). Alternative coring methods usually involve some compaction of sediments, which can be critical in the evaluation of soil bulk density. A large-diameter (15 cm) core tube can be used to minimize compaction but it usually has to be dug from the substrate causing considerable disturbance. Such disturbance is not appropriate in areas that are being monitored, i.e., where repeated sampling is required. The core segments should be weighed while wet and then oven dried before reweighing. The difference in weights indicates the water content of the soil and the weight of the dried segment which, when standardized for the segment volume, provides the dry bulk density. Organic matter content can be similarly determined by loss to ignition at 375°C for 16 h in a laboratory muffle furnace (or see Procedure 8F in U.S. Department of Agriculture, Soil Conservation Service 1984). Size determination of the ashed sediment samples by using a combination of sieving and pipette/Coulter Analyzer techniques will provide soil grain size data.

Cost per sample[2]:	Organic matter content	$100
	Dry bulk density	$100
	Water content	$50
	Grain size	$100

Accretion (Feldspar)

Feldspar marker horizons should be established at each sampling site. Areas should be at least 50 cm x 50 cm and the layer of feldspar should be at least 3 mm thick. The increment of soil deposited and accumulated above marker horizons should be monitored seasonally. The cryogenic coring technique should be used to sample the surface soil layers at randomly selected locations and

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[1] The depth to which these variables are measured within the soil and the number of samples taken from each core (e.g., 5 cm, 10 cm , 15 cm, etc.) will depend upon the nature of the project, but will be consistent between sampling within the project and control areas.

[2] Costs are very approximate and depend upon who is conducting the sampling and sample processing. Estimates were made based upon one agency or contractor conducting the monitoring and taking samples for all analyses during the same field trips. Project access costs (for example, if an airboat is required) could increase costs. Estimates were based on $100 per day for boat access to project areas. For airboats this would increase to $450.

the increment of accumulation measured to 0.5 mm. Alternative techniques for sampling feldspar marker horizons, including the use of thin-walled aluminum-core tubes, which are then frozen and split to reveal the feldspar horizon, are not effective in all wetland types. Highly organic soils, such as those in fresh to intermediate marshes, are very readily compacted by this technique. Cryogenic coring is the optimum, and it provides data in the field rather than requiring additional laboratory work.

Cost per measurement[3]: $250

Accretion (SET)

The sedimentation erosion table (SET) technique was originally used for measuring small changes in elevation on tidal flats in the Netherlands (van Erdt 1985) and is presently being used in marsh surface studies in Louisiana and Georgia. A 7.5-cm diameter aluminum pipe is inserted into the marsh surface using a vibracore until it will penetrate no further and then trimmed to within 30 cm of the marsh surface. The base of this pipe represents a datum against which marsh surface elevation is measured. A smaller notched pipe is cemented into the top of the aluminum pipe and this becomes the base for the sedimentation table. Bases are permanently located at sites where NVA (net vertical accretion) is to be measured. The sedimentation table is placed on the notched pipe during measurement. The distance between the table and the marsh surface is measured by using nine thin aluminum rods. Small discs at the end of the rods prevent penetration of the sediment surface. Changes in the distance between the marsh and the table represent changes in the elevation of the marsh surface. For each base the table can be placed in four positions, coinciding with the points of the compass, to give a total of 36 measures of marsh elevation for each manipulative plot.

Cost of set-up: $450 per site
Cost of measurements: $250

Accretion (radionuclide dating)

^{210}Pb dating of marsh soils can indicate the long-term (> 100 years) accretion rate of the marsh (DeLaune et al. 1989). The procedure involves coring the marsh surface and partitioning the core into vertical segments. The activity of the radionuclides in each segment can be plotted against depth to reveal the vertical profile. The slope of the activity profile is proportional to the rate of marsh accretion (DeLaune et al. 1989). These analyses should be handled by workers with suitable equipment and experience.

Cost of analysis: $1,000

Subsidence - basin scale

Historical tide-gauge trends can be determined by using data from existing long-term gauges operated by the National Ocean Service and the U.S. Army Corps of Engineers. In addition, within each basin, a systematic vibracore survey should be conducted to determine long-term subsidence by using radiocarbon analysis of buried horizons. In addition, GPS benchmarks and extensometers can be used to monitor subsidence. Their location should be based on an understanding of the framework geology

[3] Includes costs for establishing feldspar plots.

of each basin. Vertical extensometers are used to monitor aquifer compaction caused by withdrawal of groundwater. They consist of a well with a casing installed to a chosen depth. A pipe is placed inside the casing and anchored to the bottom of the casing. If the formation above the base of the casing compacts, the pipe appears to rise above the ground because it is free to move. Nests of three extensometers completed at different depths can be used to determine the amount of shallow compaction (or subsidence) and how it is vertically distributed.

Cost per vibracore:	$2,000
Cost per extensometer:	$14,000

Subsidence - project scale

Tide gauges established within each project (by the hydrology group) should be tied into the existing regional network of long-term gauges. Analysis of annual trends in tide-gauge data for long-term stations should be continued, with additional establishment of GPS benchmarks and extensometers (see above) at each project, which are tied to the basin-scale network.

Costs: See above.

Soil redox potential

Soil redox potential should be measured *in situ* at 5-cm intervals below the marsh surface by using brightened platinum electrodes (Mendelssohn and McKee 1988). The depth to which measurements need to be made will depend on the particular project but should be at least 20 cm to coincide with samples taken for chemical analyses.

Cost of profile measurement: $75

Marsh erosion and creation - large scale

The methodologies and costs for this type of monitoring fall under the auspices of the habitat mapping group. Those types of projects that require this evaluation are indicated in Table 1, and we defer to the recommendations of the habitat mapping group regarding the acquisition of these data.

Marsh erosion and creation - small scale

Small-scale changes in the position of the marsh edge can be determined by one of two techniques:

(1) Repeated surveys of marker stakes (standard beach survey technique).
(2) Repeated measures of the position of the marsh margin in relation to a fixed point within the marsh (Letzsch and Frey 1980).

Which technique is most appropriate will depend upon the individual projects, substrate conditions, and the rate of expected erosion and progradation. The survey technique provides information on marsh morphology and is more accurate but requires experienced personnel for surveying. The Letzsch and Frey technique requires the insertion of posts at fixed positions in relation to each other and the original marsh edge. Subsequent measurements are made with a tape measure and do not require experienced personnel. Costs vary accordingly.

Cost of measurement: $150-$300

Soil nutrients and contaminants

The soil and sediments subgroup identified soil nutrients and contaminants as important variables to be monitored. The methodologies and costs for these variables fall under the auspices of the water quality subgroup and will not be addressed in this report.

VII. HISTORICAL DATA

Very little historical data on soils and sediments issues exist in established data bases. The data sources and programs described in the *Relationship to Ongoing Programs* section all provide some degree of historical data. The published scientific literature also contains vast bodies of knowledge concerning soils, subsidence, and marsh accretion in Louisiana. This protocol has been developed in awareness of these previous studies and builds upon that information. A review of this literature was considered beyond the purview of this subgroup.

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I. TITLE: VEGETATIVE HEALTH MONITORING ON CWPPRA PROJECTS IN COASTAL LOUISIANA

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IV. INTRODUCTION

The vegetative health monitoring subgroup of the CWPPRA Monitoring Work Group was tasked to develop vegetative protocols and analyses required to determine the degree of success of the various types of projects built under the CWPPRA. The act specifically asks for the development of projects that significantly contribute to the long-term restoration or protection of the physical, chemical, and biological integrity of coastal vegetated wetlands. The major goal of protection projects is to slow or reverse coastal erosion rates, while the major goals of restoration projects are to preserve, enhance, and/or promote the growth of emergent and submergent vegetation. These goals will be evaluated through the determination of acres of wetlands saved or created. Vegetative health monitoring allows us to determine to what degree the predicted response is occurring other than by the mere presence or absence of vegetative communities.

V. GENERAL DISCUSSION

This section provides information on why certain vegetative health variables were chosen and others were not, what additional issues need to be addressed, and how vegetative health monitoring ties in to other monitoring initiatives.

Rationale

The following variables were chosen because they are proven measures of vegetative health.

Species composition

This variable is a basic structural measure for determining what plant species are present. Plant species have specific tolerances to salinities and water levels, as well as varying levels of wildlife habitat use; therefore, they can be used as an indicator of change.

Relative abundance

This variable goes hand in hand with species composition. Relative abundance more accurately documents the degree of change by providing a measure of dominance and evenness of species. It is not just a measure of percent cover, but also indicates what species dominate the area and whether that species has a high value relative to project objectives (wildlife, cover, bank stabilization, etc.).

Aboveground biomass

This variable provides an indication of the overall vigor and health of the marsh and can be used as a conservative estimate of productivity.

Herbivory

This variable can be an important factor in determining success. Herbivory can be locally intense, very destructive, and costly relative to replanting vegetative projects.

Belowground Biomass and Productivity

It is well established that belowground productivity provides a significant contribution to the overall productivity of ecological systems (Vogt et al. 1986). However, accurate measurements of belowground biomass and productivity are difficult and expensive to obtain (Symbula and Day 1988). These measurements are beyond the realm of this monitoring initiative and would be more appropriately investigated by the scientific community.

Ongoing Programs

Currently, there are no ongoing programs that are providing vegetative health monitoring throughout coastal Louisiana. There are, however, a large number of projects and studies that have collected vegetative health data, and they would be useful in a historical context.

VI. METHODOLOGY

This section defines those variables chosen to monitor vegetative health. A recommended protocol for quantitative sampling of each of the variables is identified, with a discussion of its advantages and disadvantages. In addition, qualitative measures have been identified for use if a quantitative approach is not feasible.

Species Composition

This variable provides an inventory of plant resources by determining what plant species, vegetation types, and communities are present. It requires compiling a list of all species encountered within an area that best represents the community. Although this type of survey indicates what new species occur and existing species disappear with time, it cannot indicate change in vegetational importance unless a measure of abundance or dominance is provided. Therefore, it is recommended that species composition and relative abundance be measured at the same time by using the protocols discussed under relative abundance.

Relative Abundance

Relative abundance provides an estimate of the number of individuals per species in a given sample area. It can be measured by cover estimates or stem counts, depending on whether the measurement needs to be relative or absolute. It is limited by the preciseness of measure, with the potential for introducing bias from one individual to the next. Therefore it is recommended that the same individual(s) conduct the monitoring every sampling trip, if at all possible.

The Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974) should be used to identify species compositions and abundances. It requires compiling a species-area curve, which will determine the minimal sample area size. These samples should fulfill the following requirements: the cumulative plot area should be large enough to contain all species, and the habitat should be as uniform and representative as possible. The Braun-Blanquet Cover-Abundance Scale provides absolute values in relation to fixed plot sizes. Scale values that are chosen should not be deviated from for reasons of comparability.

The advantage of this method is that it is simple, comparable, and accepted by ecological investigators. It is also a semi-quantifiable approach that is less time and labor intensive than stem count methods. The disadvantages include subjectiveness in the cover estimates as well as decreasing accuracies with increasing plot sizes. Additionally, care must be taken in selecting the size, shape, and numbers of plots.

Ocular estimates and low-level aerial photography are qualitative techniques that could be used to measure relative abundances. Another quantitative technique that could be used is stem counts.

Aboveground Biomass

This variable provides a measure of growth, health, and vigor of plants by obtaining the weight of vegetation per unit area. The limitations of this measure include its difficulty in being used in large plots and in woody vegetation.

The clip-plot method (Mueller-Dombois and Ellenberg 1974) should initially be used to obtain aboveground biomass. It would require the clipping of all aboveground matter in established plots, drying it in an oven, and weighing it. Plot size and shape are just as important for obtaining accurate estimates of biomass as they are for the other measures.

The advantages of this method are that it is quantifiable, comparable, and accepted by ecological investigators. The disadvantages include it being a destructive technique and time-intensive. It is recommended that clip-plots be used until a regression line between size and biomass can be developed. This regression could be obtained by counting stems and measuring heights.

Another method that could be used is airborne remote sensors that use Landsat Thematic Mapper and SPOT satellite images to quantify and map the distribution of live aerial biomass in monospecific marshes.

Herbivory

Herbivory is the consumption of all or part of a plant by a consumer. It can be calculated directly by a measurement of the plants themselves or indirectly by measuring the intensity of the herbivores in relation to a unit area. The limitations include the ability to determine cause and effect in terms of survival and stress.

A permanent plot method will be used to evaluate the effects of herbivory. All measurements and techniques described above will be evaluated in caged versus uncaged permanent plots in problem or potential problem areas.

The advantage of this method is that it will provide a structural estimate of potential herbivore impacts without too much additional effort. A disadvantage would be that it would not provide any measure of functional impacts.

It is suggested that during the project development stage, the evidence of herbivory should be evaluated to determine whether a qualitative or quantitative monitoring approach is necessary. For areas with intensive herbivory, a qualitative approach of looking at the presence or absence of vegetation by ocular estimates and/or low-level photography would suffice if historical vegetative composition is known.

General Recommendations

It is recommended that the Braun-Blanquet method be used when applicable because it has the broadest application for quantifying shifts in community composition and abundance. All other measurements can be incorporated into the sampling design required for this method in order to be cost and labor efficient.

Sample designs will be specific for each project. Random selection of permanent transects or plots would be preferred, and distribution and frequency depend on project area and heterogeneity.

The minimum sampling frequency for all variables is annually. Within highly diverse fresh marshes, minimum sampling should occur in the spring and fall because of seasonal species changes, which do not occur extensively in brackish and saline marshes.

The cost estimate for each field visit to the project area is $2,000. Aboveground biomass can be

analyzed for $10.00 per sample. These costs will vary depending on size and heterogeneity of the project area and mode of transportation (i.e., airboats).

Resources and project-specific goals will dictate what and how frequently vegetative health variables will be monitored. However, our recommendation is to use resources on habitat mapping first because it provides the baseline for monitoring habitat health.

The broad goals and methods of vegetative monitoring will be more specifically developed on the project level. Each project type may vary somewhat in methodology and frequency of sampling depending on the size and scope of the projects as well as on project-specific objectives.

VII. PROJECT TYPES REQUIRING MONITORING

The monitoring work group has identified nine types of projects for which vegetative health monitoring requirements are to be developed. The types of projects listed in Table 9 have been prioritized regarding their need for vegetative health monitoring. In addition, a determination of whether this monitoring should emphasize qualitative, quantitative, or mixed approaches is identified. Qualitative approaches are used on projects whose response is to create new marsh. These approaches are concerned with identifying the presence or absence of vegetation. Quantitative approaches are used on projects whose response is to shift community types. The emphasis is on determining how much of a difference there is between areas with and without project conditions. These approaches are not only concerned with identifying the presence or absence of vegetation, but also how the vegetation structurally and functionally responds to the projects. Mixed approaches may be used on projects that require some qualitative and some quantitative analyses.

Table 9. The nine types of projects for which vegetative health monitoring requirements are to be developed and their priorities.

Project type	Ranking	Monitoring emphasis
Freshwater diversion (FD)	1	quantitative
Sediment diversion (SD)	3	qualitative
Marsh management (MM)	1	quantitative
Hydrologic restoration (HR)	1	quantitative
Beneficial use of dredge material (DM)	3	qualitative
Shoreline protection (SP)	4	qualitative
Barrier island restoration (BI)	3	qualitative
Vegetative plantings (VP)	2	mixed
Sediment and nutrient trapping (S/NT)	2	mixed

The specific monitoring variables and their ranking for each project type are listed in Table 10. Rankings of 1 or 2 indicate the importance of these variables in determining if the primary and secondary objectives of a project are being met.

The vegetative health subgroup also identified water level, salinity, temperature, pH, dissolved oxygen, turbidity, and macronutrients (N, P, K) as important variables relative to vegetative health monitoring. The methodologies and costs for these variables fall under the auspices of the hydrology and water quality subgroups and will not be addressed in this report.

Table 10. Monitoring matrix for vegetative health projects.[a]

Project type	Species composition	Relative abundance	Aboveground biomass	Herbivory
FD	2	1	2	4
SD	2	2	3	3
MM	2	1	2	4
HR	2	1	2	4
DM	2	2	3	3
SP	4	3	4	4
BI	2	2	3	3
VP	2	1	1	2
S/NT	2	2	3	3

[a]Key: 1) primary objective
2) secondary objective
3) tertiary objective - long term evaluation
4) lowest priority - long term evaluation

Note: Species composition is a qualitative measure.
Relative abundance is a quantitative measure.

VIII. HISTORICAL DATA

Vegetative surveys have been conducted in coastal Louisiana every 10 years since 1968 by the Louisiana Department of Wildlife and Fisheries and Louisiana State University. Descriptive analyses have been compiled on vegetation, water, and soil characteristics; however, these variables have not been correlated (Chabreck 1972). Vegetative type maps have been completed for the years 1968, 1978, and 1988. These maps illustrate fresh, intermediate, brackish, and saline marsh areas as well as nonmarsh areas. The associated data base can provide historical information and may be used as a baseline for some projects.

The Coastal Restoration Division of the Louisiana Department of Natural Resources is in the second year of cooperative agreements with the State Soil and Water Conservation Committee and the Coastal Soil and Water Conservation Districts to implement over 50 vegetative restoration projects. Monitoring of these projects includes percent survival, number of new shoots, lateral spread, height, basal cover, vigor, seed head formation, insect damage, and herbivore damage. The herbivore monitoring in particular can provide some useful information.

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IV. INTRODUCTION

Selected wetland areas throughout coastal Louisiana have been designated by the CWPPRA as potential restoration projects. Habitat mapping can provide a useful tool in the monitoring of restoration projects. The previous wetland mapping was based on aerial photography acquired at a scale of 1:63,500 and mapped at a scale of 1:24,000. The resulting maps have not proven feasible for marsh restoration and management use.

The U.S. Fish and Wildlife Service (USFWS), National Wetlands Research Center (NWRC) is presently producing 330 wetland and upland habitat maps for coastal Louisiana using 1988, 1:63,500 scale color infrared photography. Two hundred and twenty-three of these maps will be comparable to the previous mapping efforts of 1956 and 1978. In fact, many of the completed maps and the digital data available from them are being used in the planning process for the CWPPRA. Although this habitat mapping is providing data for basin-wide planning such as measuring wetland change, land loss, and marsh loss, the detail is insufficient for providing similar comparisons for each restoration project type. The regional mapping projects of NWRC and U.S. Army Corps of Engineers (USACE) are based upon 1:63,500 scale aerial photography or base maps; this scale precludes the ability to photointerpret and map consistently or economically those parcels of marsh or open water that are less than one acre in size. Consequently, studying the processes or documenting the change in the habitats in restoration project areas is difficult.

The objectives of habitat mapping are:

* To provide a data base from which basin-wide wetland trends can be measured and to update the 1988 data base with 1993 thematic mapper data

* To provide baseline maps for a historical time period for the vegetation within each of the restoration sites prior to the restoration project being implemented

* To acquire aerial photography for each restoration site for successive years and provide that photography to other monitoring subgroups

* To develop large-scale, detailed habitat maps (and assess the classification accuracy of these maps) for successive years that can be used by the other monitoring subgroups

* To coordinate with the vegetative health subgroup in fieldwork, data collected, and maps generated

* To assess the impacts or changes brought on by the restoration activity

* To develop digital data for selected restoration projects on an as needed basis.

V. GENERAL DISCUSSION

Data Availability

Wetland and upland habitat maps and digital data are available from USFWS for the whole Louisiana coastal zone for 1956, 1978, and 1988 at a scale of 1:24,000.

The Louisiana Department of Natural Resources (LDNR) Coastal Management Division has classified satellite thematic mapper (TM) data for the whole coastal zone for winter 1984-85. Geocoded (Louisiana State Plane-South Zone) TM data are available for winter 1990-91 for the whole coastal zone. Partial January 1988 geocoded TM data are also available for the eastern half of the coastal zone.

Unclassified advanced very high resolution radiometer (AVHRR) digital data are available through the Louisiana State University on a daily basis at a course resolution of 1 km.

Land and water change data and maps are available from the USACE for the Mississippi Deltaic Plain for the 1930's, 1950's, 1970's, 1980's, and 1990's at a scale of 1:62,500.

Digital line graph (DLG) data are available from the USFWS for transportation, hydrology, and public land survey for all 1:100,000 scale maps.

Digitized 1:24,000 data for portions of the coastal zone (non-U.S. Geological Survey [USGS] source) are available from LDNR in DXF format. LDNR is in the process of entering a contract with the USGS to complete all 1:24,000 DLG's south of 30 degrees latitude within Louisiana. Expected completion date is early 1994.

Transportation and boundary digital data are available from the Louisiana Department of Transportation for the whole coastal zone.

Scale

1) Basin-wide

Minimum mapping scale should be 1:100,000.

Use the existing USACE, USFWS, and LDNR digital data available.

Acquire and classify five geocoded scenes (180 x 180 km/scene) in the fall and winter 1993-94 to cover coastal Louisiana and update the 1988 habitat data base. The comparison of the USFWS habitat data to classified TM data has several inherent problems that will affect the resultant acreages of habitat change.

2) Project specific

Minimum mapping scale should be 1:24,000 with the following recommendations for each project area:

Acreage	Scale	Minimum Mapping Unit
Under 200 acres	1:6,000	0.05 acre
200 acres to 20,000 acres	1:12,000	0.1 acre
Over 20,000 acres	1:24,000	1 acre

Color infrared aerial photography must be collected as the primary mapping medium.

The period from September to early December is the optimum window for obtaining the aerial photography.

High water conditions should be avoided by acquiring the photography during normal to low water conditions (flat tides).

The aerial photography should be collected by basin to avoid the changing water and vegetation conditions that can often vary from one basin to another.

The aerial photography should be collected each year for the first 3 years then every third year thereafter. However, this should be considered on a case by case basis after the first year because some of the projects may have changes that necessitate the acquisition of aerial photography more or less frequently than every third year.

3) Historical

Use the existing USFWS aerial photography from 1978 and enlarge to 1:24,000 scale, photointerpret the habitats, and map each unit to provide baseline data to measure changes against. For areas that are to be mapped at 1:24,000 scale, the 1988 USFWS habitat maps can be used as an additional time period since those data are readily available. For areas to be mapped at the 1:12,000 scale, the 1978 photography will be enlarged to 1:12,000 scale and photointerpreted. For areas to be mapped from present and future photography at 1:6,000, the 1978 photography cannot be enlarged to 1:6,000 and maintain sufficient clarity and resolution. Therefore these areas will be mapped at 1:12,000 for 1978.

Classification

The basic goal of the habitat mapping program is to provide a consistency of products through the use of the USFWS wetland classification system (Cowardin et al. 1979) and upland habitat delineation (as modified by Anderson et al. 1976).

1) Basin level

The 1993-94 TM imagery should be classified to Level I (modified by Perwitt Braud after Anderson et al. 1976) consisting of approximately 14 land cover categories following LDNR procedures used for the 1984-85 imagery.

2) Project specific

Use the Cowardin et al. (1979) classification to the subclass level. As per the wishes of other monitoring subgroups, water regime, salinity, and species modifiers may be added to the mapping classification if sufficient fieldwork is funded and/or data from other monitoring subgroups are available. Additional modifiers, e.g., for flotant and managed areas may be added.

3) Historical

Use the Cowardin et al. (1979) classification for the historical mapping to the subclass level, with the use of water regime and special modifiers.

Fieldwork

Amount of fieldwork depends upon the specific level of the classification desired; the greater the level of classification the more fieldwork and time will be required.

The fieldwork performed in the mapping of projects will be separate from the field data collected by or for other monitoring subgroups. If the mapping field data are deemed usable by other monitoring subgroups, it will be made available to them.

1) Basin level

Determining basin level habitat acreage depends on the availability of existing ancillary data sets. Complete coverage of the entire Louisiana coastal zone is not available for all years. Some groundtruthing may be necessary to correctly classify newly acquired TM imagery.

2) The fieldwork criteria necessary for the project-specific mapping include

* location by longitude and latitude and a vicinity requires the use of a global positioning system for location of the following vegetative characteristics:

  predominant species in cover
  other species present
  canopy height
  vegetative vigor
  percent cover

* water level at time of fieldwork
* annual fluctuations of water level
* schedule for groundtruthing
  prior to photointerpretation--all sites
  after photointerpretation--all sites
  review of draft maps--only areas over 20,000 acres
* salinity from actual measurements managed (if the area is impounded, water level managed, ditched, etc.)

3) Horizontal control (mapping accuracy)

In the mapping at detailed scales of 1:12,000 and 1:6,000, the placement of targets prior to each aerial photographic flight is necessary to provide control markers that will be seen on the aerial photography. Global positioning systems (GPS) should be used to locate targets and compare positions with the GPS readings recorded during acquisition of the aerial photography.

Required especially for areas that do not have adequate natural and cultural features to maintain horizontal control for registering aerial photography to base maps.

Products

* Aerial photographs
* Final habitat maps
* Digital data for selected restoration sites
* Field notes
* Classified TM data (including digital and hard copy products) for basin level mapping
* Regional trend maps from basin-level mapping

Dissemination

The products should be made available to researchers and monitoring groups, State and Federal agencies, parishes, and universities; however, all products should be made available to everyone. Reproduction of maps should be made simple. Photograph reproduction will be a problem of photography, maps, and digital data. One agency should be responsible for archiving and distribution of photography, maps, and digital data, but this will be costly.

Review

1) Basin level

   Series of demonstrations for task force and subgroup chairs

2) Project specific

   Internal review

   Regional review

   Draft map review - maps would be available to the public for comments from those interested in reviewing the maps. Schedule, though, may negate this if rushed for time.

Statistical Review

While there are no statistical criteria or standards for mapping, classification and positional accuracy will be assessed in order to estimate the overall accuracy of the data.

VI. METHODOLOGY

Basin-level Mapping

The wetland cover and trend work currently being completed for the CWPPRA task force is establishing historical regional trends on either a basin or coastwide basis. There is no need to repeat this process except to update the coastal trend data sets by including the 1988 habitat data set when completed.

Basin-level mapping for a more recent vintage should use coastwide, level-one classification of geocoded TM imagery. Hybrid image classification techniques should be used to classify the geocoded TM data for major habitat categories. Resulting landcover and wetland trend maps, digital data, and reporting data (acreage by habitat category) generated by GIS analysis of the classified TM data should be made available for each basin in reproducible form.

Project-Specific Mapping

The color infrared aerial photography should be acquired at scales of 1:12,000 or 1:24,000 for each of the restoration projects. Acquisition should be accomplished through a contract with an aerial photographic that uses a 9 inch by 9 inch format camera to provide stereo coverage of each restoration site. The contractor should simultaneously acquire vertical airborne video tape for each site. The photography and video tape should be acquired within a late September to December window for each year from 1992 to 1994, and every third year thereafter. The aerial photography should be acquired for all projects within a basin for each flight. Each flight should avoid high water or high tide conditions.

The aerial photography should be interpreted for wetlands according to the Cowardin et al. (1979) classification system. Uplands within each project should be classified according to the Anderson et al. (1976) upland classification system as modified by L.R. Handley. The photointerpretation process involves the stereoscopic identification of various wetland and upland signatures. These signatures should be delineated by using a 6 x 0-size technical drafting pen and labeled according to the applicable classification system and mapping conventions. Where necessary, the classification system should be modified to fit the needs of these specific restoration projects. For example, because of the large scale of photography being interpreted (1:12,000) for some of the projects, the minimum mapping unit should be decreased to 0.1 acre. The modified mapping unit may also describe additional factors (e.g., salinity, species, density of coverage) if the information is available from the other monitoring subgroups.

Once the photointerpretation process has been completed, the interpreted photographs should be groundtruthed and any corrections should be made. The photographs should then be reviewed for quality control. Here the delineations and interpretations should be checked for positional and thematic accuracy and consistency. The delineations should then be transferred to an overlay placed on a 1:12,000 or 1:24,000 topographic base map. The 1:12,000 scale base maps should be prepared by either photographically enlarging a quarter of a USGS topographic base map or by manipulating the digital data for USGS topographic maps that may be available for some of the quadrangles to the desired scale. Each new 1:12,000 base map will then represent 1/4 of a 1:24,000 USGS topographic quadrangle. The delineations made on the 1:12,000 scale or 1:24,000 scale photography should then be transferred to the base maps by using a zoom transfer scope. The drafted map should be taken to the field for review, and copies distributed for review and comment. Final map production would come after all review comments were incorporated. A large-scale review should follow. In this step the final quality control is performed. All interpretation and mapping should follow the reporting and documentation process developed by NWI.

Deliverables of the mapping project should be paper copies of the maps drafted at 1:6,000, 1:12,000, and 1:24,000 scales. The aerial photography should be available for viewing and for copying on a cost reimbursable basis.

Final habitat maps should be digitized for selected restoration projects. It may not be feasible to digitize each project for each year. The restoration projects to be digitized should be determined on reviewing the draft maps to evaluate the extent of change that has taken place. Digitization should be done using the Analytical Mapping System (AMS) on a UNIX workstation. The AMS digital data should be available in DLG-3 format for use on ArcInfo, Integraph, Infocad, etc. Deliverables will be the digital data on standard tape format and acreage summaries for each quad.

GIS should be used to analyze the digitized habitat maps for the purpose of developing wetland trend maps to identify areas of wetland loss and gain occurring within restoration plans over time. Digital data, wetland trend maps, and reporting data (landcover and wetland trend acreage tables) should be available for use on a cost reimbursable basis.

VII. PROJECT TYPES

Project Ranking

Because the mapping program is providing a supporting role, projects are not ranked by the habitat mapping subgroup but should follow the consensus ranking of the other subgroups to do the project-specific mapping.

Proposed Mapping Scale for Each Project Type

Project	Acreage		Scale
Fourchon	2,300	acres	1:12,000
Gulf Intracoastal waterway			
to Clovelly wetland	60,000	acres	1:24,000
Cameron-Creole watershed	64,000	acres	1:24,000
Bayou Sauvage National Wildlife Refuge	6,000	acres	1:12,000
Turtle Cove shoreline	1,000	acres	1:12,000
Sabine National Wildlife Refuge	13,000	acres	1:12,000
Vegetative plantings			
West Hackberry	> 100	acres	1:6,000
Dewitt-Rollover Gulf	< 100	acres	1:6,000
Falgout Canal shoreline	> 100	acres	1:6,000
Timbalier Island	> 100	acres	1:6,000
West Bay sediment diversion	9,800	acres	1:12,000
Barataria Bay waterway	1,000	acres	1:12,000
Lower Bayou LaCache	4,200	acres	1:12,000
LaBranche wetlands	300	acres	1:12,000
Cameron Prairie	640	acres	1:12,000
Vermilion River cutoff	200	acres	1:12,000
Eastern Isles Dernieres	100	acres	1:6,000
GIWW to U.S. 90	40,000	acres	1:24,000
Tiger Pass marsh	415	acres	1:12,000
Falgout Canal South wetland	220	acres	1:6,000
Lake Salvador shoreline	> 100	acres	1:6,000

1) Projects added in future years should be mapped at scales according to the following guidelines:

Average	Scale
Under 200 acres	1:6,000
200 acres to 20,000 acres	1:12,000
Over 20,000 acres	1:24,000

2) Although the general procedure proposed is to obtain aerial photography for each project for each of the first 3 years and then every third year thereafter, it is the general consensus of the mapping subgroup that this be considered on a case-by-case basis because projects may show significant changes that should be monitored frequently.

Estimated Project Cost	1993	1994	1995
Project-Specific Mapping			
Photointerpreter(s)	$39,000	$79,000	$82,000
Cartographic technician(s)	$55,000	$58,000	$61,000
Geographer	$20,000	$20,000	$20,000
	$114,000	$157,000	$163,000
Photography	$24,000	$30,000	$35,000
Historical photography	$9,000	$4,000	$0
Supplies	$18,000	$12,000	$10,000
Materials (horizontal control)	$8,000	$4,000	$4,000
Travel	$2,000	$4,000	$4,000
Equipment	$106,000	$7,000	$0
	$167,000	$61,000	$53,000
Total cost	$281,000	$218,000	$216,000
Basin-level mapping			
TM scenes	$16,000	$20,000	$0
Geographer (classification)	$10,000	$36,000	$36,000
Total cost	$26,000	$56,000	$36,000
Digitizing selected project-specific maps	$18,000	$38,000	$38,000
GIS analysis of digital data from project-specific maps	$16,000	$36,000	$38,000

VIII. PEER REVIEWERS

Pat O'Neil	U.S. Geological Survey
Melvin Fuhrmann	U.S. Fish and Wildlife Service
James Gosselink	Louisiana State University
Carol Clark	Louisiana Department of Natural Resources
Nancy Powell	U.S. Army Corps of Engineers
Paul Kemp	Coalition to Restore Coastal Louisiana
Edward Hickey	U.S. Soil Conservation Service
James Johnston	U.S. Fish and Wildlife Service
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I. TITLE: WILDLIFE MONITORING ON COASTAL WETLANDS PLANNING, PROTECTION, AND RESTORATION ACT PROJECTS IN COASTAL LOUISIANA

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IV. INTRODUCTION

The wildlife monitoring subgroup of the CWPPRA Monitoring Work Group examined the feasibility of developing wildlife monitoring protocols and analyses to determine the success of a wide range of wetland restoration projects planned for coastal Louisiana. The CWPPRA defines a restoration project as a technically feasible activity to create, restore, protect, or enhance coastal wetlands.

V. GENERAL DISCUSSION

The wildlife monitoring subgroup supports a monitoring program to evaluate the success of prescribed restoration projects in maintaining long-term wetland protection and conservation. The subgroup stressed the importance of selecting monitoring variables that are expected to show a direct (cause and effect) response to project design and actions. The subgroup determined that, since wildlife populations are influenced and controlled not only by local or basin-wide wetland conditions, but also by external factors, monitoring wildlife would be neither biologically sound nor cost-effective in evaluating project success. Several subgroup members pointed out that wildlife populations fluctuate greatly over time and space, and establishing statistically valid relationships between project features, wetland responses, and wildlife populations would be very difficult. For these reasons the wildlife monitoring subgroup recommends not developing a detailed, project-specific wildlife monitoring program.

The wildlife monitoring subgroup recognized that populations of herbivorous species such as the nutria (*Myocastor coypus*) and muskrat (*Ondatra zibethicus*) may have a significant effect on the rate of

recovery of coastal wetland plant communities. The subgroup felt, however, the herbivory issue could best be addressed by the vegetative health monitoring subgroup.

The wildlife monitoring subgroup identified wildlife surveys conducted by the Louisiana Department of Wildlife and Fisheries (LDWF) and the U.S. Fish and Wildlife Service (USFWS) as having limited value for use in evaluating the success of specific coastal wetland creation and restoration projects. Both agencies collect annual records of waterfowl abundance and distribution within the Louisiana coastal zone, and the LDWF conducts inventories of fishery abundance and American alligator (*Alligator mississippiensis*) populations. The LDWF also periodically surveys colonial waterbird populations in Louisiana's coastal zone. The subgroup felt that some of these wildlife data bases, especially that for the alligator, may provide a valuable general index of the status and trends of wildlife populations across the Louisiana coast where wetland creation and restoration projects are underway. These data sets are, however, not considered to be adequate for use in evaluating the success of specific projects in achieving long-term wetland conservation.

VI. METHODOLOGY

The wildlife monitoring subgroup recommends that current and ongoing LDWF and USFWS surveys be used, where needed, as secondary data sets for examining correlations between wetland changes, wildlife abundance, and distribution problems. When used in conjunction with more quantitative monitoring data for water quality, vegetation, etc., these wildlife data bases may have value in confirming over a broad scale (i.e., entire Louisiana coast) what basin-specific monitoring data show for more localized areas.

Methodologies used by the LDWF and by the USFWS for wildlife surveys are either transect-based or are based on observations made on known wildlife concentration areas.

I. TITLE: ASSESSMENT OF CWPPRA PROJECT IMPACTS ON FISHERY RESOURCES

II. AUTHORS:

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We would like to thank Greg Steyer, Barton Rogers, Anna Shaughnessy, Geoffrey Matthews, Rick Hartman, Warren Stuntz, Jeanene Peckham, and Sammy Ray for their assistance in the development of this plan.

IV. INTRODUCTION

Most coastal habitats being lost in Louisiana are valuable in sustaining fishery productivity. Inherent in the goals of the CWPPRA is the idea that projects will be beneficial to coastal fisheries. However, this objective must be considered within the context of the entire program; some projects may benefit fisheries at the expense of other natural resources, and some benefits to fishery resources may not be realized for many years. Determining whether CWPPRA projects have benefited fishery resources will require assessments of impacts after these projects are initiated. The objective of this monitoring plan, therefore, is to provide scientifically defensible data for determining whether CWPPRA projects have had major impacts (either positive or negative) on fishery resources in coastal Louisiana.

All CWPPRA projects have the potential for impacts on fishery resources. Decisions as to the types of projects that should be monitored, however, should be based on the likelihood of these impacts, the time frame of expected impacts, and the difficulty in assessment of impacts.

V. GENERAL DISCUSSION

Variables to be Measured

Ideally, impacts of CWPPRA projects should be assessed by measuring fishery production from a project area. Realistically, however, the effort required to measure productivity is prohibitive, and measures of standing stock must be used as an indicator of fishery value in an area. Each project is likely to have a different assemblage of ecologically important species. These will include the following species of commercial, recreational, and food-chain importance: white shrimp, brown shrimp, grass shrimp, blue crab, stone crab, spotted seatrout, southern flounder, gulf menhaden, spot, Atlantic croaker, red drum, oysters, striped mullet, bay anchovy, and black drum. Other resident forage species may also be abundant, and certain freshwater species may be important in some projects. Most of these species can be sampled with similar gears and sampling designs. Because oysters are sedentary, however, different sampling techniques will be required for this species; monitoring for oysters can also include measures of recruitment, growth, and survival.

Juveniles and small adults (generally less than 100-mm total length [TL]) of the fishes and crustaceans should be targeted for sampling. Because the habitats being modified are usually nursery grounds for the young, juvenile stages are more abundant, making population sizes easier to estimate. Moreover, the best methods have been developed to quantitatively sample these small animals. Large juveniles and adults of these target species, if they are present in the area, will be extremely difficult to sample quantitatively. In addition, abundance measures for older juveniles and adults are subject to greater variances and may not reflect habitat value if populations are reduced by local fishing pressure.

The primary variables to be measured for juvenile fishes and crustaceans should be density (number of animals per area of bottom), size, and biomass. The number of species (species richness) collected within some standardized area should also be recorded. In certain instances, catch in standard gear (such as trawls and seines) may be measured rather than animal density. Catch per standard unit of effort can be useful in assessing relative abundance and species composition, but these data must be interpreted with caution because of the instability in catch efficiency (see Gear Selection).

Important Fishery Habitats

Different coastal habitats support different numbers and species of fishery organisms, and sampling efforts should be stratified within a project area by habitat. Examples of habitats include unvegetated sand or mud bottom, submerged aquatic vegetation, emergent vegetation, organic detrital bottom (coffee grounds), oyster reefs, and channels.

An assessment of relative area for each of these habitats will be necessary to determine sampling strata. Shallow unvegetated bottom is expected to be most common and must be sampled. Submerged aquatic vegetation and emergent shoreline vegetation are known to support high densities of juvenile fishery species and will also need to be sampled if present. Emergent vegetation may be omitted from the sampling program only if sampling can be conducted at low water levels (see section on water level). Sampling crustaceans will probably not be practical on bottoms with large amounts of organic detrital matter (coffee grounds) or on oyster reefs because quantitative sampling of these habitats is prohibitively labor and cost intensive. Combining solid-walled throw traps with the use of rotenone, however, could allow sampling of fishes in these habitats. Although deepwater channel habitats may be important for some animals, most juvenile fishery species are likely to be more abundant in shallow-water habitats. Shallow channels such as marsh creeks may be important habitats to sample.

In some situations, sampling of zones within habitats may be appropriate. For example, high-elevation intertidal wetlands have been shown to support different animal densities and species than low-elevation wetlands. Also, open-water habitats near access structures probably differ from areas further from these structures.

Gear Selection

Gear catch efficiency is a major problem that must be addressed in the selection of sampling gear for CWPPRA projects. Commonly used gear such as trawls and seines, which use the area-sweep method to estimate animal densities, usually have low catch efficiencies. If these efficiencies were stable, appropriate corrections could be made to estimate animal density. Unfortunately, these efficiencies also appear to be highly variable. For example, otter trawls are generally recognized as being selective in the sizes and species of animals caught. This gear catches some unknown percentage (the gear catch efficiency) of the animals present in any given area swept. Catch efficiency varies with net mesh size and with the species and size of the target animals. For small brown shrimp, catch efficiencies of 17.5-52.9% (Loesch 1976), 17% (Zimmerman et al. 1986), and 49% (Minello et al. 1991) have been measured. Catch efficiencies for spot (6%), Atlantic croaker (26%), and anchovies (7%) have also been reported (Loesch 1976; Minello et al. 1991).

A related and more insidious problem is that catch efficiency probably varies with habitat and environmental characteristics, and often these characteristics are related to the treatments being measured in a sampling design. Unless this bias is corrected, site differences attributed to a project may simply be a reflection of a systematic shift in gear efficiency. It has been shown that differences in turbidity affect the catch efficiency of trawls for small fish (Nielson 1983). Vegetation, unconsolidated bottom (coffee grounds), uneven bottom topography, sediment texture, and even temperature are also likely to affect this catch efficiency. Juvenile shrimp often avoid capture in nets because they are burrowed into the substrate, thus all the environmental factors that affect shrimp burrowing (incident light, turbidity, substrate type, predators, hunger level) are candidates for affecting catch efficiency of shrimp. Thus, to make legitimate comparisons among sampling sites and habitats by using catch from sampling gear with low catch efficiencies, researchers must adjust abundance estimates to correct for site-related differences in gear catch efficiency. These corrections could be made for each sampling site and habitat combination by making limited comparisons with gear known to have a high catch efficiency in that habitat.

The confounding problem of variables affecting both animal density and gear efficiency can be avoided if the catch efficiency of the sampling gear is very high. Enclosure devices, such as throw traps or drop samplers (Kushlan 1981; Zimmerman et al. 1984), appear to have high catch efficiencies that do not vary substantially in the presence of vegetation (Zimmerman et al. 1986). In addition, recovery efficiency (a major component of catch efficiency) can be easily measured for these samplers through simple tagging procedures after the sampler has been deployed. The area sampled with throw traps is generally smaller than the area sampled with other types of gear such as seines and trawls, but increasing the sample number can generally compensate for this limitation. Drop enclosures are also limited to water depths less than 4-6 ft, but water depth will probably be shallow for most habitats to be sampled in CWPPRA projects.

In some limited situations, trawls and seines may be useful in monitoring fishery abundance at CWPPRA project areas. These gear can be deployed in deeper water, sample larger areas, and provide data that is more comparable with historical data bases. Trawls and seines also have the advantage of being relatively easy to use, and they are more familiar to people conducting monitoring; they are

often preferred by state research agencies. In general use, however, these gear are often only appropriate for measuring the presence or absence of species in an area. Abundances cannot be accurately measured in habitats where emergent or submerged vegetation is present; thus comparisons among habitats are not possible. Trawls and seines can provide semi-quantitative (moderately stable catch efficiency) abundance samples of non-burrowing animals in nonvegetated habitats. These data can be useful in making comparisons among nonvegetated areas if environmental factors that affect catch efficiency (such as turbidity and bottom type) are examined as potential causes of bias.

Monitoring Costs

The fishery monitoring subgroup has attempted to address the problem of limited monitoring funds in several ways:

1) By restricting the types of projects that require fishery monitoring.

2) By emphasizing monitoring mainly of juvenile fishes and crustacea that occur in greater numbers and are more readily sampled.

3) By limiting assessment of impacts to more easily measured variables such as standing crop, size, and species richness rather than attempting to measure productivity. Productivity estimates (growth, survival, recruitment) are only recommended for oysters.

4) By limiting the recommended temporal replication of sampling efforts.

The following prioritized list (one being most important) of sampling procedures should be used to reduce sampling effort and cost:

1. Collect high quality samples to accurately measure animal density.
2. Select appropriate controls.
3. Collect sufficient sample numbers at any one time for rigorous hypothesis testing.
4. Sample all dominant habitats.
5. Collect samples during biologically different times of year (early spring, late spring, fall).
6. Collect samples in successive years following project implementation.
7. Collect samples every 2 months during a year.

Procedures 1-3 in this list are mandatory, and procedures 1-5 are probably necessary to provide a scientifically sound assessment of project impacts.

The projected cost of assessing impacts on fishery resources depends upon the size of the project areas, the number of important fishery habitats present, and the variability of the measured variables (this determines sample size). Following the procedures outlined in this document, a cost of approximately $150-$200 per throw-trap sample might be expected.

The Water Level Problem

The effect of water-level fluctuations must be considered in estimating the abundance of fishery organisms (see Figure 2). Most fishery species require water and are associated with the bottom in some manner. Changing of water levels at a site, either from tidal fluctuations, water-level control

structures, or alterations in freshwater inflow can drastically alter density estimates of animals. As an example, the rising tide in many coastal areas can easily cause a two-fold difference in the amount of bottom area flooded in a basin. This doubles the area of bottom available for animals, and if the animals are distributed evenly over the bottom, this tidal flooding will reduce the density of animals by half. If water level is not considered in comparing density estimates among sites or over time, spatial and temporal differences in animal abundance will be indistinguishable from density changes caused by this water-level effect. This concentrating factor at low water levels is often ignored in sampling designs. To further complicate this situation, many animals such as brown shrimp, blue crab, and spotted seatrout are attracted to shoreline emergent vegetation when it is available at high water levels (Zimmerman and Minello 1984). If sampling efforts are concentrated in the adjacent open-water habitats, density estimates for these organisms will increase dramatically as water levels drop and animals are forced out of the shoreline vegetation.

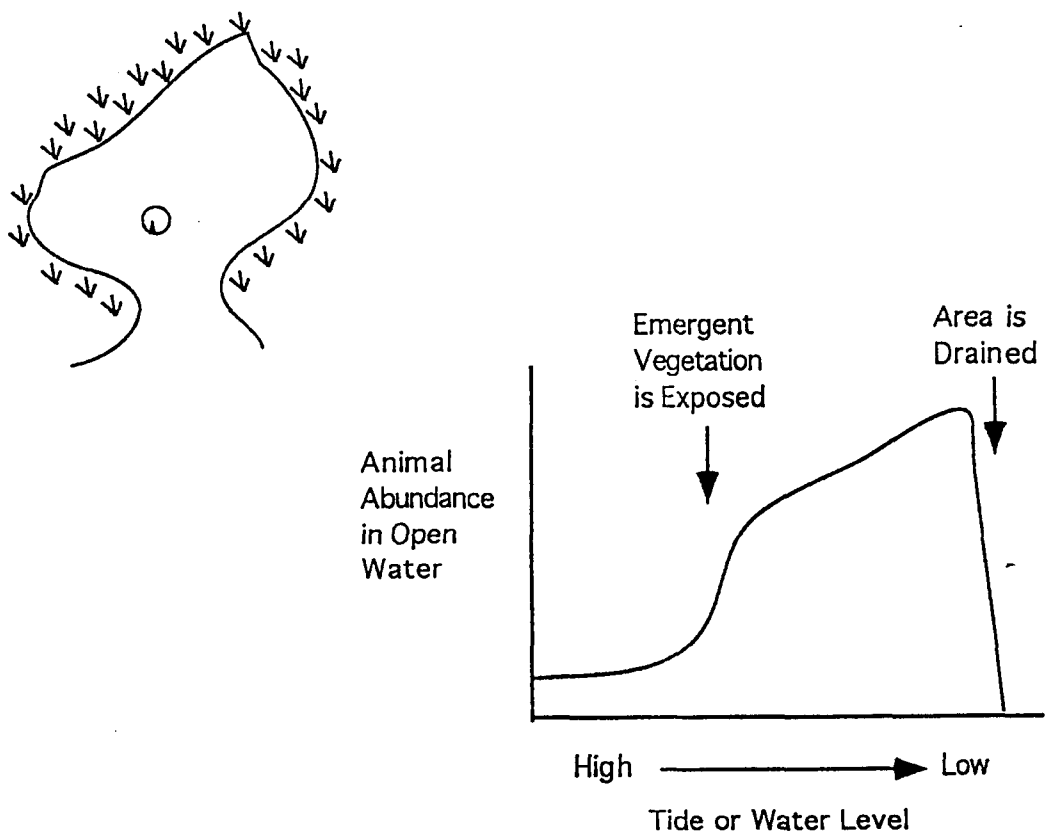

Figure 2. Hypothetical relationship between water level and abundance estimates in a marsh pond.

The most realistic picture of habitat use at a site would require sampling at all water levels in proportion to the time these water levels occur in the sampling area. This approach, however, would increase sample variances and result in unrealistic effort required to detect project impacts. The practical solution to this sampling problem is to sample both the control and project areas at similar water levels. Low-water sampling may be most desirable because it can eliminate the need to sample shoreline habitats (flooded vegetation) and will result in higher open-water densities. However, many locations are inaccessible at low tide except with air boats. In situations where water levels are being controlled as part of the project, sampling study and control areas at similar water levels should still be possible by carefully selecting sampling periods. If water level differences between project and control areas are persistent, all flooded habitats must be sampled, and differences in water levels and area flooded must be considered in interpreting the data.

Common Data

Availability of comprehensive water-quality data (temperature, salinity, dissolved oxygen, turbidity, water level) at the project and control areas will be essential in interpreting sampling results. These variables should also be measured every time a fishery sample is collected. In addition, estimates of coverage for different fishery habitats within project and control areas will be essential for fishery monitoring.

Ongoing Programs

The Marine Fisheries Division of the Louisiana Department of Wildlife and Fisheries monitors fishery species using a variety of equipment at stations in six coastal study areas of Louisiana. Samples are collected with plankton nets, 16-ft trawls, 6-ft trawls, seines, gill nets, and trammel nets. Oysters are sampled with Butler plates, a square-meter frame, and with an oyster dredge. The frequency of sampling and sampling locations are identified in a draft manual of their field procedures on file with the monitoring work group.

VI. METHODOLOGY

Sampling

Density of abundant juvenile and small adult fishes and crustaceans

1) Juveniles and small adults (generally less than 100-mm TL) should be targeted, and the density of animals per square meter of bottom area should be measured. In conjunction with this variable, the size of the organisms, the biomass of dominant species, and the number of species (species richness) collected within some standardized area should also be measured.

2) Throw traps similar to those described by Kushlan (1981) are recommended as sampling gear. The advantages are high catch efficiency in most shallow-water habitats; area sampled is fixed and known; easy and inexpensive to construct; easily deployed from an air boat; and recovery efficiency is measurable. The disadvantages are the area sampled is small, and large and highly motile organisms may avoid the sampler, especially in very clear water. A rough cost estimate that includes all overhead, personnel, and equipment costs would be approximately $150-$200 per sample.

3) Measuring density over time - density should optimally be measured every 2 months following project implementation. Minimally, samples should be collected in early spring, late spring, and fall.

4) Measuring density over space - spatial coverage and number of samples should be determined by the number of sampling zones identified and the variance among samples.

5) Other prioritized protocol (gear and procedures)

   a) Use of small-meshed seine to completely encircle a known area of shoreline habitat. This technique would have the advantage of sampling a larger area, thus reducing between-sample variability and providing a better estimate of abundance for low-density organisms. The technique could be used in deeper water and on all types of nonvegetated bottom, and recovery of enclosed animals could be measured with simple marking techniques. This seining technique, however, will not work well in vegetation, and sampling is restricted to areas where a suitable bank is present to "haul up" the catch and there are few obstructions (such as oysters, rocks, tires, etc.). Additional disadvantages include the possible enclosure of heterogenous bottom and the severe under-sampling of burrowed and bottom-hiding organisms. The cost per sample for this technique will be substantially higher than for throw traps, but the number of samples required for statistically valid comparisons will be significantly lower. Thus, overall project costs between these two gear types might be similar. The major reason this technique is not generally recommended is that sampling would have to be restricted to only certain nonvegetated habitats.

   b) Use of a beam-trawl. This gear is often used to collect small shrimp and fishes and has a relatively high catch efficiency for shrimp on nonvegetated bottom (Zimmerman et al. 1986). As with a seine, the beam trawl can be used in deeper water and samples can cover larger areas of bottom, thus reducing between-sample variability. This gear, however, is not restricted by access to the shoreline; samples can therefore be randomly distributed within an area. Disadvantages include restriction to sampling on nonvegetated bottom, and even here variability in catch efficiency may be related to environmental factors. The cost of a beam-trawl sample will probably be similar to a throw-trap sample, but the number of samples required in the sampling program will probably be reduced.

Oyster growth and survival

1) A standard set of small oysters will be used to measure growth and survival.

2) Nestier trays containing 20-25 oysters will be placed at selected sites within the study and control areas for the measurement of growth and survival. The advantage of this technique is that the initial size and number of oysters is known, commercial harvesting will not affect measurements, and permission to sample private leases is not required. Disadvantages include problems with vandalism of trays, and measurements of survival and growth in these trays may not exactly reflect survival and growth on reefs. Nestier trays are available for a negligible cost from biological supply houses. The trays are easy to deploy and retrieve, and two people could deploy or "read" dozens of trays in one day. Thus, the major expense will be salaries of personnel.

3) Measurements over time - trays will be monitored quarterly for oyster growth and survival. Trays and oysters will be replaced annually in January.

4) Measurements over space - spatial coverage and number of samples will be determined by the number of sampling zones identified and the variance among samples. Sampling zones will be different for oysters than for fish and crustaceans.

Oyster settlement and early survival

1) The number of oyster spat settling and surviving on a defined area will be used as an indicator of recruitment success.

2) Butler plates will be deployed in conjunction with the Nestier trays.

3) Measurements over time - plates will be replaced quarterly when Nestier trays are surveyed, and the number of spat will be recorded in the laboratory.

4) Measurements over space - spatial coverage and number of samples will be the same as for Nestier trays.

VII. PROJECT TYPES REQUIRING MONITORING

All CWPPRA projects have the potential for positive or negative impacts on fishery resources. Decisions as to the types of projects that should be monitored, however, should be based on the likelihood of these impacts, the time frame of expected impacts, and the difficulty in assessment of impacts. Project types have been grouped into the following categories:

Projects that definitely require impact assessment:
- Hydrological restoration
- Freshwater diversion
- Marsh management

Projects that require limited assessment (selected projects):
- Sediment diversion
- Beneficial uses of dredged material (including terracing)
- Sediment and nutrient trapping

Projects where assessment is unlikely to provide valuable information:
- Vegetative plantings
- Barrier island restoration
- Shoreline protection

VIII. HISTORICAL DATA

The Louisiana Department of Wildlife and Fisheries (LDWF) collects fishery samples at numerous stations throughout coastal Louisiana. The Field Procedures Manual, on file with the monitoring work group, identifies station locations and summarizes the variables being estimated, frequency of collection, and gear types in use.

Data collected in the LDWF fishery monitoring program are valuable in determining long-term trends and general abundance patterns of fishery species. In a broad-scale sampling program, variability in gear catch efficiency is more likely to simply increase variability among samples rather than cause biased estimates. In addition, the wide variety of gear types in use (each with its own specific catch efficiency characteristics), makes it unlikely that all samples will be biased in the same direction. In contrast to the large-scale sampling program of LDWF, sampling for CWPPRA projects must be designed on a smaller scale with specific hypotheses to be tested, and samples must be comparable in a variety of shallow-water habitats.

Therefore, the LDWF data base will be most useful in determining long-term fishery trends and assessing the comparability of control and project areas. In addition, these data should be valuable in assessing whether the overall abundance of fishery species for one specific year is abnormally high or low. This information will be important in comparisons of project area results before and after project implementation.

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LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Studies, Plans, Programs and Existing Projects

Exhibit 6

Louisiana Coastal Wetlands Restoration Plan

EXHIBIT 6

Studies, Plans, Programs, and Existing Projects

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STUDIES, PLANS, PROGRAMS, AND EXISTING PROJECTS

A number of studies and reports on water resources development in coastal Louisiana have been prepared by the U. S. Army Corps of Engineers (USACE), the Environmental Protection Agency (EPA), the U. S. Fish and Wildlife Service (USFWS), the Soil Conservation Service (SCS), the National Marine Fisheries Service (NMFS), other federal agencies, the state of Louisiana (Louisiana Department of Natural Resources, LDNR), and local agencies, research institutes, and individuals. The information was used to identify historical trends and existing conditions in the Louisiana coastal zone, to obtain insight for projecting future conditions, and to assist in identifying problems. The more relevant studies, reports, and projects are summarized in the following paragraphs.

STUDIES, PLANS AND PROGRAMS

Department of the Army, U.S. Army Corps of Engineers.

A USACE report entitled *Flood Control, Mississippi River and Tributaries,* published as House Document No. 90, 70th Congress, 1st Session, submitted December 8, 1927, resulted in authorization of a project by the Flood Control Act of May 15, 1928. The project provides comprehensive flood control for the lower Mississippi Valley below Cairo, Illinois, and has had a significant impact on water and land resources in the Louisiana coastal zone. Presently the Mississippi River and Tributaries (MRT) projects includes a combination of features: levees along the main stem of the Mississippi River and its tributaries in the alluvial plain to confine floodflows; reservoirs on the tributaries to store excess flood flows; floodways; and channel improvements to increase channel capacity. Other features include control structures, cutoffs, pumping plants, floodwalls, and floodgates.

Under this authority the Mississippi River levees, which extend to Bohemia, Louisiana, on the east bank and Venice, Louisiana, on the west bank, were constructed. The levee system is essentially complete except in locations where additional work is necessary to bring the levees up to project grade.

Also under this authority, the Atchafalaya Basin Floodway system was developed. An inventory of authorized features in the basin is described herein. The Old River Complex (authorized by the Flood Control Act of September 1954) consists of a low sill structure, an auxiliary structure, an overbank structure and a navigation lock. The complex is designed to pass normal and flood flows from the Mississippi River system and the Red River system through the Atchafalaya Basin. The complex is managed to divert 30 percent of the total latitude flow (the sum of the flows of the Mississippi River at Tarbert Landing and the Atchafalaya River at Simmesport) into the Atchafalaya River. The remaining project features are the Morganza Floodway, the Atchafalaya River, the West Atchafalaya Floodway, and the Lower Atchafalaya Basin Floodway.

A USACE report entitled *Louisiana-Texas Intracoastal Waterway, New Orleans, La. to Corpus Christi, Texas,* was published as House Document No. 230, 76th Congress, lst Session. The report and prior River and Harbor Acts provide for the construction of a 12- by 125-foot channel 384 miles long from the mouth of the Rigolets to the Sabine River. The project was authorized by the River and Harbor Act of 23 July 1942. The main stem of the project was completed in 1944. The River

and Harbor Act of 23 October 1962 authorized enlargement of the channel between the Sabine River and Atchafalaya River to 16 feet by 200 feet and between the Atchafalaya River and Mississippi River to 16 feet by 150 feet; however, this modification has never been implemented and the study was terminated and placed on an inactive status in May 1991.

The USACE is currently conducting a feasibility study under the authority of the Gulf Intracoastal Waterway, Louisiana-Texas study which will address the replacement of the locks on the Gulf Intracoastal Waterway (GIWW) system west of the Mississippi River. The preliminary results of the reconnaissance study indicated that the most immediate needs for capacity increases are at Bayou Sorrel and Calcasieu Locks. Also, a future need for capacity increases at Port Allen and Algiers Locks was indicated. The feasibility phase study will be initiated upon approval of the reconnaissance study. The reconnaissance report was certified in February 1993.

The USACE prepared a reconnaissance report on the authority of the Louisiana Coastal Area Study entitled *Louisiana Comprehensive Coastal Wetlands Study* in June 1990. The report developed a detailed scope of study which was a blueprint for the development of a comprehensive wetlands plan to address Louisiana's coastal wetlands loss problem. The study blueprint called for the Corps of Engineers and the State of Louisiana to do the bulk of the work. An interagency planning team and four interagency technical working groups would assist and guide the Corps and the State in formulating alternatives, reviewing and analyzing information, and screening alternatives. The interagency participation and coordination would assure that a comprehensive plan would result from the study. The study was not funded and is currently inactive.

A USACE report entitled *New Orleans-Baton Rouge Metropolitan Area, Louisiana* was completed in 1981. The report contains a comprehensive plan for development and conservation of water and related land resources in a 21-parish area. The report includes 13 parishes in the current study area.

The USACE prepared an initial evaluation report, *Louisiana Coastal Area, Louisiana Water Supply* in September 1984. This study investigated the advisability of improvements or modification, in the interest of water supply, of existing improvements in the coastal area of Louisiana. The report recommended that 5 of the 6 problem areas found be further investigated in the cost-shared feasibility phase of the study. Currently the study is inactive due to lack of a local cost-sharing agreement.

The USACE prepared an initial evaluation report entitled *Louisiana Coastal Area, Louisiana, Shore and Barrier Island Erosion Study* in September 1984. The Shore and Barrier Island Feasibility Study investigated the causes and consequences of the reduction and loss of the barrier islands and adjacent shores to the combined forces of erosion and subsidence. This study found that the barrier islands and barrier beaches of coastal Louisiana are effective barriers against hurricane and storm surges at locations far inland of the barriers; however, no economically justified erosion abatement plans were identified. This study is currently inactive.

A USACE report entitled *Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana,* was published as House Document No 215, 76th Congress, lst Session. The report recommended a navigation channel 35 to 40 feet deep by 800 to 1,000 feet wide. Construction of the channel was completed in 1963. The General Design Memorandum Supplement No. 2, dated April 1984, provides for the restoration of

deteriorated bank lines below Venice and Southwest Pass with rock foreshore dikes and hydraulic fill to reduce shoaling. Shoal material not needed for bank restoration would be used to create marsh.

A USACE report entitled *Deep-Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana,* was completed in 1981. The report recommended deepening the Mississippi River to a project depth of 55 feet from the Gulf of Mexico to the Ports of New Orleans and Baton Rouge. Dredged material would be placed in subsiding areas east and west of the river below Venice to create 11,600 acres of marsh over a 50-year period. The project was authorized by the 1985 Supplemental Appropriations Act, dated 2 July 1985, and the Water Resources Development Act of 1986, dated 17 November 1986. Construction of Phase I of the project, a 45-foot channel to mile 181 Above Head of Passes (A.H.P.), was completed in December 1988.

A USACE report entitled *Mississippi River-Gulf Outlet,* was published as House Document No. 245, 82nd Congress, lst Session. The report recommended an additional outlet, a 36- by 500-foot channel 76 miles long from New Orleans to the Gulf of Mexico. The improvements were authorized by the River and Harbor Act of 29 March 1956. Construction was completed in July 1963.

The USACE published the reconnaissance report *Mississippi River-Gulf Outlet, St. Bernard Parish, Louisiana (Bank Erosion)* in February 1988. The report assessed navigation channel shoaling, marsh loss, and other erosion-related problems along the Mississippi River-Gulf Outlet. Initial evaluation determined that erosion abatement measures could not be economically justified. The report is currently being reevaluated to justify the erosion control methods based on the intangible value of the wetlands protected. The report is scheduled for completion in February 1994.

The USACE prepared an initial evaluation report *Louisiana Coastal Area, Louisiana, Land Loss and Marsh Creation* in November 1984. The report recommended proceeding into the feasibility phase. The feasibility phase of this study, which is underway now, is investigating methods of creating vegetated wetlands to protect and enhance existing wetland habitat, and to preserve, to the maximum extent practical, the inherent functions of wetlands in the coastal area of Louisiana in the interest of preventing land loss and creating marsh. The feasibility study is limited to St. Bernard, Plaquemines, and Jefferson Parishes.

The USACE conducted a reconnaissance study under the Louisiana Coastal Authority entitled *Mississippi River Delta Study* in February 1990. The purpose of this study was to determine the feasibility of realigning the lower Mississippi River navigation channel to increase the river's marsh-building capacity. The general study finding was that there are no economically justified alternatives for realigning the Mississippi River navigation channel.

The USACE prepared a feasibility report, *Louisiana Coastal Area, Freshwater Diversion to Barataria and Breton Sound Basins,* in September 1984. The report recommended diverting water from the Mississippi River at two locations near the City of New Orleans to enhance habitat and improve fish and wildlife resources. Diversions were recommended near Caernarvon, Louisiana, into the Breton Sound Basin, and near Davis Pond, Louisiana, into the Barataria Basin. The report also recommended that the plan be implemented under the authorized Mississippi Delta Region Project, which is identical in purpose.

These diversions are predicted to prevent the loss of about 99,000 acres of marsh during the 50-year projects. The Caernarvon structure was completed in February 1991. The Davis Pond structure is currently in the detailed design phase. Construction of the Davis Pond structure is scheduled to begin in March 1994, and is scheduled for completion in August 2997.

A USACE feasibility report entitled *Mississippi and Louisiana Estuarine Areas* was completed in 1984. The report recommended the diversion of Mississippi River water into the Lake Pontchartrain Basin and Mississippi Sound to enhance habitat conditions and improve fish and wildlife resources. The project was authorized by the Water Resources Development Act of 1988. The Preconstruction Engineering and Design phase was initiated in fiscal year 1984. Construction could begin in March 1994, and is scheduled for completion by June 1998.

A USACE report entitled *Barataria Bay, Louisiana* was published as House Document No. 82, 85th Congress, lst Session. The project provides for a 12- by 125-foot channel approximately 37 miles long from the Gulf Intracoastal Waterway (GIWW) to Grand Isle, Louisiana. These improvements were authorized by the River and Harbor Act of 3 July 1958. All work was completed in December 1967.

The USACE prepared an reconnaissance report, *Louisiana Coastal Area, Hurricane Protection,* which investigated hurricane induced surges associated with the anticipated future losses of coastal wetlands and barrier islands in the coastal zone of Louisiana. The report recommended that the study proceed into the cost shared feasibility phase for an area of St. Charles Parish on the west bank of the Mississippi River. The report was certified in March 1989. The feasibility study was initiated in March 1990. The local sponsor notified the USACE that they would not continue to participate in the cost shared study in January 1991; consequently, the study was terminated.

A USACE report entitled *Lake Pontchartrain, Louisiana and Vicinity* authorized, under the Flood Control Act of 1965 and by the Water Resources Development Act of 1974, hurricane protection for a portion of the metropolitan New Orleans area on the east bank of the Mississippi River. The plan called for construction of barriers at the entrance to Lake Pontchartrain. In December 1977, a Federal court injunction stopped construction of portions of the authorized project until a new Environmental Impact Statement could be prepared. A reevaluation study, dated July 1984, recommended construction of the Lake Pontchartrain High Level Plan and the Chalmette Area Plan. The plans consist of raising existing levees and constructing new levees, with no barriers at the entrance to Lake Pontchartrain. Construction of the project is ongoing.

A USACE report entitled *New Orleans to Venice, Louisiana, Hurricane Protection* was published as House Document No. 550, 87th Congress, 2nd Session. The project provides hurricane protection to developed areas in Plaquemines Parish along the Mississippi River. The locally constructed back levee from City Price to Venice on the west bank would be enlarged and the existing levee from Phoenix to Bohemia on the east bank would be brought up to grade. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife Refuge as mitigation for marsh loss caused by the levees. The project is approximately 53 percent complete and construction along all five reaches is scheduled to be completed in September 2013.

The USACE published the *Grand Isle and Vicinity (Larose to Vicinity of Golden Meadow), General Design Memorandum* in May 1972. The Larose to Golden Meadow Hurricane Protection Project was authorized by Public Law 298, 89th Congress, 1st Session, approved October 27, 1965. The project provides protection against hurricane surge flooding with a levee loop approximately 43 miles in length along both banks of Bayou Lafourche at Larose and Golden Meadow. The project includes floodgates in Bayou Lafourche at Larose and Golden Meadow. Construction of the project is continuing.

A USACE report published as House Document 112, Eighty-sixth Congress, first session, titled *Bayou Lafourche and Lafourche-Jump Waterway, Louisiana,* recommended modification of the existing project. The report recommended an auxiliary channel 12-by 125-feet from the Intracoastal Waterway (mile 37.2) generally parallel to and west of Bayou Lafourche along Grand Bayou Blue to Bayou Lafourche below the highway bridge at Leeville, and thence in the bayou to the 12-foot depth contour in the Gulf of Mexico; a channel 9 by 100 feet in Bayou Lafourche from Leeville to the lower limits of Golden Meadow restoring and extending the existing jetties at Belle Pass from the 6- to 12-foot depth if found advisable to reduce maintenance; and dredging a 12- by 125-foot channel from Bayou Lafourche at Leeville through the Southwestern Louisiana Canal to and through Bayou Rigaud (Grand Isle). The dredging between mile -0.3 and mile 13.2 on Bayou Lafourche has been completed; dredging Bayou Lafourche from Leeville to Golden Meadow (9 feet by 100 feet) has been completed, and dredging of Bayou Lafourche Auxiliary Channel will be initiated contingent upon availability of right-of-way and funds.

A USACE report published as House Document 583, Eighty-seventh Congress, second session, titled *Bayous Terrebonne, Petit Caillou, DuLarge, and Connecting Channels, Louisiana, and the Atchafalaya River, Morgan City to the Gulf of Mexico,* contained an evaluation of a 9- by 80-foot channel in Bayou Grand Caillou from the Houma Navigation Canal to the Gulf of Mexico. The study was unfavorable, and no improvements were recommended for Bayou Grand Caillou or other streams under study. Federal maintenance of the Houma Navigation Canal, as constructed by the Terrebonne Parish Police Jury, was recommended in the report and was authorized by Congress in the River and Harbor Act of 1962.

The USACE prepared a feasibility report and EIS, *Atchafalaya Basin Floodway System, Louisiana,* in 1982. The report recommended a plan to satisfy the flood control needs of southern Louisiana and optimize the environmental protection of the Lower Atchafalaya Basin Floodway. In February 1983, the Chief of Engineers recommended further study of the Atchafalaya Bay-Terrebonne marsh complex. This study will analyze backwater flooding problems east of the floodway. The study results will be presented in a reevaluation report. In addition, a delta management study will analyze techniques for managing the developing delta in Atchafalaya Bay that are consistent with USACE navigation and flood control responsibilities. Study results will be included in a feasibility report entitled *Atchafalaya Basin Land and Water Resources, Louisiana.*

A USACE report published as Senate Document Number 93, Seventy-seventh Congress, titled *Bayou Teche, Teche-Vermilion Waterway, and Vermilion River, LA* recommended an 8- by 80-foot channel from Vermilion Bay to the Gulf Intracoastal Waterway; a navigable 9- by 100-foot channel from the Gulf Intracoastal Waterway to the head of navigation at Lafayette for navigation and flood control

improvement of the non-navigable channels of Vermilion River and Bayou Fusilier from Lafayette, Louisiana to Bayou Teche; channel enlargement in Bayou Teche from 2 miles below Arnaudville to Port Barre, Louisiana; an increase in pool elevation above Keystone Dam; and construction of suitable control works in Ruth Canal by local interests. All work has been completed. The project was reclassified as an "Operation and Maintenance, General" project under the category "Navigation" in 1956.

A USACE report on the Mermentau River and Tributaries and Gulf Intracoastal Waterway, which was published as Senate Document Number 231 Seventy-ninth Congress, recommended improvement or modifications to existing improvements in the coastal area of Louisiana. The report recommended the construction of a saltwater guard lock (Calcasieu Lock) in the Gulf Intracoastal Waterway; channel enlargement of the Mermentau River below Grand Lake and the construction of a sector gated control structure in the Mermentau River at Catfish Point; channel enlargement and realignment of the Inland Waterway from Vermilion Bay to Grand Lake; construction of a sector gated control structure in the enlarged channel near Schooner Bayou; and enlargement of the North Prong of Schooner Bayou and Schooner Bayou Cut-Off. All work was completed as of 1952.

A USACE report entitled *Calcasieu River and Pass, Louisiana,* was published as House Document No. 436, 86th Congress, 2nd Session. The report and prior River and Harbor Acts authorized a 35- by 250-foot channel 36 miles long from the Lake Charles Harbor and Terminal District (including the Clooney Island Loop) to the Gulf of Mexico. The project was authorized by the River and Harbor Act of 14 July 1960. Work was completed in October 1968.

A USACE report published as House Document 582, Eighty-seventh Congress, second session, titled *Calcasieu River Salt Water Barrier, Louisiana* recommended a salt water barrier structure with five 40-foot tainter gates in a new channel; a parallel channel with a navigation structure and single sector type gate; an earthen closure dam and a woven lumber type revetment. The project modification has been completed.

The USACE, under Section 1135 of the Water Resources Development Act (WRDA) of 1986 and as modified under Section 304 of the WRDA of 1990, is authorized to conduct studies on the operation of USACE water resources projects to determine the need for modification of the project for the purpose of improving the quality of the environment in the public interest. Proposed projects must be feasible, must be consistent with the authorized project purpose, and must emphasize fish and wildlife restoration. Project cost are cost shared 75 percent Federal and 25 percent non-federal. The total Federal cost to any particular project is limited to $3.75 million.

The USACE regulates construction and other work in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899, and has authority over the discharge of dredged or fill material into the "waters of the United States"--a term which includes wetlands and all other aquatic areas--under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500, the "Clean Water Act"). The Section 404 program is the principal way by which the Federal Government protects wetlands and other aquatic environments. The program's goal is to ensure protection of the aquatic environment while allowing for necessary economic development.

In an effort to ensure adequate disposal areas for dredged material removed during maintenance of Federal navigation projects, the USACE, New Orleans District, develops a Long Term Disposal Plan. As part of this effort, the District evaluates the existing disposal plan and possible alternatives with the objective of developing a more environmentally desirable plan at a reduced, comparable, or justifiably increased cost. The goal is a long-term disposal plan incorporating beneficial use of the dredged material to the maximum extent practicable.

U.S. Department of the Interior (U.S. Fish and Wildlife Service, U.S. Geological Survey, Minerals Management Service, and National Park Service).

The USFWS administers six National Wildlife Refuges encompassing over 264,000 acres; the majority of those lands are coastal wetlands. The USFWS carries out an active program to protect, restore, and enhance those wetlands. Funding for wetland conservation activities is derived from the USFWS's budget; the Sate of Louisiana's Wetland Conservation and Restoration Fund; the North American Wetlands Conservation Act (NAWCA) grants, matched with State and other non-Federal contributions; and private contributions matched by National Fish and Wildlife Foundation grants. An example of wetland restoration on refuge lands with multiple funding sources is the recent and ongoing construction of numerous small scale sediment diversions (crevasses) on the Delta National Wildlife Refuge. The USFWS also requires private and public entities to mitigate the impacts of their activities on refuge lands, including coastal wetlands.

The USFWS also provides leadership in the implementation of the North American Waterfowl Management Plan (NAWMP), a strategy for restoring continental waterfowl populations to levels observed in the 1970's. Joint ventures have been established to help implement the NAWMP in key geographic regions. Coastal Louisiana is a key component of the Gulf Coast Joint Venture. In support of the NAWMP, the USFWS and key public and private entities have management strategies to benefit waterfowl and other wetland dependent wildlife in coastal Louisiana. To help implement those strategies, the Service assists other entities in the preparation of applications for North American Wetlands Conservation Act grants, and advocates other means of achieving habitat conservation goals (*e.g.*, modifying USACE projects to benefit wetlands, implementation of selected State funded coastal wetland restoration projects, *etc.*)

The USFWS has a major consultation, reporting, and advocacy role under provisions of the Fish and Wildlife Coordination Act. Under the Act, the Service provides its findings and recommendations to Federal construction and permitting agencies regarding impacts to, and conservation of , important fish and wildlife resources. In coastal Louisiana, the USFWS participates in the planning and evaluation of proposed water resource development projects carried out by the USACE and the SCS, and advocates measures to reduce the loss of wetlands and to benefit wetland habitats whenever possible. The Service also has consultation responsibility under the Coastal Barrier Improvement Act and Section 7 of the Endangered Species Act of 1973, as amended; consultation with other Federal agencies under those authorities can ultimately result in reduced losses of coastal wetlands. The USFWS also participates in interagency wetland conservation planning efforts such as the Barataria-Terrebonne National Estuary Program.

The USFWS provides technical assistance to LDNR and private landowners in the planning and design of coastal wetland conservation and restoration projects. Limited cost share funding for coastal wetland restoration on private lands is available through the USFWS's Partners for Wildlife Program.

The USFWS's National Wetlands Research Center has produced numerous reports, habitat maps and other data sources dealing with Louisiana's coastal wetlands. Examples of their products which are useful in coastal restoration planning include ecological characterizations of the Chenier Plain and Mississippi Deltaic Plain ecosystems, a community profile of the delta marshes of coastal Louisiana, and habitat maps and associated trend analyses of coastal Louisiana for various time periods. The National Wetlands Research Center is conducting research on the effects of marsh management on coastal wetlands in Louisiana.

The Partners for Wildlife program promotes the restoration, enhancement and protection of fish and wildlife habitat on private lands through alliances between the USFWS, other organizations and individuals. Both technical and financial assistance can be provided to eligible landowners.

The Partners for Waterfowl Tomorrow program promotes the development and management of wetlands and waterfowl habitat on private lands. Landowners agree to operate and maintain development projects for 10 or more years. Landowners are provided water control structures, but must install, maintain and operate the structures for 10 years. The USFWS administers this program.

The U.S. Geological Survey (USGS) is involved in a variety of coastal geoscience research, topographic mapping, and data inventory activities in coastal Louisiana. The USGS investigates geological processes and monitors various water quality and contaminant parameters in that area, and their published findings provide a source of scientific information utilized in the planning, design, monitoring and evaluation of coastal wetland restoration projects. The USGS, in cooperation with Louisiana State University and other Federal agencies, has also produced maps, atlases and reports documenting the results of investigations of Louisiana's barrier islands, sand sources for possible maintenance and restoration of those islands, and critical wetland processes. The USGS is also incorporating major data bases in a computerized geographic information system network for coastal Louisiana. The agency is also involved in marsh management research being conducted jointly with the National Wetlands Research Center.

The Minerals Management Service (MMS) regulates mineral (primarily oil and gas) leasing, exploration, and production on the Outer Continental Shelf (OCS). MMS has funded several studies addressing OCS related impacts to sensitive habitats in the Gulf of Mexico coastal region, including impacts on Louisiana's coastal wetlands. MMS has provided financial support for a 1987 report which quantified wetland losses associated with various human activities, including but not limited to OCS related activities, in the central Gulf of Mexico coastal region. MMS also published a report in 1990 on marsh management practices in coastal Louisiana.

The National Park Service administers the Jean Lafitte National Historical Park and Preserve, authorized by Congress in 1978. The park was established to protect significant cultural and natural resources of Louisiana's Mississippi Delta Region and to interpret the area as it related to development of cultural diversity in the delta.

Environmental Protection Agency.

The National Estuary Program is a five-year, multi-agency planning effort that works toward the development of a Comprehensive Coastal Management Plan for specific estuarine systems. The Barataria-Terrebonne Estuary system is enrolled in this program. The Louisiana Department of Environmental Quality is the lead agency.

The Environmental Monitoring and Assessment Program (EMAP), includes the Louisiana Province within the estuaries section. Coastal monitoring includes the EMAP-Estuaries suite of benthic indicators, water quality and fish. The 1993 field samples are being processed at four province Laboratories.

The EPA has overview responsibility in the Clean Water Act, Section 404 program, which deals with the permitting of discharges of dredge and fill material into waters of the United States, including wetlands. This includes the responsibility to prohibit or restrict a fill that may have unacceptable impacts on these waters.

The EPA has responsibility to review and comment on environmental impacts and compliance with the National Environmental Policy Act for federal projects that may have significant impacts on the environment.

With CWA, Section 404 "extramural funds", EPA Region 6 and Headquarters has provided studies and small wetland related projects including the following:

Feasibility of Using Pipelines and Dredged Sediments to Restore Wetlands in Terrebonne Parish, September, 1991.

Demonstration Project for Revegetation and Wetland Restoration (Hammock Lake and the Gulf Intracoastal Waterway), November, 1993.

Gulf Intracoastal Waterway Spoil Bank Herbivory Study, April, 1993.

Sedimentation Processes of Natural and Dredged Material in the Atchafalaya Delta, scheduled completion date January, 1994.

Vegetational Analysis of the Avoca Island Marsh Management Plan in the Lower Atchafalaya Basin, Louisiana, May, 1991.

Field Monitoring of Marsh Management Activities at Rockefeller Wildlife Refuge and Fina-LaTerre. Accretion and flux studies reported in 1993, including vegetation stress and simulated drawdown studies now in progress.

Spoil Bank Management Study in Terrebonne Parish, in process.

Study of Ecological Effects of Mariculture on an Estuarine Marsh System Under Management (Preliminary Investigation), September, 1989.

A Project to Monitor the Effectiveness of Sediment Fences Constructed Near Leeville, Louisiana, 1992.

Development and Application of Spatial Simulation Model for Predication of Impacts from Marsh Management Practices in Coastal Louisiana, July, 1992.

Analysis of marsh loss and gain on sixteen marsh management sites and sixteen unmanaged (control sites in coastal Louisiana (1988).

Additional EPA programs have provided demonstration projects for the restoration of oil and gas canals with vegetation and sediment fencing, and for the development of vegetation in open water areas using submerged berms.

U.S. Department of Agriculture, (Soil Conservation Service, Agricultural Stabilization and Conservation Service).

The primary objective of the Soil Conservation Service Plant Material Program center located in Golden Meadow, Louisiana, is the development and introduction of plant species to be used to reduce coastal erosion.

The Swampbuster Provisions of the 1985 Food Security Act prohibits farm program payments to farmers who convert wetlands into croplands or transform wetlands into a condition that will allow crops to be planted.

Under the Conservation Reserve Program (CRP), the Agricultural Stabilization and Conservation Service (ASCS) will cost-share with landowners to implement an approved soil conservation plan and pay landowners annual rental payments for 10 years to maintain these practices. Specific land eligibility requirements must be met.

Under the Agricultural Conservation Program (ACP), ASCS provides up to 75 percent cost-share for certain practices designed to reduce sedimentation and pollution or provide wildlife habitat (permanent cover and shallow water) on land presently in agricultural production. Specific land eligibility requirements must also be met.

Under the Wetland Reserve Program (WRP), landowners are paid by ASCS for long-term or permanent easements on prior converted cropland that is restored both vegetatively and hydrologically into its natural wetland state. ASCS will also cost-share up to 75 percent of the restoration costs.

In Louisiana, the Water Bank Program is used primarily to protect existing wood duck nesting habitat. In coastal parishes, however, the program has been used to restore and protect mottled duck nesting habitat in former marsh pump-outs and abandoned rice fields. Contracts consist of 10-year agreements which require landowners to follow a conservation plan. Participating landowners receive rental payments from the U.S. Department of Agriculture.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service.

The National Sea Grant Program seeks to increase understanding, assessment, development, utilization and conservation of the Nation's ocean and coastal resources by promoting a strong educational base, responsive research and training activities and broad dissemination of knowledge and techniques. To accomplish this, the program has developed an infrastructure of marine research and technology transfer at its educational institutions, including Louisiana State University. Within this general framework, the National Sea Grant Program is structured to focus on NOAA-wide interests such as the Coastal Ocean Program and the Climate and Global Change Program.

Fishery Management Councils have the major responsibility for developing fishery management plans (FMP) for domestic and foreign fisheries in the U.S. Exclusive Economic Zone. The councils also evaluate estuarine and freshwater issues affecting managed species under their purview. NOAA provides the councils with technical and administrative assistance and financial support to develop, monitor, implement and amend the FMP's. Councils conduct public hearings, review applications from foreign countries, estimate yields and determine the total allowable level of foreign fishing for each fishery under their management jurisdiction. NOAA reviews management plans developed by the council to ensure

their compliance with the Magnuson Fishery Conservation and Management Act. In the Gulf of Mexico, FMPs have been implemented for red drum, shrimp, mackerel, and other living marine resources.

NOAA's Habitat Restoration Center was established in 1991 to provide in-house expertise and coordination for restoration and habitat research. The NMFS is the lead office for the center and works with other NOAA components to develop appropriate restoration methodologies. The center leads the planning, implementation and monitoring of case specific programs to restore NOAA trust resources after successful settlement of natural resource damage claims. NOAA also has a ready response capability (utilized during oil spills in Louisiana) to provide critical information regarding oil spill trajectory, chemical hazard analyses and assessments of the sensitivity of marine and estuarine habitats. To fulfill the responsibility of the Secretary of Commerce under the Superfund and Clean Water Acts, NOAA, as Federal trustee for living natural resources in coastal and marine areas, conducts comprehensive assessments of damages to NOAA trust resources from discharge of oil or releases of other hazardous substances.

The NMFS, under the Fish and Wildlife Coordination Act, has a major role in the review process for applications regarding wetlands alterations and possible degradation, NMFS Habitat Conservation Division (HCD) provides substantive comments to Federal and state permitting agencies on the impacts of projects involving habitat which supports marine fishery resources and recomments appropriate and practicable measures to mitigate those impacts. The HCD also participates in numerous interagency wetland conservation planning efforts in Louisiana such as the Barataria-Terrebonne National Estuary Program and Coastal America.

NOAA, through its Coastal Ocean Program, has initiated a cooperative Federal and state interagency effort (C-CAP) to map coastal wetlands and adjacent upland cover and change in coastal regions of the U.S. every 2 to 5 years and to annually monitor areas of significant change.

The Fisheries Statistics Division collects, compiles and publishes data on U.S. commercial and recreational landings, foreign catches, employment, vessels, prices, production of processed fishery products and per capita consumption. Statistics for fish and shellfish landed in Louisiana are available by species in pounds and dollars, port landed, and harvest zone.

State of Louisiana.

The Louisiana Department of Wildlife and Fisheries (LDWF) Land Acquisition Program is administered by the LDWF and is funded primarily by duck stamp and hunting license revenues. Wetlands are given high priority. Revenue allocations for this program include $1.5 million to acquire waterfowl habitat, $800,000 from hunting licenses for general land acquisition, and $18,000,000 in one-time funding.

The LDWF Fur and Refuge Program, Refuge Division includes almost 200,000 acres of coastal wetlands in four separate refuges. Providing waterfowl habitat is the primary purpose of these wetlands.

The LDWF Natural Heritage Program's primary mission is the identification and indexing of unique natural habitats in Louisiana (including many wetlands).

The Louisiana Natural and Scenic Rivers Program is administered by the LDWF and provides for a system to protect certain rivers and streams from certain forms of destruction.

The Statewide Environmental Investigation Program is administered by the LDWF and allows for mitigating fish and wildlife habitat loss caused by local, state or federal development projects.

The Coastal Management Division Coastal Use Permitting Program is administered by the Louisiana Department of Natural Resources-Coastal Management Division (DNR-CMD). This program provides guidelines for the permitting of coastal zone developmental activities in the least environmentally damaging manner. Coastal Use Permits (CUP) are required for any activity in the coastal zone except those specifically exempted by the Louisiana State Legislature.

The Coastal Management Division Consistency Program is administered by DNR-CMD and involves the review of all federal activities in the coastal zone to ensure consistency with the Louisiana Coastal Management Program.

The Coastal Management Division Local Coastal Programs interfaces with local parish governments and provides for the development and implementation of local coastal management plans consistent with the state program for management of activities of local concern. Parishes with an approved local program can permit coastal activities of local concern.

The Louisiana Coastal Wetlands Conservation and Restoration Program is an action program administered by the Governor's Office of Coastal Activities that establishes specific coastal restoration or conservation projects through an annual updated priority plan approved by the Louisiana State Legislature. The program is funded from a portion of the state oil and gas severance taxes placed in a Wetlands Trust Fund.

The Forestry Stewardship Program is administered by the Louisiana Department of Forestry and Agriculture Office of Forestry. It provides financial incentives and/or technical support for farmers to improve habitat, including forested wetlands. Improvements include erosion control, water quality management, *etc.*

Louisiana Land & Exploration Company (LL&E) is the largest private owner of coastal wetlands in the U.S., with holdings in excess of 600,000 acres. Since the mid-1950's the company has conducted an aggressive wetlands management and conservation program. LL&E's efforts are continuing.

The Fina LaTerre Mitigation Bank program includes a comprehensive management effort to maintain and enhance vegetated wetlands to accrue credits used to mitigate for development projects within the same hydrologic basin.

The Mud Lake Marsh Conservation Plan involves two separate areas. Management techniques are oriented toward fisheries interests.

The Fina LaTerre Marsh Management Program manages extensive coastal wetlands to make a profit. The surface-leasing program includes leases for fur, alligator, deer, ducks, and campsites.

The Nutria Control Program was established by Act 552 and provides up to $50,000 to encourage trapping of nutria on private wetlands being destroyed by nutria.

The Louisiana Nature Conservancy program is designed to preserve plants and animals in natural communities that represent the diversity of life in unique and threatened habitats (including coastal and inland wetlands) by protecting the land

and water. This program is carried out by the acquisition of land that includes the habitats in question.

Act 1040 of the 1990 Louisiana Legislature requires LDNR to adopt regulations to require mitigation for the ecological values lost as a result of activities permitted in the Louisiana Coastal Zone. LDNR is in the process of developing those regulations with input from Federal and state agencies, landowners, development interests, local governments, and the environmental community. An initial draft of the regulations was distributed for review on November 18, 1992. The draft is presently undergoing significant revisions. LDNR intends to proceed with formal rulemaking procedures during Summer 1993, with a goal of adopting the regulations by the late Summer or Fall 1993.

The Short-Term Dredged Material Survey program is administered by the LDNR and provides for the development of short-term plans for the beneficial disposal of materials dredged in the Atchafalaya River, Barataria Bay Waterway, Houma Navigation Canal, Mississippi River Gulf Outlet, Calcasieu Ship Channel, and Freshwater Bayou. The dredged material disposal plans identify feasible disposal options which restore, create, conserve, and enhance vegetated wetlands.

The Long-Term Management Strategies Plan for Coastal Navigation Channels is administered by the LDNR and provides for the development of ten-year beneficial dredged material disposal plans for coastal zone portions of the following navigation channels in Louisiana: Gulf Intracoastal Waterway, Calcasieu River, Mermentau River, Freshwater Bayou, Atchafalaya River, Houma Navigation Canal, Bayou LaFourche, Barataria Bay Waterway, Mississippi River, and Mississippi River Gulf Outlet.

The LDNR has completed feasibility studies on a number of potential wetland benefiting projects. The purpose of the studies was to identify the causes for coastal degradation in the project area and submit alternatives for protecting the project area. Feasibility studies have been prepared for the following projects:

White's Ditch Outfall
Grand/Spanish Pass Diversion
Violet Siphon Enlargement
Tiger/Red Pass Diversion
Shark Island/Weeks Bay
Davis Pond Diversion Outfall
Caernarvon Outfall Big Mar
Lake Salvador Shoreprotection
Caernarvon Outfall Lake Lery
White Lake
West Point a la Hache Outfall
Black Bayou Marsh Management
LaReussite Outfall Management
Deep Lake Marsh Protection
Grand Bayou Wetland
Boudreaux/Broussard Marsh Protection
Bohemia Diversion Outfall
Sweet Lake/GIWW Bank Restoration
White's Ditch Enlargement
Redfish Point
Cameron Creole Freshwater GIWW
Back Ridge Freshwater Introduction
Violet Siphon Diversion Outfall

Weeks Bay Shore Restoration
North Shore Wetland
Black Lake South Shore Protection
Holly Beach to Calcasieu
Constance Beach to Ocean View

EXISTING PROJECTS (INTERBASIN)

Numerous projects have been constructed within the Louisiana coastal zone by Federal, State, and local agencies. Listed in this section are the relevant projects and their corresponding basin. The effects these projects have on a particular basin are discussed in the individual basin plans appended to this report.

Department of the Army, U.S. Army Corps of Engineers.

Project	Basin
Bayous Chene, Boeuf, and Black Navigation Project	Atchafalaya-Terrebonne
Gulf Intracoastal Waterway	All Basins
Larose to Golden Meadow, LA, Hurricane Protection	Terrebonne-Barataria
Mississippi River, Baton Rouge to the Gulf of Mexico, LA	Bar-Pontch-Bret-Delta
Mississippi River Ship Channel, Gulf to Baton Rouge, LA	Bar-Pontch-Bret-Delta
Mississippi River Channel Improvements (Dredging, Foreshore Protection, Levees, and Revetments)	Bar-Pontch-Bret-Delta
New Orleans to Venice, LA, Hurricane Protection	Breton-Barataria
Old River Control Structure	Atch-Bar-Pontch-Bret-Delta

State of Lousiana.

Project	Basin
Christmas tree Projects - 23 Projects	All Basins
Vegetative Plantings - 70 Projects	All Basins

EXISTING PROJECTS (INTRABASIN)

Department of the Army, U.S. Army Corps of Engineers.

River and Harbor Projects

Project	Basin
Amite River and Bayou Manchac, LA	Pontchartrain
Atchafalaya River, Morgan City to the Gulf of Mexico, LA	Atchafalaya
Barataria Bay Waterway, LA	Barataria
Queen Bess Island Habitat Restoration	Barataria
Wine Island Restoration	Terrebonne
Bayou Dupre, LA	Pontchartrain
Bayou Grand Caillou and Le Carpe, LA	Terrebonne
Bayou Lacombe, LA	Pontchartrain
Bayou Lafourche and Lafourche Jump Waterway, LA	Terrebonne
Bayous La Loutre, St. Malo and Yscloskey, LA	Breton Sound
Bayou Segnette Waterway, LA	Barataria
Bayou Teche, LA	Atchafalaya
Bayou Teche and Vermilion River,LA	Teche/Vermilion
Bayou Terrebonne, LA	Terrebonne
Bayou Vermilion, LA	Teche/Vermilion
Calcasieu River at Coon Island, LA	Calcasieu/Sabine
Calcasieu River at Devil's Elbow, LA	Calcasieu/Sabine
Calcasieu River and Pass, LA	Calcasieu/Sabine
Calcasieu River Saltwater Barrier, LA	Calcasieu/Sabine
Freshwater Bayou, LA	Teche/Vermilion
Grand Bayou Pass, LA	Barataria
Gulf Intracoastal Waterway	All Basins
Algiers Lock	Pontchartrain
Bayou Boeuf Lock (MRT)	Atchafalaya
Calcasieu Lock	Calcasieu/Sabine
Harvey Lock	Barataria
Inner Harbor Navigation Lock	Pontchartrain
Leland Bowman Lock	Mermentau
Houma Navigation Canal, LA	Terrebonne
Inland Waterway from Franklin to the Mermentau River, LA	Teche/Vermilion
Mississippi River to Bayou Tech, LA	Atchafalaya
Lake Charles Deep Water Channel, LA	Calcasieu/Sabine
Little Caillou Bayou, LA	Terrebonne
Mermentau River, LA	Mermentau
Catfish Point Control Structure	Mermentau
Scooner Bayou Control Structure	Mermentau
Mississippi River Gulf Outlet, LA	Pontchartrain
Mississippi River Outlets, Venice, LA	Miss River Delta
Michoud Canal, LA	Pontchartrain
Waterway from Empire, LA to the Gulf of Mexico, LA	Breton-Barataria
Waterway from the GIWW to Bayou Dulac, LA	Terrebonne

Flood Control, Mississippi River and Tributaries

Project	Basin
Atchafalaya Basin Floodway System, LA	Atchafalaya
Atchafalaya River Navigation	Atchafalaya
Bonnet Carre Spillway	Pontchartrain
Teche-Vermilion Basin, LA	Atchafalaya

Flood Control Projects

Project	Basin
Amite River and Tributaries, LA	Pontchartrain
Grand Isle, LA and Vicinity-Hurricane Protection	Barataria
Harvey Canal Bayou Barataria Levee, LA	Barataria
Lake Pontchartrain, LA and Vicinty-Hurricane Protection	Pontchartrain
Morgan City, LA and Vicinity-Hurricane Protection	Atchafalaya
Westwego to Harvey Canal	Barataria

Freshwater Diversions

Project	Basin
Bonnet Carre Freshwater Diversion Stucture (authorized, not constructed)	Pontchartrain
Caernarvon Freshwater Diversion Structure	Breton Sound
Davis Pond Freshwater Diversion Structure (authorized, not constructed)	Barataria

Department of the Interior, USFWS.

Projects on National Wildlife Refuges (NWR)

Project	Basin
Crevasses (Wetland Establishements) Delta NWR	Miss River Delta
Operation and Maintenance of 16,000 acre Lacassine Pool, Lacassine NWR	Mermentau
Wetland Management Projects Cameron Prairie NWR	Mermentau
Operation and Monitoring of Cameron-Creole Watershed Sabine NWR	Calcasieu
Operation of Water Control Sturctures Sabine NWR	Calcasieu
Operation and Maintenance of 30,000 acre Pool Sabine NWR	Calcasieu

State of Louisiana.

Projects	Basin
Three crevasse splays cut at Pass-a-Loutre	Mississippi
Pass Fourchon Closure and Beach Protection	Barataria
LaBranche Shoreline Stabilization and Canal Closure	Pontchartrain
Blind Lake Shoreline Stabilization (rocks)	Calcasieu/Sabine
Six Crevasse Splays Cut at Pass-a-Loutre	Mississippi
Baie de Chactas Shoreline Protection	Barataria
Brannon Ditch	Calcasieu/Sabine
Sabine Terraces	Calcasieu/Sabine
Sabine Shell bank Stabilization	Calcasieu/Sabine
Pecan Island Outfall Management	Mermentau
Three crevasse splays cut at theDelta Wildlife Refuge	Mississippi
Falgout Canal Protection and Enhancement	Terrebonne
Central Wetlands Pump Outfall	Pontchartrain
West Point-a-Hache Diversion	Barataria
Violet Siphon	Pontchartrain
Pecan Island Freshwater Introduction	Mermentau
Hammock Lake	Teche/Vermilion
Queen Bess Island Revegetation	Barataria
Naomi (LaReussite) Diversion	Baratatia
Montegut Levee	Terrebonne
Beachcones at Fourchon	Terrebonne
Yellow Bayou	Teche/Vermilion
Pass-a-Loutre Sediment Fencing	Mississippi
Constance Beach to Ocean View Breakwaters	Calcasieu/Sabine
Bayou Lamoque Freshwater Diversion	Breton Sound
White's Ditch Freshwater Diversion	Breton Sound
Bohemia Freshwater Diversion	Breton Sound
Teche/Vermilion Freshwater Diversion	Atchafalaya
Beach Nourishment at Grand Isle	Barataria
Beach Jetties at Grand Isle	Barataria
Canals, Marsh Management and Habitat Restoration at Rockefeller Wildlife Management Area	Mermentau
Little Pecan Island Habit Restoration	Mermentau

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

U. S. Fish and Wildlife Service Coordination Act Letter

Exhibit 7

United States Department of the Interior

FISH AND WILDLIFE SERVICE
825 Kaliste Saloom Road
Brandywine Bldg. II, Suite 102
Lafayette, Louisiana 70508

October 1, 1993

Colonel Michael Diffley
District Engineer
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Diffley:

The Fish and Wildlife Service (Service) has reviewed the June 1993 Draft Louisiana Coastal Wetlands Restoration Plan (Restoration Plan). The Restoration Plan was prepared by the Louisiana Coastal Wetlands Conservation and Restoration Task Force (Task Force), pursuant to Section 303(b) of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA).

The purposes of this letter report are to underscore the importance of the Restoration Plan to nationally significant fish and wildlife resources, to document the involvement of the Service in the development of the Restoration Plan, to acknowledge how the plan will benefit fish and wildlife resources, and to outline the future involvement of the Service in the implementation, evaluation, and refinement of that plan. The following comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), but do not fulfill our total planning and reporting responsibilities under Section 2(b) of that Act for the specific projects recommended in the Restoration Plan.

FISH AND WILDLIFE RESOURCES

The Service has determined that the marshes, forested wetlands, and associated habitats of coastal Louisiana are truly of national importance to fish and wildlife resources. Coastal Louisiana contains an estimated 40 percent of the vegetated estuarine wetlands in the conterminous United States. Those wetlands provide essential habitat to diverse and abundant fish and wildlife resources.

The vast wetlands of coastal Louisiana produce the greatest tonnage of commercial fish and shellfish landings of the lower 48 States. As noted in the Restoration Plan, the market value of the commercial fish and shellfish harvest supported by Louisiana's coastal wetlands averages almost $1 billion annually. Coastal Louisiana also supports an important recreational fishery. In 1986, recreational fishermen made over 3.1 million saltwater fishing trips in Louisiana; the majority of their catch was comprised of species that rely on the coastal marshes and estuaries as nursery habitat. The swamps and

freshwater marshes of coastal Louisiana provide important habitat for numerous freshwater sport fishes. Sport fishing for freshwater species is also an important recreational activity in that area.

The Louisiana coastal marshes provide winter habitat to more than two-thirds of the waterfowl population of the Mississippi Flyway, an estimated 20 to 25 percent of North America's puddle duck population, and large concentrations of diving ducks. Those wetlands are a vital component of the Gulf Coast Joint Venture, established to help achieve the goals of the North American Waterfowl Management Plan. The fresh and intermediate marshes support the greatest concentrations of wintering waterfowl in coastal Louisiana.

Coastal Louisiana's marshes, swamps, and associated habitats also support many other migratory birds, such as rails, gallinules, shorebirds, seabirds, wading birds, and numerous songbirds. Over 150 nesting colonies of wading birds, shorebirds, and seabirds (representing 25 species and hundreds of thousands of nesting adults) were observed in coastal Louisiana during a 1990 survey conducted by the Louisiana Department of Wildlife and Fisheries. The cheniers and natural levee forests of coastal Louisiana provide essential stop-over habitat to numerous neotropical migratory passerine birds.

Federally listed threatened and endangered species found in coastal Louisiana wetlands and associated habitats include, but are not limited to: bald eagle, brown pelican, Arctic peregrine falcon, piping plover, and Louisiana black bear. The bald eagle and brown pelican both nest extensively in that area.

Coastal Louisiana has long been a leading fur-producing area in North America. Common fur-bearers in that area include nutria, mink, muskrat, raccoon, and river otter. The coastal marshes and swamps also support game mammals such as white-tailed deer and swamp rabbit. That area also supports more than 500,000 alligators, and closely regulated sport and commercial hunting for that species.

The Service administers seven National Wildlife Refuges in coastal Louisiana, encompassing over 257,000 acres. Those refuges include Sabine, Cameron Prairie, Lacassine, Shell Keys, Delta, Breton, and Bayou Sauvage National Wildlife Refuges. The Louisiana Department of Wildlife and Fisheries operates nine refuges and wildlife management areas in that area, comprising over 481,000 acres. Coastal wetlands make up the majority of those Federal and State wildlife areas.

SERVICE INVOLVEMENT IN RESTORATION PLAN DEVELOPMENT

The Service has been involved throughout the Restoration Plan formulation process. Service personnel have represented the Department of the Interior on the Task Force and its Technical Committee, Planning and Evaluation Subcommittee, Environmental Work Group, and Monitoring Work Group. As members of the interagency planning teams for each of the nine coastal basins, we participated actively and extensively in the formulation of comprehensive restoration strategies for each basin. Service biologists actively

participated in the identification and preliminary evaluation of numerous restoration projects proposed for those basins. We also helped to develop monitoring protocols to guide the future evaluation of completed restoration projects, also required by Section 303(b) of CWPPRA.

The Service has played a leadership role in the development, refinement, and application of the Wetland Value Assessment methodology, a habitat-based system used to quantify the benefits associated with proposed restoration projects. That methodology, along with cost data, was used to rank proposed restoration projects considered for the first three Priority Project Lists approved by the Task Force. Projects were ranked on the basis of their cost effectiveness, measured as cost per average annual habitat unit.

On May 19, 1993, the Service provided extensive review comments on the preliminary draft Restoration Plan. We also provided intensive editorial assistance to the Task Force in the preparation of the draft Restoration Plan. Service comments on the Draft Restoration Plan were incorporated in the Department of the Interior's September 3, 1993, response to that draft plan and the associated Draft Programmatic Environmental Impact Statement.

IMPACTS TO FISH AND WILDLIFE RESOURCES

Implementation of the proposed Restoration Plan will have major benefits to nationally important fish and wildlife resources. Key plan features include:

1. sediment and freshwater introduction to establish additional wetlands, reduce the loss of existing wetlands, and restore more favorable salinities in those wetlands and adjacent waters;

2. improved management of fresh water in the receiving (outfall) areas of freshwater diversion structures;

3. management to facilitate the growth of the emerging delta in Atchafalaya Bay;

4. use of dredged material to create wetlands or nourish deteriorated wetlands;

5. reduction of shoreline erosion along navigation channels, lakes, and bays;

6. restoration and protection of barrier islands; and

7. hydrologic restoration and marsh management to reduce the loss of wetlands and restore deteriorated wetlands.

The primary source of those benefits is the anticipated net reduction in wetland losses. With full implementation of the Restoration Plan, wetland losses would be reduced by an estimated 202,800 acres over the

next 20 years; that reduction represents 70 percent of the wetland losses that would occur without plan implementation. In addition, an estimated 330,000 acres of wetlands will benefit by introduction of additional nutrients and restoration of more favorable salinity patterns.

The anticipated reduction in wetland losses with implementation of the Restoration Plan will benefit the full spectrum of fish and wildlife resources found in coastal Louisiana. Coastal Louisiana's estuarine fish and shellfish production is largely dependent on the nursery habitat provided by that area's extensive marshes and associated shallow waters. Therefore, the Restoration Plan-associated reduction in wetland loss will have major benefits to the sport and commercial harvest of estuarine-dependent species. Those species include spotted seatrout, sand seatrout, Atlantic croaker, spot, red drum, black drum, southern flounder, blue crab, white shrimp and brown shrimp. The plan will also reduce and reverse saltwater intrusion and its associated adverse effects on sport and commercial freshwater fishes, including largemouth bass, crappie, warmouth, bluegill, and catfishes.

Because much of the net wetland savings will be in fresh and low salinity marshes, migratory waterfowl, especially puddle ducks, will greatly benefit. Those wetland types provide the highest-value habitat to puddle ducks. The accelerated growth of the Atchafalaya Delta will also be highly beneficial to the large numbers of waterfowl that winter in that area. Numerous species of shorebirds and wading birds that feed on the tidal flats in that expanding delta will also benefit. The reduction in losses of forested wetlands will benefit a variety of non-game birds, including hawks, owls, and numerous migratory songbirds. Fur animals will also benefit from wetland loss reduction, as will American alligators and numerous other species of reptiles and amphibians.

Several measures recommended in the Restoration Plan would benefit Sabine, Cameron Prairie, Lacassine, Bayou Sauvage, and Delta National Wildlife Refuges, all of which are managed by the Service. That plan also identifies five projects on the first two Priority Project Lists, which were approved by the Task Force and are being implemented by the Service on and adjacent to Sabine, Cameron Prairie, and Bayou Sauvage National Wildlife Refuges. Implementation of the Restoration Plan will also benefit several refuges and wildlife management areas managed by the Louisiana Department of Wildlife and Fisheries.

In the Service's March 19, 1993, comments on a preliminary draft of the Mississippi River Delta Basin Restoration Plan, we expressed concern over the proposed full-scale diversion of Mississippi River flows into Breton Sound. Our concern focused on the anticipated adverse impacts of that proposal on Delta National Wildlife Refuge and the adjacent State-owned Pass a Loutre Wildlife Management Area. To address those concerns, the Service recommended that a detailed assessment be conducted, as part of the required feasibility study, to determine whether the full-scale diversion can create enough marsh to offset the accelerated loss of existing deltaic wetlands. We also recommended that the feasibility study evaluate alternative designs involving phased implementation of the full-scale diversion, resulting

in a phased reduction of Mississippi River flows into the active delta. Such a phased approach could reduce potential negative impacts, both in the existing delta and in Breton Sound. A related Service recommendation was that the feasibility study compare the effects of smaller diversions of varying sizes to the effects of the full-scale diversion; the smaller diversions would be evaluated under the assumption that the supporting projects (recommended in the Restoration Plan) would be also be implemented.

The draft Restoration Plan acknowledges that a detailed feasibility study of the full-scale diversion will be conducted. The Service continues to recommend that the issue and alternatives identified above be fully addressed in that feasibility study, to include the use of predictive models to ensure the greatest possible reliability of impact predictions. The position of the Service on the proposed full-scale diversion will be presented upon completion of that study, and will be based on a careful analysis of the net fish and wildlife resource impacts of the various alternatives considered.

FUTURE SERVICE INVOLVEMENT

The Service intends to be actively involved in implementation and periodic revision of the Restoration Plan. That involvement will include:

1. participation in selection of future Priority Project Lists;

2. participation in feasibility analyses of proposed wetland restoration projects;

3. evaluation of project designs to ensure that projects achieve optimal benefits to fish and wildlife resources;

4. construction, operation, and maintenance of projects for which the Service is the designated lead agency;

5. evaluation of the effectiveness of completed restoration projects, as required by CWPPRA; and

6. active participation in the periodic revision of the Restoration Plan by the Task Force.

Under provisions of Section 7 of the Endangered Species Act of 1973, as amended, the Service will also assist the agencies responsible for implementation of projects proposed in the Restoration Plan to ensure that those projects do not jeopardize the continued existence of threatened and endangered species, or adversely modify any designated critical habitat. The required consultations will be accomplished on a project-by-project basis.

SUMMARY AND SERVICE POSITION

The Service has actively participated in the formulation of the Restoration Plan. We support the overall restoration strategies recommended for each of the nine basins along the Louisiana coast, and believe that implementation of those strategies will result in major benefits to nationally significant fish and wildlife resources. Those resources are threatened by the continuing, severe loss of Louisiana's coastal wetlands. To help ensure that optimum fish and wildlife resource benefits are achieved, the Service plans to remain actively involved throughout the implementation process. Our findings and recommendations on individual projects recommended in that plan will be provided under the authority of the Fish and Wildlife Coordination Act during required feasibility studies and following review of applications for required Department of the Army permits.

We compliment you for your exemplary leadership as Task Force chairman throughout the formulation of the Restoration Plan. Please contact me if you have any questions regarding the preceding comments.

Sincerely,

David W. Frugé

David W. Frugé
Field Supervisor

cc: FWS, Atlanta, GA (AES)
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
LA Dept. of Natural Resources, Baton Rouge, LA
Governor's Office of Coastal Activities, Baton Rouge, LA
EPA, Dallas, TX
NMFS, Baton Rouge, LA
SCS, Alexandria, LA

LOUISIANA COASTAL WETLANDS RESTORATION PLAN

Recommendations of the State of Louisiana for CWPPRA Planning Studies

Exhibit 8

EDWIN W. EDWARDS
GOVERNOR

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December 2, 1993

Colonel Michael Diffley
District Engineer
U.S. Army Corps of Engineers
New Orleans District
P.O. Box 60267
New Orleans, LA 70160

Dear Col. Diffley:

The Louisiana Coastal Wetlands Conservation and Restoration Task Force has reviewed the comprehensive plan developed under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) during a two day technical workshop that included input from the academic community and the private sector. In addition, the state Task Force considered the relative urgency of the specific long term concepts identified in my letter of September 13.

The consensus adopted by the state Task Force as a result of the workshop was that re-establishing large scale sedimentation processes is the principal long term solution to Louisiana's coastal wetlands loss. With that overall goal in mind, it is clearly in the best interest of Louisiana to initiate feasibility studies of several of the major project concepts immediately, using the $800,000 of CWPPRA planning monies that have been set-aside for this process.

Specific recommendations resulting from the technical workshop are shown in the attached memorandum from the chairman of the state Task Force. These recommendations constitute the official state request for the initiation of feasibility studies, as discussed at the CWPPRA Task Force meeting on October 1, 1993.

I ask that the CWPPRA Task Force, at its next meeting, develop an official response to this request by proposing schedules and estimated budgets, as well as any requested modifications of the prioritization outlined here.

If additional information or assistance is needed, please call Dr. Len Bahr at 504-922-3244.

Sincerely,

Edwin W. Edwards

Attachment

c: Senator John Breaux
Senator J. Bennett Johnston

EDWIN W. EDWARDS
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December 1, 1993

MEMORANDUM

TO: Col. Michael Diffley, Chairman
Coastal Wetlands Planning Protection and Restoration Act Task Force

FROM: LB Len Bahr, Chairman
Louisiana Coastal Wetlands
Conservation and Restoration Task Force

SUBJECT: Recommendations for Initiating CWPPRA Feasibility Studies

Re-establishing large scale sedimentation processes and hydrologic "buffers" are the principal long term solutions to Louisiana's coastal wetlands loss. A strategy to reverse the loss calls for initiating feasibility studies on the following four major project concepts[1]. This list reflects the state's desired order of initiation and does not imply their relative importance:

1) Increasing the share of Mississippi River borne sediments sent down the Atchafalaya River in accordance with P.L. 101-646, Section 307(b) to maximize delta development;

2) The re-establishment of the barrier island systems in the Barataria and Terrebonne Basins, to an extent sufficient to ameliorate the trend of increasing tidal prism amplitudes;

3) Modifications to major navigation channels sufficient to offset marine transgressions of historically fresh and intermediate coastal wetlands and to reallocate flow and sediment for diversions and sub-delta building in other areas. Channels to be studied, at a minimum, include the MRGO, Barataria Waterway, Houma, Calcasieu, GIWW, Sabine, lower Atchafalya, and the lower Mississippi;

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[1] These feasibility studies will require the development of an onshore sediment budget for the Mississippi/Atchafalaya river system and an offshore sediment budget for the barrier islands.

4) A Mississippi River diversion plan[2] including: upper basin diversions, Bayou LaFourche corridor diversion, lower Mississippi diversions below New Orleans, and lower Atchafalaya diversions; in order to maximize the wetland conservation and creation potential of the water and sediment resources of the lower Mississippi River system.

To ensure that appropriate large scale projects are implemented within a reasonable time, the feasibility studies should begin immediately (January 1994) and should have achieved most major objectives by 1996. This date coincides with the three year statutory deadline for the evaluation of the comprehensive plan called for in P.L. 101-646 (Section 303, b, 7).

In order to save time and reduce cost, the feasibility studies should, to the maximum extent possible, incorporate existing data that have been published in scientific papers and technical reports. The studies should also take advantage of the technical expertise available in state agencies, academic institutions and the private sector.

Please initiate the appropriate procedures to commence these studies and keep the state Task Force agencies involved.

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[2]The initiation of small upper basin freshwater diversions would not be precluded by the development of the overall Mississippi River diversion plan.