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Louisiana Trustee Implementation Group *Draft Restoration Plan / Environmental Assessment #5: Living Coastal and Marine Resources (LCMR) – Marine Mammals and Oysters*

March 2020

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LIST OF ABBREVIATIONS AND ACRONYMS

Audubon	Audubon Nature Institute Coastal Wildlife Network
BGEPA	Bald and Golden Eagle Protection Act of 1940
BMP	Best management practice
BP	BP Exploration and Production Inc.
BSE	Bay, Sound, and Estuary
CAA	Clean Air Act
CEQ	Council on Environmental Quality
CMP	Coastal Master Plan
CPRA	Coastal Protection and Restoration Authority
CRMS	Coastwide Reference Monitoring System
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZM Program	Coastal Zone Management Program
DOI	Department of the Interior
DWH	Deepwater Horizon
ECG	Electrocardiogram
EIS	Environmental Impact Statement
EFH	Essential Fish Habitat
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
GCERC	Gulf Coast Ecosystem Restoration Council
GEBF	Gulf Environmental Benefit Fund
LCMR	Living Coastal and Marine Resources
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDWF	Louisiana Department of Wildlife and Fisheries

LNHP	Louisiana Natural Heritage Program
LOSCO	Louisiana Oil Spill Coordinator's Office
LPBF	Lake Pontchartrain Basin Foundation
LSU	Louisiana State University
MAM	Monitoring and Adaptive Management
MBTA	Migratory Bird Treaty Act
MMPA	Marine Mammal Protection Act
MMSN	Marine Mammal Stranding Network
MRGO	Mississippi River Gulf Outlet
MSA	Magnuson-Stevens Fishery Conservation and Management Act of 1976
MSDS	Material Safety Data Sheets
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act of 1969
NGO	Non-governmental organization
NHPA	National Historic Preservation Act
NFWF	National Fish and Wildlife Foundation
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
NOI	Notice of Intent
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
OCS	Outer Continental Shelf
OSHA	Occupational Safety and Health Administration
OPA	Oil Pollution Act of 1990
PCEs	Primary Constituent Elements
Final PDARP/PEIS	Deepwater Horizon Oil Spill: *Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement*
POA	Public Oyster Area
POSG	Public Oyster Seed Grounds

POSR	Public Oyster Seed Reservations
RESTORE Act	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act
RP/EA	Restoration Plan/Environmental Assessment
ROD	Record of Decision
SAV	Submerged Aquatic Vegetation
SHPO	State Historic Preservation Office
SOP	Standard Operating Procedures
TIG	Trustee Implementation Group
UME	Unusual mortality event
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

On April 20, 2010, the *Deepwater Horizon* (DWH) mobile drilling unit exploded, resulting in a release of approximately 3.19 million barrels (134 million gallons) of oil from the BP Exploration and Production Inc. (BP) Macondo well. The incident was followed by the sustained release of oil over 87 days, resulting in extensive natural resource injuries. Oil spread from the deep ocean to the surface, through the water column, and into the coastal environment from Texas to Florida. The associated response actions undertaken to reduce environmental impacts, in some cases, resulted in collateral impacts on the environment and on natural resource services.

In 2016, a settlement was reached in which BP agreed to pay a total of $8.1 billion in natural resource damages (inclusive of Early Restoration funding) over a 15-year period, and up to an additional $700 million for adaptive management or to address injuries to natural resources that are presently unknown but may come to light in the future.

The Louisiana Trustee Implementation Group (TIG) developed this *Draft Restoration Plan/Environmental Assessment (RP/EA) #5: Living Coastal and Marine Resources (LCMR) - Marine Mammals and Oysters* in an effort to contribute to the restoration of lost natural resources in the Louisiana restoration area as a result of the DWH oil spill. This RP/EA was prepared to (1) inform the public about the Louisiana TIG's DWH natural resource damage assessment (NRDA) restoration planning efforts, and (2) present analyses on the potential restoration benefits and environmental consequences of the alternatives proposed in this document.

As discussed in the *DWH Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Final PDARP/PEIS), the purpose of restoration is to make the environment and the public whole for injuries resulting from the oil spill (DWH Trustees, 2016). Restoration actions are implemented with the purpose of returning injured natural resources and services to baseline conditions and compensating for interim losses in accordance with the Oil Pollution Act (OPA) of 1990 and associated NRDA regulations. The Final PDARP/PEIS and Record of Decision (ROD) can be found at: https://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/.

The Louisiana TIG includes five Louisiana state Trustee agencies and four federal Trustee agencies: Coastal Protection and Restoration Authority (CPRA), Louisiana Department of Natural Resources (LDNR), Louisiana Department of Environmental Quality (LDEQ), Louisiana Oil Spill Coordinator's Office (LOSCO), Louisiana Department of Wildlife and Fisheries (LDWF), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of the Interior (DOI), U.S. Department of Agriculture (USDA), and U.S. Environmental Protection Agency (EPA). NOAA is the lead federal Trustee for preparing this RP/EA. All federal agencies on the Louisiana TIG are acting as cooperating agencies for the purposes of compliance with NEPA and intend to adopt, if appropriate, the NEPA analyses documented in this RP/EA. In accordance with 40 CFR §1506.3(a), each of the four federal cooperating agencies (NOAA, DOI, EPA, and USDA) participating on the Louisiana TIG will review the RP/EA for adequacy in meeting the standards set forth in its own NEPA implementing procedures and will choose whether to adopt the analysis via signature on the relevant NEPA decision document.

The Louisiana TIG developed a reasonable range of restoration alternatives by reviewing more than 200 restoration project ideas submitted to the DWH project portal since 2010. Restoration project ideas have been submitted by the public, non-governmental organizations (NGOs), and local, state, and federal agencies. Programmatic restoration goals and restoration type-specific goals identified in the Final PDARP/PEIS (DWH Trustees, 2016), evaluation factors in the OPA regulations (15 CFR §990.54), and the availability of funds under the DWH NRDA settlement payment schedule were considered in selecting the reasonable range of alternatives.

In this RP/EA, the Louisiana TIG evaluates six different project-based alternatives as well as a "no action" alternative. The alternatives evaluated in this RP/EA are consistent with the restoration approaches described in the Final PDARP/PEIS for the marine mammal and oyster restoration types (DWH Trustees, 2016). After evaluating the reasonable range of alternatives, the Louisiana TIG proposes four alternatives, one for marine mammals and three for oysters, as preferred. The total cost of these four alternatives is estimated to be $28,717,075. Appendix D of this RP/EA includes draft Monitoring and Adaptive Management (MAM) plans for each preferred alternative.

The public is encouraged to review and comment on this RP/EA, available for 30 days following its release as specified in the public notice published in both the Federal and Louisiana Registers and specified on the DWH Trustee Council website. Comments must be postmarked no later than 30 days after the start of the comment period. Comments on the RP/EA can be submitted during the comment period by one of following methods:

- Online: http://www.gulfspillrestoration.noaa.gov/restoration-areas/louisiana
- By mail (hard copy), addressed to: U.S. Fish and Wildlife Service, P.O. Box 29649, Atlanta, GA 30345. Please note that personally identifiable information included in submitted comments (e.g., address, phone number, email address, etc.) may be made publicly available.
- Online during the public webinar.

The Louisiana TIG will hold one public webinar on April 8, 2020 to facilitate the public review and comment process for this RP/EA. After the close of the public comment period, the Louisiana TIG will consider all input received during the public comment period and revise the RP/EA as necessary prior to publishing the Final RP/EA. A summary of comments received, the Louisiana TIG's responses, and any changes made to the Draft RP/EA will be included in the Final RP/EA. If appropriate, NOAA will prepare a Finding of No Significant Impact (FONSI) in accordance with NEPA regulations.

Overall, this RP/EA is intended to provide the public with information and analysis needed to enable meaningful review and comment on the Louisiana TIG's proposal to implement alternatives addressing injuries to the marine mammals and oyster restoration types. This RP/EA and the opportunity for the public to review and comment on the document are intended to guide the Louisiana TIG's selection of alternatives for implementation that best meet its purpose and need, as summarized above and described in more detail in subsequent sections of this document.

1. INTRODUCTION

The Louisiana Trustee Implementation Group[1] (TIG) prepared this *Draft Restoration Plan/Environmental Assessment (RP/EA) #5: Living Coastal and Marine Resources (LCMR) - Marine Mammals and Oysters* in accordance with the *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Final PDARP/PEIS; DWH Trustees, 2016), Record of Decision (ROD), Oil Pollution Act of 1990, as amended (OPA), and the National Environmental Policy Act of 1969 (NEPA). Marine mammals and oysters are the two restoration types considered in this RP/EA to support the overall goal in the Final PDARP/PEIS to 'Replenish and Protect LCMR.' This RP/EA describes the Deepwater Horizon (DWH) natural resource damage assessment (NRDA) restoration planning efforts, presents and analyzes alternatives for the proposed projects, and identifies four preferred alternatives that would best help compensate the public for injuries to marine mammals and oysters caused by the DWH oil spill in the Louisiana restoration area. The Louisiana TIG seeks public comment on the reasonable range of alternatives for implementation in this RP/EA.

Restoration activities, as presented in this RP/EA and discussed more broadly in the Final PDARP/PEIS (DWH Trustees, 2016), are designed to make the environment and the public whole for injuries resulting from the incident, both by returning injured natural resources and services to baseline conditions and by compensating for interim losses in accordance with the OPA and associated NRDA regulations. The Final PDARP/PEIS and ROD can be found online at http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan.

This RP/EA proposes to implement one preferred alternative for the marine mammal restoration type and three preferred alternatives for the oyster restoration type at a total estimated cost of $28,717,075.

1.1. Background and Summary of Settlement

On April 20, 2010, the DWH mobile drilling unit exploded, resulting in a release of approximately 3.19 million barrels (134 million gallons) of oil from the BP Exploration and Production Inc. (BP) Macondo well. The incident was followed by a sustained release of oil over 87 days, which resulted in extensive natural resource injuries. Oil spread from the deep ocean to the surface, through the water column, and into the coastal environment, extending from Texas to Florida. Response actions were undertaken to reduce environmental impacts, but in some cases these actions resulted in collateral impacts on the environment and on natural resource services.

[1] The Louisiana Trustee Implementation Group includes five Louisiana state Trustee agencies and four federal Trustee agencies: Coastal Protection and Restoration Authority (CPRA), Louisiana Department of Natural Resources (LDNR), Louisiana Department of Environmental Quality (LDEQ), Louisiana Oil Spill Coordinator's Office (LOSCO), Louisiana Department of Wildlife and Fisheries (LDWF), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of the Interior (DOI), U.S. Department of Agriculture (USDA), and U.S. Environmental Protection Agency (EPA).

The DWH oil spill occurred in the northern Gulf of Mexico, approximately 41 miles (66 kilometers) off the southeast coast of Louisiana. This region is characterized by diverse habitat types with a high level of connectivity such that injuries to one habitat or species can have cascading impacts across the entire ecosystem (DWH Trustees, 2016). The DWH Trustees conducted an assessment of the natural resource damages and documented injuries to many taxa, including marine mammals and oysters. Injuries to LCMR taxa included, but were not limited to, decreased growth rates, reproductive effects, and mortality.

On February 19, 2016, the DWH Trustee Council issued the Final PDARP/PEIS detailing the proposed plan to fund and implement restoration projects over the next 15 years. In March 2016, the Trustees published a Notice of Availability (NOA) of a ROD for the Final PDARP/PEIS. Based on the DWH Trustees' injury determination established in the Final PDARP/PEIS, the ROD set forth the basis for the DWH Trustees' decision to select Alternative A: Comprehensive Integrated Ecosystem Alternative (DWH Trustees, 2016). On April 4, 2016, the United States District Court for the Eastern District of Louisiana entered a Consent Decree resolving civil claims by the DWH Trustees against BP arising from the DWH oil spill. (United States v. BPXP et al., Civ. No. 10-4536, centralized in MDL 2179, In re: Oil Spill by the Oil Rig "Deepwater Horizon" in the Gulf of Mexico, on April 20, 2010 (E.D. La.)). This settlement resolved the Trustees' claims against BP for natural resource damages under OPA.

Under the Consent Decree, BP agreed to pay a total of $8.1 billion in natural resource damages (which includes $1 billion that BP committed to pay for early restoration projects), and up to an additional $700 million for adaptive management or to address injuries to natural resources that are presently unknown but may come to light in the future. Each restoration area has a specific monetary allocation to each of the 13 restoration types specified in the Consent Decree. The DWH settlement allocation for the Louisiana TIG by restoration type is described in Section 5.10.2 of the Final PDARP/PEIS and presented below in TABLE 1-1 (DWH Trustees, 2016).

Additional background on the DWH oil spill, the impact of the spill, settlement, and allocation of funds can be found in Chapter 2 of the Final PDARP/PEIS (DWH Trustees, 2016).

TABLE 1-1. Restoration funding for the Louisiana restoration types (not including allocations for Early Restoration work).

Major Restoration Categories and Restoration Types	Louisiana Restoration Area Funding Allocation
1. Restore and Conserve Habitat	
Wetlands, Coastal, and Nearshore Habitats	$4,009,062,700
Habitat Projects on Federally Managed Lands	$50,000,000
2. Restore Water Quality	
Nutrient Reduction (Nonpoint Source)	$20,000,000
3. Replenish and Protect Living Coastal and Marine Resources	
Sea Turtles	$10,000,000
Submerged Aquatic Vegetation	$22,000,000
Marine Mammals	$50,000,000
Birds	$148,500,000

Major Restoration Categories and Restoration Types	Louisiana Restoration Area Funding Allocation
Oysters	$26,000,000
4. Provide and Enhance Recreational Opportunities	
Provide and Enhance Recreational Opportunities	$38,000,000
5. Monitoring, Adaptive Management, and Administrative Oversight	
Monitoring and Adaptive Management	$225,000,000
Administrative Oversight and Comprehensive Planning	$33,000,000

1.2. Deepwater Horizon Trustees, Trustee Council, and Trustee Implementation Groups

The DWH Trustees are government entities authorized under OPA to act as Trustees on behalf of the public to assess the natural resource injuries resulting from the DWH oil spill. DWH Trustees develop restoration plans, provide the public with opportunities to suggest restoration projects and to review and comment on proposed plans, implement and monitor restoration projects, manage natural resource damage funds, and document Trustee decisions through a publicly available administrative record. The DWH Trustees are responsible for governance of restoration planning throughout the entire Gulf Coast.

1.3. Restoration by the Louisiana TIG to Date

This RP/EA is based on the Louisiana TIG project selections for marine mammal and oyster restoration types and is consistent with the Final PDARP/PEIS, which is incorporated by reference (DWH Trustees, 2016).

The Final PDARP/PEIS outlines the process for DWH restoration planning. This process includes the establishment of a governance structure that consists of a TIG for each of the seven restoration areas (i.e., one for each of the five Gulf states, a Regionwide TIG, and an Open Ocean TIG). The Louisiana TIG makes all restoration decisions regarding how funding is allocated to the Louisiana restoration area, which includes both coastal and nearshore areas across the state. The Final PDARP/PEIS also provides guidance for TIGs to phase restoration projects across multiple restoration plans (DWH Trustees, 2016).

In June 2014, the DWH Trustees issued the Final Programmatic and Phase III Early Restoration Plan and Programmatic Environmental Impact Statement (Phase III ERP/PEIS). To date, the Louisiana TIG has released the following eight restoration plans and four supplemental environmental assessments to the public.

- **Louisiana TIG Final Restoration Plan #1**: *Restoration of Wetlands, Coastal, and Nearshore Habitats; Habitat Projects on Federally Managed Lands; and Birds*, which selects six restoration alternatives for engineering and design: two bird island projects (Queen Bess and Rabbit Island Restoration), three coastal wetlands projects (Terrebonne Basin Ridge and Marsh Creation Project: Bayou Terrebonne Increment; Barataria Basin Ridge and Marsh Creation Project: Spanish Pass Increment; and Lake Borgne Marsh Creation Project: Increment One), and one

habitat project on federally managed lands (Shoreline Protection and Jean Lafitte National Park and Preserve; Louisiana TIG, 2017a).

  - **Louisiana TIG Final Phase 2 Restoration Plan #1.1:** *Queen Bess Island Restoration*, which evaluates design alternatives for restoration of bird habitat (Louisiana TIG, 2019a).
  - **Louisiana TIG Draft Phase 2 Restoration Plan #1.2:** *Spanish Pass Ridge and Marsh Creation Project and Lake Borgne Marsh Creation Project*, which proposes construction activities for the restoration of wetlands, coastal, and nearshore habitats (Louisiana TIG, 2019b).
  - **Louisiana TIG Final Restoration Plan #1.3:** *Rabbit Island Restoration & Shoreline Protection at Jean Lafitte Historical National Park and Preserve*, which evaluates design alternatives for construction activities to help restore injured resources under the "birds" and "habitat projects on federally managed lands" restoration types (Louisiana TIG, 2020a).

- **Louisiana TIG Final Restoration Plan #2:** *Provide and Enhance Recreational Opportunities,* which proposes to reallocate the Early Restoration funds earmarked for the Louisiana Marine Fisheries Enhancement, Research, and Science Center to four projects intended to provide and enhance recreational use (Louisiana TIG, 2017b).
  - **Louisiana TIG Final Supplemental Restoration Plan and Environmental Assessment for the Lake Charles Science Center and Educational Complex Project Modification** assesses the environmental impacts resulting from modifications to the scope and design of the Lake Charles Science Center and Educational Complex project (Louisiana TIG, 2019c).
  - **Louisiana TIG Draft Supplemental Restoration Plan and Environmental Assessment for the Elmer's Island Access Project Modification** assesses the environmental impacts resulting from modifications to the scope and design of the Elmer's Island Access project (Louisiana TIG, 2018a).
- **Louisiana TIG Final Strategic Restoration Plan and Environmental Assessment #3:** *Restoration of Wetlands, Coastal, and Nearshore Habitats in the Barataria Basin, Louisiana* was prepared to identify a restoration strategy that will help prioritize future decisions regarding project selection and funding in Barataria Basin, Louisiana (Louisiana TIG, 2017c).
- **Louisiana TIG Final Restoration Plan and Environmental Assessment #4:** *Nutrient Reduction (Nonpoint Source) and Recreational Use* was prepared to address both nutrient reduction (nonpoint source) within Louisiana's coastal watersheds and lost recreational use opportunities in the state of Louisiana resulting from the DWH oil spill (Louisiana TIG, 2018b).
  - **Louisiana TIG Draft Supplemental Environmental Assessment for the Point-Aux-Chenes Wildlife Management Area (PACWMA) Recreational Use Enhancement Project** proposes modifications to the design of the PACWMA Recreational Use Enhancement project (Louisiana TIG, 2020b).
  - **Louisiana TIG Draft Supplemental Environmental Assessment for the Wetlands Center Project Modification** assesses the environmental impacts resulting from modifications to the scope and design of the Wetlands Center project (Louisiana TIG, 2019d)

- **Louisiana TIG Draft Restoration Plan and Environmental Assessment #6:** *Wetlands, Coastal, and Nearshore Habitats* proposes three restoration projects for the Wetlands, Coastal, and Nearshore Habitats restoration type (Louisiana TIG, 2019e).

In creating these restoration plans, the Louisiana TIG considered the following:

- OPA screening criteria;
- Restoration goals and other criteria identified by the Trustees in the Final PDARP/PEIS;
- Contents of Louisiana's Comprehensive Master Plan for a Sustainable Coast from 2012 (CPRA, 2012; later updated in 2017);
- The need to provide restoration benefits across the many Louisiana basins impacted by the DWH oil spill;
- Input from the public; and
- Current and future availability of funds under the DWH oil spill NRDA settlement payment schedule.

1.4. Authorities and Regulations

1.4.1. Oil Pollution Act Compliance

The DWH oil spill is subject to the provisions of OPA, 33 U.S.C. §§ 2701 *et seq.,* a goal of which is to make the environment and public whole for injuries to natural resources and services resulting from incidents involving an oil discharge or substantial threat of an oil discharge. Under OPA, responsible parties are liable for, among other things, costs to contain and remove the oil, and for damages for injury to, destruction of, and loss or loss of use of natural resources, including the reasonable costs of assessing the damage.

OPA provides statutory authority for NRDA, a process that allows Trustees to evaluate and restore wildlife, habitats, and human resources impacted by oil spills and certain other causes of injury. OPA's authority to promulgate NRDA regulations is described under Section 1006 (33 U.S.C. § 2706). Louisiana state law also provides statutory authority for NRDA under the Louisiana Oil Spill Prevention and Response Act (Louisiana Rev Stat. §§ 30:2451 *et seq.*).

Under both OPA's NRDA regulations (15 C.F.R. Part 990) and under the Louisiana Oil Spill Prevention and Response Act regulations (Louisiana Admin. Code 43:XXIX.101 *et seq.*), the NRDA process consists of three phases: (1) Pre-assessment; (2) Assessment and Restoration Planning; and (3) Restoration Implementation. The DWH Trustees are currently in the Restoration Planning and Restoration Implementation phases of the NRDA. As part of the initiation of restoration implementation, this RP/EA identifies potential alternatives, evaluates those alternatives under various criteria, and identifies a suite of alternatives that would compensate the public for the lost LCMR and associated ecological services in Louisiana caused by the DWH oil spill.

1.4.2. National Environmental Policy Act Compliance

Under the OPA regulations, federal Trustees must comply with NEPA, 42 §§USC 4321 *et seq*., and its regulations, 40 CFR 1500 *et seq*., among others when planning restoration projects. NEPA requires federal agencies to consider the potential environmental impacts of planned actions. NEPA provides a framework for federal agencies to: (1) determine if their proposed actions have significant environmental impacts and related social and economic impacts, (2) consider these impacts when choosing between alternatives, and (3) inform and involve the public in the environmental analysis and decision-making process.

Given the scale of the DWH oil spill and associated restoration, the DWH Trustees established a tiered restoration planning and NEPA compliance process. The Final PDARP/PEIS evaluated a suite of restoration approaches and techniques to address the ecosystem-scale injury. From the Final PDARP/PEIS, the Trustees subsequently tier narrower environmental analyses on site-specific plans or projects (DWH Trustees, 2016). The Louisiana TIG has incorporated select restoration approaches and techniques described and evaluated in the Final PDARP/PEIS and has selected specific alternatives for further restoration planning and environmental review under NEPA.

The Louisiana TIG has found that: (1) the Final PDARP/PEIS included a thorough evaluation of the potential range of environmental impacts that could result from the various restoration approaches and techniques analyzed in the Final PDARP/PEIS; (2) the analysis of the environmental consequences of those approaches and techniques in the Final PDARP/PEIS remain valid; (3) the impacts of the restoration approaches and techniques are within the range of impacts evaluated in the Final PDARP/PEIS; and (4) any new information regarding the environmental consequences of the restoration approaches and techniques are within the range of and consistent with the environmental impacts identified and analyzed within the Final PDARP/PEIS. The Louisiana TIG has reviewed the environmental impacts of the alternatives considered in this RP/EA and found neither substantial changes in the types of restoration actions evaluated in the Final PDARP/PEIS nor new information indicating significant environmental impacts that would result from the implementation of the alternatives.

More information about OPA and NEPA, as well as their application to DWH oil spill restoration planning, can be found in Chapters 5 and 6 of the Final PDARP/PEIS (DWH Trustees, 2016).

1.5. Trustee Council Standard Operating Procedures

The 2016 *Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the DWH Oil Spill* (Trustee Council, 2016) contains standard operating procedures (SOPs) for administration, implementation, and long-term management of restoration under the Final PDARP/PEIS (DWH Trustees, 2016). Developed and approved by consensus of the Trustee Council, and subject to future amendments as needed, the included SOPs codify common procedures used by all DWH TIGs. Specifically, Trustee Council SOPs address the following: decision-making and delegation of authority, funding, administrative procedures, project reporting, monitoring and adaptive management (MAM), consultation opportunities among the DWH Trustees, public participation, and the administrative record.

1.6. Lead, Cooperating Agencies, and Intent to Adopt

The Trustees comprise state and federal government entities authorized under OPA to act on behalf of the public to assess the injuries to natural resources resulting from the DWH oil spill. The DWH Trustee Council includes representatives of Florida, Alabama, Mississippi, Louisiana, Texas, and the U.S. Department of Commerce, represented by NOAA, DOI, EPA, and USDA. The agencies representing the state of Louisiana are CPRA, LDNR, LDEQ, LOSCO, and LDWF. Federal and state agencies work in collaboration to assess natural resource injuries and develop and implement a restoration plan to compensate for those injuries. Table 7.2-1 of the Final PDARP/PEIS summarizes the division of responsibilities among the Trustee Council, TIGs, and individual Trustee agencies (DWH Trustees, 2016).

NOAA is the lead federal Trustee for preparing this RP/EA pursuant to NEPA. Other federal and state agencies of the Louisiana TIG act as cooperating agencies for the purposes of compliance with NEPA in the development of this RP/EA. The federal cooperating agencies intend to adopt the NEPA analysis presented in Section 4 of this RP/EA. In accordance with 40CFR §1506.3(a), each of the participating federal agencies will review this RP/EA for adequacy when compared to its own NEPA implementing procedures. Each agency will then choose whether to adopt the NEPA analysis presented in this RP/EA to inform its own federal decision-making and fulfill its responsibilities under NEPA. Adoption of the RP/EA would be completed via signature on the relevant NEPA decision document.

1.7. Purpose and Need

The Louisiana TIG has developed this RP/EA to contribute to the restoration of natural resources and services injured in the Louisiana restoration area as a result of the DWH oil spill. The proposed alternatives are intended to restore or replace habitats, species, and services to their baseline condition and to compensate the public for interim losses from the time of the DWH spill until they recover to baseline conditions.

This RP/EA is consistent with and expands upon the Final PDARP/PEIS, which identifies extensive and complex injuries to natural resources and services across the Gulf of Mexico (DWH Trustees, 2016). More specifically, the alternatives proposed in this RP/EA address the programmatic restoration goal of replenishing and protecting LCMR in the Louisiana restoration area, focusing on the marine mammal and oyster restoration types. Additional information about the overall purpose and need for DWH NRDA restoration can be found in Section 5.3.2 of the Final PDARP/PEIS (DWH Trustees, 2016).

The Final PDARP/PEIS identifies goals and approaches for each restoration type (DWH Trustees, 2016; Sections 5.5.2 through 5.5.14). These goals and approaches are intended to help guide restoration planning and project selection and describe options for implementation and, in some cases, to identify techniques and methods that could be used. The marine mammal and oyster restoration type goals, outlined in Sections 5.5.9 and 5.5.11 of the Final PDARP/EIS, are as follows:

- **Marine Mammals:** Implement an integrated portfolio of restoration approaches to restore injured BSE, coastal, shelf, and oceanic marine mammals across the diverse habitats and geographic ranges they occupy; identify and implement restoration activities that mitigate key

stressors in order to support resilient populations. Collect and use monitoring information, such as population and health assessments and spatiotemporal distribution information; identify and implement actions that support ecological needs of the stocks; improve resilience to natural stressors; and address direct human-caused threats such as bycatch in commercial fisheries, vessel collisions, noise, industrial activities, illegal feeding and harassment, and hook-and-line fishery interactions.

- **Oysters:** Restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs; restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time; restore a diversity of oyster reef habitats that provide ecological functions for estuarine dependent fish species, vegetated shoreline and marsh habitat, and nearshore benthic communities.

When developing a reasonable range of alternatives for this RP/EA, the Louisiana TIG considered the following restoration approaches identified in the Final PDARP/PEIS:

- **Marine Mammals:** Increase marine mammal survival through better understanding of causes of illness and death as well as early detection and intervention for anthropogenic and natural threats.[2]
- **Oysters:** Oyster reef habitat restoration, with emphasis on projects that address recruitment issues.

1.8. Reasonable Range of Alternatives

The Louisiana TIG considered a reasonable range of restoration alternatives before selecting their preferred alternatives (15 CFR § 990.53) by reviewing project ideas submitted to the DWH project portal[3] by the public, Trustee agencies, and others. Public involvement is an important component of restoration planning (DWH Trustees, 2016; Section 1.7).

Consistent with the Final PDARP/PEIS, the Consent Decree, and OPA, the Louisiana TIG utilized a full screening process to develop a reasonable range of alternatives. In total, the Louisiana TIG evaluates six projects in this RP/EA. Pursuant to NEPA, a no action alternative is also considered and used as a benchmark against which to compare the environmental consequences of the action alternatives. TABLE 1-2 lists the reasonable range of alternatives, presents their estimated costs, and identifies those preferred by the Louisiana TIG for implementation. Section 3 of this RP/EA provides a detailed description of each alternative.

[2] The Louisiana TIG will consider additional approaches to marine mammal restoration in future RP/EAs.

[3] This portal can be accessed at http://www.gulfspillrestoration.noaa.gov/restoration/give-us-your-ideas

TABLE 1-2. Action alternatives considered in this RP/EA.

Action Alternative	Preferred/ Not Preferred	Estimated Project Costs
Marine Mammals		
Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response	Preferred	$3,095,628
Region-wide Marine Mammal Conservation Medicine and Health Program	Not Preferred	$6,334,000
Oysters		
Cultch Plant Oyster Restoration	Preferred	$10,070,000
Enhancing Oyster Recovery Using Brood Reefs	Preferred	$9,701,447
Hatchery-based Oyster Restoration	Preferred	$5,850,000
Caillou Lake Artificial Reef	Not Preferred	$21,450,000

1.9. Proposed Action

The Louisiana TIG proposes to undertake the planning and implementation of the four preferred alternatives in order to replenish and protect LCMR. Funds made available through the DWH Consent Decree will be used for this process.

1.10. Coordination with Other Gulf Restoration Programs

In order to maximize the overall ecosystem impact of DWH NRDA restoration efforts and to make the most efficient use of available funds (DWH Trustees, 2016; Section 1.5.6), the Louisiana TIG has coordinated and will continue to coordinate with other DWH oil spill and Gulf of Mexico restoration programs. This includes the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act, 33 U.S.C. § 1321 note, PL 112-141) as implemented by the Gulf Coast Ecosystem Restoration Council (GCERC); the Gulf Environmental Benefit Fund (GEBF) managed by the National Fish and Wildlife Foundation (NFWF); and other state and federal funding sources. The Louisiana TIG has reviewed the implementation of projects in other coastal restoration programs and is working to develop synergies with those programs.

For example, CPRA maintains a statewide project database[4] that describes three oyster barrier reef projects that have been or are currently being implemented along the Louisiana coastline:

- Funds from the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) helped facilitate a bio-engineered oyster reef demonstration in Cameron Parish to evaluate the performance of oyster break structures at preventing beach erosion and increasing habitat diversity. This assessment will inform future CWPPRA restoration efforts.

[4] CPRA's interactive project map for the state of Louisiana is available at: https://cims.coastal.louisiana.gov/outreach/projects/OPL_Full_page.html

- The state of Louisiana funded a 163-acre living shoreline project along coastal fringe marsh in St. Bernard Parish in conjunction with other locally led living shoreline projects in Plaquemines and Jefferson Parishes.
- Funds from the RESTORE Council are helping to create a bioengineered, marsh-fringing oyster reef in the Biloxi Marsh area of St. Bernard Parish in order to promote self-sustaining living shoreline structures. The project will leverage work that has been conducted on the Coastal Impact Assistance program funded by the Living Shoreline Demonstration Project to evaluate candidate reef-based technologies.

In addition, the NFWF funded a statewide oyster project titled "Evaluation and Creation of Alternative Gulf Oyster Habitat" in 2011[5] and NOAA is currently implementing a statewide marine mammal project, titled "Assessment of Marine Mammal Physiological Responses to Low Salinity Exposures" using DWH NRDA funding.[6]

Several oyster projects were selected for funding under the DWH NRDA Early Restoration, including four subtidal oyster cultch placement projects in Louisiana, Florida, Alabama, and Mississippi, as well as seven living shoreline projects with components to support secondary benthic productivity in Florida, Alabama, and Mississippi. Recent DWH restoration plans that include marine mammal and/or oyster projects include:

- Alabama TIG *Final Restoration Plan II/Environmental Assessment: Restoration of Wetlands, Coastal, and Nearshore Habitats; Habitat Projects on Federally Managed Lands; Nutrient Reduction (Nonpoint Source); Sea Turtles; Marine Mammals; Birds; and Oysters* (Alabama TIG, 2018).
- Open Ocean TIG *Draft Restoration Plan II/Environmental Assessment: Fish, Sea Turtles, Marine Mammals, and Mesophotic and Deep Benthic Communities* (Open Ocean TIG, 2019).
- Texas TIG *Final 2017 Restoration Plan/Environmental Assessment: Restoration of Wetlands, Coastal, and Nearshore Habitats; and Oysters* (Texas TIG, 2017).

Funding opportunities for the marine mammal and oyster restoration types include the following:

- **The John H. Prescott Marine Mammal Rescue Assistance Grant Program**, administered by NOAA, provides federal assistance to eligible members of the National Marine Mammal Stranding Network (MMSN) to (1) support basic needs of organizations for response, treatment, and data collection from living and dead stranded marine mammals; (2) fund scientific research objectives designed to answer questions about marine mammal strandings, health, or rehabilitation techniques utilizing data from living and dead stranded marine mammals; and (3)

[5] https://dwhprojecttracker.org/project-information/?project=421

[6] The 2018 annual report for this project is available at: https://www.fws.gov/doiddata/dwh-ar-documents/2505/DWH-ARZ003571.pdf

support facility operations directly related to the recovery, treatment, and data collection from living and dead stranded marine mammals.

- **The Marine Mammal Commission**, established by the Marine Mammal Protection Act (MMPA) in 1972, provides independent oversight of the marine mammal conservation policies and programs being carried out by federal regulatory agencies. The commission carries out a small grant program that supports projects aimed at meeting the conservation and protection goals of the MMPA. The Commission's research program includes all relevant activities, including basic and applied research, workshops, literature reviews, compilations of expert opinion, and drafting manuscripts or reports. The research program is administered by the Commission's Scientific Program staff in consultation with the Commissioners and the Committee of Scientific Advisors on Marine Mammals.
- **The National Academies of Science Gulf Research Program** works to enhance oil system safety and the protection of human health and the environment in the Gulf of Mexico and other U.S. outer continental shelf (OCS) areas. This program seeks to improve understanding of the region's "interconnecting human, environmental, and energy systems and fosters application of these insights to benefit Gulf communities, ecosystems, and the Nation.
- **The NFWF GEBF** is a $2.5 billion fund that supports projects benefiting natural resources of the Gulf Coast that were impacted by the DWH spill.
- **The NFWF Gulf Response Grants** have provided $22.9 million in conservation investments for projects focused on at-risk species, including shorebirds, waterfowl, marsh birds, seabirds, sea turtles, marine mammal, oysters, and others.
- **The RESTORE Council** helps to restore the ecosystem and economy of the Gulf Coast region by developing and overseeing implementation of a comprehensive plan and carrying out other responsibilities.
- **NOAA's RESTORE Act Science Program** prioritizes projects focused on assessing ecosystem modeling, evaluating indicators for ecosystem conditions, and assessing and developing recommendations for monitoring and observing in the Gulf of Mexico.
- **The Gulf of Mexico Research Initiative** competitively funds projects that investigate the impacts of oil, dispersed oil, and dispersant on the ecosystems of the Gulf of Mexico and affected coastal states in a broad context of improving fundamental understanding of the dynamics of such events and their environmental stresses and public health implications.
- **The Gulf of Mexico Alliance** was established in 2004 to develop and implement projects related to the priority issues identified by the Gulf State Governors in early discussions.

1.11. Public Involvement

Public input is an integral part of the DWH oil spill restoration planning effort. The public is encouraged to review and comment on this RP/EA to facilitate discussion regarding the restoration alternatives, allow the Trustees to solicit and consider public comment, and ensure that final plans consider relevant stakeholder issues.

1.11.1. Public Involvement in the Final PDARP/PEIS and Louisiana Coastal Master Plan

Chapter 8 of the Final PDARP/PEIS describes the process used to obtain public input for the Final PDARP/PEIS (DWH Trustees, 2016). Previous DWH NRDA restoration plans, including Early Restoration Plans, provide more detail on public outreach and involvement. These plans are available at: http://www.gulfspillrestoration.noaa.gov/restoration/early-restoration.

In addition, during the development of the 2017 Coastal Master Plan (CMP), CPRA provided opportunities for coastal communities to provide input, both in person and online. Community conversations along with the development of tools and materials to help communities understand coastal resiliency, placed citizens in the position to take active ownership in future adaptation decisions. After release of the draft CMP, CPRA hosted four official public hearings and traveled across coastal Louisiana to participate in meetings, briefings, and presentations to receive feedback and comments from coastal citizens. In all, CPRA received over 1,300 public comments on the 2017 CMP.

1.11.2. Public Involvement in the Development of the LCMR RP/EA #5

Restoration project submissions potentially relevant to the DWH Trustees have been submitted to the internet based DWH project portal since it opened in 2010. From August 18, 2017 through July 17, 2019, the Louisiana TIG specifically solicited restoration project ideas from the public for marine mammals and oysters.

The Louisiana TIG reviewed more than 200 restoration project ideas proposed by the public, NGOs, and state, federal, and local agencies. Section 2 of this RP/EA describes the project screening process in more detail.

The public is encouraged to review and comment on this RP/EA. It is made available for public review and comment for 30 days following its release as specified in the public notice published in both the Federal and Louisiana Registers. Comments can be submitted by one of following methods:

- Online at: http://www.gulfspillrestoration.noaa.gov/restoration-areas/louisiana
- By mail (hard copy) addressed to: U.S. Fish and Wildlife Service, P.O. Box 29649, Atlanta, GA 30345
- Online during the public webinar on April 8, 2020.

Submissions must be postmarked no later than 30 days after the release date of this RP/EA.

1.11.3. Administrative Record

A publicly available administrative record for DWH NRDA process, including restoration planning activities, was opened concurrently with publication of the 2010 notice of intent (NOI; pursuant to 15 CFR § 990.45). DOI is the federal Trustee that maintains the administrative record, which is available at http://www.doi.gov/deepwaterhorizon/adminrecord. The administrative record provides the public with information about project implementation. An additional website containing information on the DWH oil spill and restoration, http://www.gulfspillrestoration.noaa.gov, is maintained for the public to access information.

1.12. Decision to Be Made

This RP/EA is intended to provide the public and decision makers with information and analyses on the alternatives presented in this LCMR RP/EA. This RP/EA and its corresponding public review are intended to guide the Louisiana TIG's selection of alternatives for implementation. Alternatives not selected may be considered for inclusion in future restoration plans.

1.13. Document Organization

This RP/EA is organized into the sections listed below.

- **Section 1 - Introduction** provides the background and context for this document, identifies the purpose and need for the proposed projects, describes the decision to be made, and provides avenues for public involvement.
- **Section 2 - Restoration Planning Process: Project Screening and Alternatives** presents the NRDA restoration planning process, summarizes the injuries addressed by the restoration, and summarizes the screening process used to arrive at the reasonable range of alternatives.
- **Section 3 - OPA Evaluation of Alternatives** summarizes the reasonable range of alternatives and provides an analysis of the reasonable range of alternatives against criteria set forth in OPA.
- **Section 4 - Affected Environment and Environmental Consequences** provides a description of the affected environment (i.e., coastal Louisiana), the approach taken in evaluating the reasonable range of alternatives against criteria set forth in NEPA, and an analysis of the alternatives' environmental consequences against NEPA criteria.
- **Section 5 - Compliance with Other Laws and Regulations** presents federal and state laws, regulations, and executive orders (EO) that may be applicable to the proposed alternative.
- **Section 6 - Literature Cited** lists the literature referenced in this document.

2. RESTORATION PLANNING PROCESS: PROJECT SCREENING AND ALTERNATIVES

2.1. Final PDARP/PEIS and Record of Decision

On February 19, 2016, the DWH Trustees issued the Final PDARP/PEIS which details a programmatic plan to allocate settlement funds paid by BP over 15 years to several restoration projects across the Gulf (DWH Trustees, 2016). The Trustees proposed a comprehensive, integrated ecosystem restoration approach based upon their assessment of impacts on the Gulf's natural resources. On March 29, 2016, in accordance with OPA and NEPA, the DWH Trustees published a NOA of a ROD for the Final PDARP/PEIS in the Federal Register (81 FR 17438) which selects Alternative A: Comprehensive Integrated Ecosystem Alternative (DWH Trustees, 2016).

2.2. Summary of Injuries Addressed in this RP/EA

The DWH oil spill introduced numerous contaminants into the environment including an estimated 3.19 million barrels of oil (~507 million liters), 7.7 billion standard cubic feet (218 billion liters) of natural gas, 1.84 million gallons (7.0 million liters) of chemical dispersants used in response to the spill, and an unknown volume (up to 30,000 barrels [4.8 million liters]) of synthetic-based drilling mud released during the blowout and response (DWH Trustees, 2016). The release of these contaminants introduced chemicals of known and unknown toxicity into the northern Gulf of Mexico. Natural weathering processes (e.g., photo-oxidation) and the intentional burning of the floating oil at sea formed additional contaminants.

Chapter 4 of the Final PDARP/PEIS summarizes the nature, degree, and extent of injuries from the DWH oil spill to both natural resources and the services they provide (DWH Trustees, 2016). Sections 2.2.1 and 2.2.2 of this RP/EA summarize the injuries to marine mammals and oysters.

2.2.1. Injury to Marine Mammals

The Final PDARP/PEIS evaluated injuries to marine mammals as part of the DWH NRDA (DWH Trustees, 2016). That evaluation demonstrated spill-related effects to a vast number of marine mammal species across a wide geographic range. Contamination of habitat in the nearshore and offshore waters of the northern Gulf of Mexico resulted in marine mammals inhaling, ingesting, aspirating, and possibly absorbing oil. As a result, thousands of animals have suffered physical injury and toxic effects to organs and tissues, including lung disease, adrenal disease, poor body condition, and other adverse health effects. Animals that experienced these adverse health effects contributed to the largest and longest marine mammal unusual mortality event (UME) on record in the Gulf of Mexico. Bottlenose dolphins were the most impacted species in this UME, and dead, stranded individuals included near-term fetuses from failed pregnancies. Moreover, marine mammal populations that overlap with the footprint of the DWH oil spill still have demonstrable, quantifiable injuries. Bottlenose dolphin stocks in Barataria Bay and Mississippi Sound were two of the most severely injured stocks, experiencing a 52 percent and 62 percent maximum reduction in their population sizes, respectively (DWH Trustees, 2017c). Because cetaceans are long-lived animals, give birth to only one calf every few years, and are slow to reach

reproductive maturity, injured marine mammal stocks will take many decades to recover without active restoration.

2.2.2. Injury to Oysters

The Final PDARP/PEIS (DWH Trustees, 2016) evaluated injuries to oysters as part of the DWH NRDA. That evaluation demonstrated substantial spill- and response action-related impacts on intertidal and subtidal oysters in the northern Gulf. More specifically, the combined effects of reduced spawning stock, larval production, spat settlement, and spat substrate availability have compromised the sustainability of nearshore and subtidal oysters throughout the north-central Gulf of Mexico. Nearshore oyster cover in the northern Gulf was significantly reduced over 155 miles of shoreline, resulting in the loss of 8.3 million adult-equivalent oysters. An additional estimated 5.7 million oysters per year (adult equivalents) are still unable to settle because of the loss of oyster shell cover in reef habitats. The loss of oyster reef habitat has contributed to a lack of recruitment and recovery for oysters and has also contributed to shoreline erosion rates and wetland loss. These effects are particularly observed throughout the Mississippi Sound where reduced larval production, spat settlement, and spat substrate availability have compromised the sustainability of oyster reefs. Along oiled shorelines of Louisiana, loss of oyster reefs have been associated with accelerated coastal erosion.

2.3. Screening for Reasonable Range of Alternatives

Using the DWH and state of Louisiana restoration portals, the Louisiana TIG undertook a screening process to identify a reasonable range of alternatives suitable for addressing DWH-related injuries to marine mammals and oysters in Louisiana. The screening process considered an alternatives' ability to meet both OPA criteria while also resulting in no major adverse environmental impacts under NEPA.

Screening for marine mammal and oyster alternatives is a stepwise process (FIGURE 2-1). The Louisiana TIG first conducted a general eligibility screening (Step 1) in which projects that were geographically located in the Louisiana restoration area and that met the goals outlined in the Final PDARP/PEIS for each restoration type were accepted (DWH Trustees, 2016). Projects that did not meet the eligibility criteria were screened out and received no further consideration. Similarly, projects that were already identified for NRDA or other funding, were part of existing projects, were appropriately considered by another TIG, or were more clearly aligned with other restoration types were also screened out and received no further consideration.

Projects accepted in Step 1 were next evaluated by the Louisiana TIG based on the alternative's ability to meet the OPA criteria (Step 2), and then on individual project merit (Step 3). The projects that progressed through Steps 2 and 3 were re-evaluated and prioritized by the Louisiana TIG in Step 4, with emphasis placed on projects that met the goals and objectives of the Louisiana TIG, other governmental plans, and the goals and objectives of the Final PDARP/PEIS (DWH Trustees, 2016). Lastly, in Step 5, projects with similar methodologies or project elements were identified and combined into single alternatives. Throughout the evaluation process, each project was tracked and reported in a spreadsheet, including projects removed from consideration, to document its status, record comments

on why it was removed, and for reference in future reports or consideration under future restoration plans. The following section describe the detailed screening methodology in more detail.

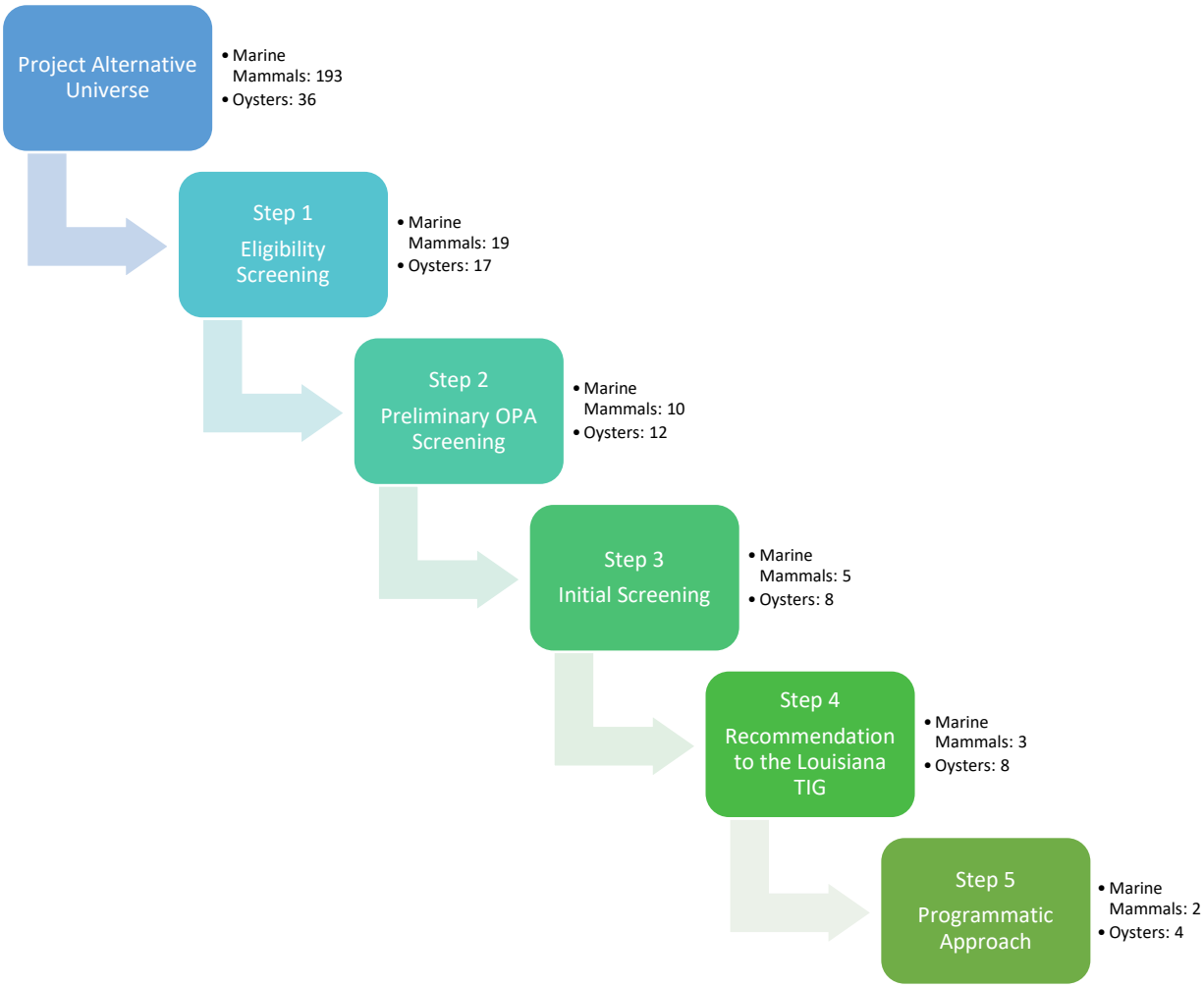

FIGURE 2-1. Graphical summary of project screening process used to arrive at a reasonable range of alternatives for more detailed OPA and NEPA analyses.

2.3.1. Restoration Alternative Universe

The Louisiana TIG first assembled an initial list of candidate restoration projects for the marine mammal and oyster restoration types (i.e., the project alternative universe), based on the following sources:

- The DWH public comment portal established soon after the spill, which allowed the public to submit projects for the DWH Trustees' consideration;

- A similar web-based portal created in 2015 by the state of Louisiana (Louisiana Project Portal);
- Projects submitted to the DWH Trustee or Louisiana TIG portals by the public during the scoping period established by the notice of solicitation [August 18, 2017 through September 18, 2017]; and
- Projects submitted by individual state and federal Trustees, including projects submitted on behalf of non-Trustee agencies.

In total, the restoration alternative universe comprised 193 marine mammal projects and 36 oyster projects that underwent the stepwise screening process described below.

2.3.2. Eligibility Screening

The Louisiana TIG reviewed and screened for eligibility all submissions in the restoration alternative universe using the following criteria:

For marine mammals:

- Projects must be geographically located in the Louisiana restoration area.
- Projects must meet at least one of the goals outlined in the Final PDARP/PEIS to compensate for marine mammal population injuries resulting from the DWH spill.
- Projects must align with the preferred approach of increasing marine mammal survival through better understanding of causes of illness and death, as well as early detection and intervention of anthropogenic and natural threats.
- Projects must benefit marine mammal stocks impacted by the DWH oil spill.
- Projects must contain sufficient information to permit screening.

For oysters:

- Projects must be geographically located in the Louisiana restoration area.
- Projects must meet at least one of the goals outlined in the Final PDARP/PEIS to compensate for oyster population injuries resulting from the DWH spill.
- Projects must benefit oysters in basins that were directly impacted by oiling from the DWH oil spill.
- Projects must contain sufficient information to permit screening.

Projects not meeting all the above criteria for their respective restoration type were screened out and received no further consideration for this plan.

2.3.3. Preliminary OPA Criteria Screening

The Louisiana TIG evaluated each screened project against the OPA criteria in order to identify projects that are most likely to address the relevant restoration type's goals and priorities. The application of OPA criteria in this step of the screening process (Step 2) was not intended to be as rigorous as or a substitute for the OPA evaluation conducted later in this RP/EA (Section 3); rather, Step 2 was intended to be a preliminary assessment of the OPA criteria.

The OPA criteria are as follows:

- Is the cost to carry out the project reasonable?
- Is the project expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses?
- Is the project likely to succeed?
- Will the project prevent future injury as a result of the incident and avoid collateral injury as a result of implementing the alternative?
- Will the project benefit more than one natural resource and/or service?
- Will the project benefit, and avoid collateral injury to, public health and safety?

2.3.4. Initial Project Screening Criteria

2.3.4.1. Marine Mammals

The Louisiana TIG decided to focus on the Final PDARP/PEIS restoration approach to increase marine mammal survival through better understanding of causes of illness and death and early detection and intervention of anthropogenic and natural threats (DWH Trustees, 2016). The Louisiana TIG identified five projects in the Initial Project Screening Criteria (Step 3) that would support the specific restoration approach. The following criteria were examined during Step 3:

- Can the project be implemented in a reasonable timeframe?
- Does the project improve the ability to detect and rescue free-swimming dolphins that are entangled, entrapped, or out of habitat in Louisiana?
- Does the project develop and increase technical and infrastructure capabilities to respond to major events or disasters in Louisiana?
- Does the project improve understanding of key causes of morbidity and mortality and early detection and mitigation of natural or anthropogenic threats?
- Does the project have a reasonable likelihood of long-term success?

Eligible submittals were evaluated and categorized into three "Tiers" of projects:

- Tier I – Projects that are **highly likely** to restore marine mammal populations via the selected restoration approach and that meet the selected criteria.
- Tier II – Projects that are **likely** to restore marine mammal populations via the selected restoration approach and that meet the selected criteria.
- Tier III – Projects that are **least likely** to restore marine mammal populations via the selected restoration approach and that meet the selected criteria. Projects that lack sufficient information to determine the likelihood of success were also placed into this tier.

2.3.4.2. Oysters

The Final PDARP/PEIS identified three oyster restoration goals: (1) to restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels, (2)

Restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time, and (3) Restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities (DWH Trustees, 2016).

The Louisiana TIG identified projects that met these goals and could be achieved through one or more of the following restoration techniques:

- Restore or create oyster reefs through placement of cultch in nearshore and subtidal areas;
- Construct living shorelines;
- Enhance oyster reef productivity through spawning stock enhancement projects such as planting hatchery-raised oysters; and
- Develop a network of oyster spawning reef reserves.

Eligible submittals were evaluated and categorized into three "Tiers" of projects:

- Tier I – Projects that are **highly likely** to restore oyster populations via one or more of the four focus techniques.
- Tier II – Projects that are **likely** to restore oyster populations via one or more of the four focus techniques.
- Tier III – Projects that are **least likely** to restore oyster populations via one or more of the four focus techniques. Projects that lack sufficient information to determine the likelihood of success were also placed into this tier.

2.3.5. Completion of Screening

Completion of Steps 1 through 3 of the screening process resulted in a reasonable range of alternatives for review by the TIG. In Step 4, projects were evaluated with respect to how they may be implemented as part of a suite of projects under this and previous restoration plans. Criteria used for this evaluation included:

- Cost of projects/utilization of available funding in the most efficient and effective manner;
- Geographic distribution of projects from this and previous plans;
- Location of project in an area of geographical and biological need; and
- Feasibility of permitting and ease of implementation.

2.3.6. Programmatic Approach

The Louisiana TIG adopted a programmatic approach in order to either (1) combine alternatives that feature similar methodologies and/or project locations, or (2) evaluate a broad project area that extends beyond the boundaries of the proposed project so that future projects can be implemented without the need for supplemental evaluation. Adopting a programmatic approach allows the Louisiana TIG to carry forward analyses to consider multiple restoration projects that may be tiered for implementation in the future.

2.4. Summary of Screening Process

Implementation of the Louisiana TIG's screening methodology provides a rigorous and comprehensive approach to identifying a reasonable range of alternatives for evaluation in this RP/EA. Overall, the process yielded two marine mammal alternatives and four oyster alternatives for more detailed OPA and NEPA analyses.

2.5. Alternatives Not Considered for Further Evaluation in this RP/EA

Some alternatives considered during screening were ultimately not selected by the Louisiana TIG for inclusion in the reasonable range of alternatives. The Louisiana TIG's decisions to advance alternatives are based on balancing the considerations outlined above and have been made in the context of the full suite of restoration alternatives being advanced for analysis in this restoration plan. As a result, while an alternative considered in Step 2 may have received a generally favorable review, the Louisiana TIG may still have decided not to advance it to the reasonable range of alternatives for this plan. While these alternatives have restoration potential and may be evaluated and potentially selected in a future restoration plan, they are not considered for further evaluation under OPA or NEPA in this plan.

2.6. Reasonable Range of Restoration Alternatives Considered

As noted above, the stepwise screening process produced two reasonable alternatives for marine mammals and four reasonable alternatives for oysters to be carried forward for detailed OPA and NEPA analysis. Section 3 of this RP/EA presents a detailed description and OPA evaluation for each alternative and Section 4 presents a NEPA evaluation for each alternative.

2.6.1. Natural Recovery/No Action Alternative

OPA regulations require consideration of a "natural recovery alternative in which no human intervention would be taken to directly restore injured natural resources and services to baseline" (15 CFR §990.53[b][2]). Under a natural recovery alternative, the Trustees would not implement any restoration to accelerate the recovery of injured natural resources or to compensate for lost services. This could produce one of four outcomes for injured resources: (1) gradual recovery, (2) partial recovery, (3) no recovery, or (4) further deterioration.

Under the natural recovery alternative, even if injured resources could recover to baseline or near baseline conditions, recovery would take much longer compared to a scenario in which appropriate restoration actions were undertaken. As noted in the Final PDARP/PEIS, interim losses of natural resources, and the services they provide would not be compensated under a natural recovery alternative (DWH Trustees, 2016).

Since technically feasible restoration approaches are available, the Trustees rejected the option of natural recovery from further consideration in the Final PDARP/PEIS (DWH Trustees, 2016). Consistent with OPA regulations, the Louisiana TIG has incorporated the natural recovery alternative in this RP/EA by reference; however, the Louisiana TIG rejects the natural recovery alternative as a viable means of compensating the public for the injuries caused to marine mammals and oysters by the DWH oil spill.

Pursuant to NEPA, a no action alternative is considered in Section 4 of this RP/EA as a basis for comparison of potential environmental consequences of the action alternatives.

3. OPA EVALUATION OF ALTERNATIVES

Section 3 provides detailed descriptions and OPA analyses of the preferred and non-preferred alternatives considered in this RP/EA. A summary of the evaluation standards (Section 3.1), background information on monitoring requirements (Section 3.2), estimated costs of the alternatives (Section 3.3), and best management practices (BMPs; Section 3.4) are presented first, followed by a description of the restoration alternatives, grouped by restoration type. Each specific restoration alternative section begins with a general description of the alternative and relevant background information, followed by a discussion of the alternative's consistency with OPA evaluation standards. Section 3 concludes by presenting the findings of the OPA evaluations for the marine mammal and oyster restoration alternatives, respectively.

3.1. Summary of OPA Evaluation Standards

Trustees consider a reasonable range of restoration alternatives (15 CFR §990.53(a)(2)) before selecting their preferred alternative(s) in accordance with the OPA evaluation standards (15 CFR §990.54). The following OPA criteria (15 CFR §990.54(a)) include:

- The cost to carry out the alternative.
- The extent to which each alternative is expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses (the ability of the alternative to provide comparable resources and services; that is, the nexus between the alternative and the injury).
- The likelihood of success of each alternative.
- The extent to which each alternative would avoid collateral injury as a result of implementation.
- The extent to which each alternative would benefit one or more natural resource and/or service.
- The effect of each alternative on public health and safety.

3.2. Monitoring Requirements

Trustees establish restoration objectives that are specific to the natural resources that were injured (15 CFR §990.55(b)(2)). These objectives should clearly specify the desired outcome, and the performance criteria by which successful restoration will be determined, including criteria that would necessitate corrective actions (15 CFR §990.55(b)(2)).

In the Final PDARP/PEIS, the DWH Trustees identified "Monitoring, Adaptive Management, and Administrative Oversight" as a programmatic restoration goal (DWH Trustees, 2016). As described in Chapter 5, Appendix E of the Final PDARP/PEIS, the Trustee Council has committed to a MAM Framework that incorporates the best available science into planning and design of the alternative, identifies and reduces key uncertainties, tracks and evaluates progress toward restoration goals, and determines the need for corrective actions (DWH Trustees, 2016). The MAM Framework provides a flexible, science-based approach to implement and monitor restoration.

The Louisiana TIG developed MAM plans for the preferred alternatives identified in this RP/EA, included in Appendix D. These MAM plans outline the monitoring needed to evaluate each alternative's progress toward meeting site-specific objectives, the appropriate corrective actions, and adaptive management where applicable. The plans included in Appendix D are consistent with the requirements and guidelines set forth in the Final PDARP/PEIS (DWH Trustees, 2016), the Trustee Council SOPs (Trustee Council, 2016), and the Trustees' MAM Manual (DWH Trustees, 2017a). Monitoring goals, objectives, parameters, potential corrective actions, and monitoring schedules are included. The MAM plans are intended to be updated as needed to reflect changing conditions and to incorporate new information as it becomes available. For example, if initial data analysis indicates that the sampling design for the alternative is inadequate, or if any uncertainties are resolved or new uncertainties are identified during implementation and monitoring of the alternative, the plan may need to be revised. Updates to MAM plans and any additional details concerning the status of monitoring activities would be made publicly available through the NOAA Restoration Portal.

3.3. Project Costs

The Louisiana TIG has developed estimated costs for each restoration alternative using information available at the time of drafting this RP/EA. The estimated costs reflect all activities associated with implementing the alternative, potentially including but not limited to revising/finalizing engineering and design, acquiring supplies and materials, permitting, pilot studies, monitoring, Trustee oversight, and contingencies.

3.4. Best Management Practices

As part of the environmental compliance process, federal regulatory agencies provide guidance on BMPs including design criteria, lessons learned, expert advice, tips from the field, and more. DWH Trustees must incorporate appropriate BMPs into planning and design to avoid or minimize impacts on natural resources, including protected and listed species and their habitats. BMPs are identified in required permits, consultations, or environmental reviews, including those described in Appendix 6.A of the Final PDARP/PEIS (DWH Trustees, 2016).

3.5. OPA Evaluation for the Marine Mammal Restoration Type

The Louisiana TIG's screening process resulted in the identification of a reasonable range of alternatives, including two marine mammal restoration alternatives.[7] A description of each alternative is provided below followed by the OPA evaluation of the alternative.

[7] The marine mammal restoration type addressed in this subsection is a type of restoration designed to address specific injuries to marine mammals and support the overall goal from the Final PDARP/PEIS of "Replenish and Protect LCMR" (DWH Trustees, 2016).

3.5.1. Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

3.5.1.1. Project Description

The nationwide MMSN was formalized by the 1992 Amendments to the MMPA, and volunteer MMSNs authorized by NOAA Fisheries exist throughout all coastal states to respond to live and dead marine mammal strandings, including injured, entangled, and out-of-habitat small cetaceans (i.e., whales, dolphins, and porpoises). These volunteer MMSN organizations do not receive consistent financial support from the federal government for their activities; thus, the ability of the MMSN to identify, respond to, and investigate strandings can vary by organization, level of training, funding, and frequency of strandings. Participants in the MMSN may apply for NOAA Fisheries' John H. Prescott Marine Mammal Rescue Assistance grants (Prescott grant), which do provide limited support for stranding response activities to some MMSN organizations; however, no Prescott grants were awarded in Louisiana in the Fiscal Year 2019 grant cycle.

In Louisiana, the Audubon Nature Institute Coastal Wildlife Network (Audubon) and LDWF are authorized under the MMPA to respond to live or dead stranded marine mammals. Audubon is also authorized to rehabilitate marine mammals. Both MMSN organizations have limited capacity to respond to strandings across Louisiana's large, complex coastline. Historically, the two organizations divided their response capabilities, with LDWF providing first response and necropsy of most dead stranded cetaceans and first response to live stranded cetaceans, including injured, entangled, and out-of-habitat small cetaceans, and Audubon providing veterinary assistance and rehabilitation of live stranded cetaceans. In September 2019, LDWF transitioned MMSN roles to establish Audubon as the primary organization for investigation of marine mammal strandings in the state. As the MMSN responsibilities have transitioned, the participating agencies have identified an urgent need to increase existing capacity by expanding the MMSN and partnerships along the Louisiana coastline.

On average, approximately 81 cetaceans strand along the coast of Louisiana each year. Of these, 5 percent are found alive and 95 percent are found dead. The most commonly stranded species is the bottlenose dolphin (86 percent of all strandings). However, from January 1 to August 31, 2019, there were 110 bottlenose dolphin strandings, with 98 of those occurring between February and May, straining the current capacity of Louisiana's MMSN. Due to resource limitations, only 52 percent of those dolphins were responded to or examined by stranding network personnel. Thus, there is a need to increase the capabilities of Louisiana's MMSN organizations, especially their ability to diagnose causes of illness and death in stranded marine mammals and to use that information to better understand population health. Increasing existing capacity and expanding networks would fill gaps in capabilities and spatial coverage of personnel and material resources along the Louisiana coastline. This alternative would address gaps and enhance capacity in the current capabilities of the MMSN in Louisiana to improve timeliness of response, enhance survival, and improve diagnosis of illness and cause of death in cetaceans to better understand natural and anthropogenic threats, which would inform future restoration efforts, monitoring, and adaptive management.

This alternative is anticipated to benefit many marine mammal species in the Gulf of Mexico, but would improve the health and survival of coastal and estuarine stocks of bottlenose dolphins, in particular. Other offshore species that are subject to mass strandings or die-offs, such as short-finned pilot whales and rough-toothed dolphins, may also benefit.

Implementation Methodology and Schedule

The specific objectives of the alternative are to increase coordination among MMSN partners by identifying new partners, developing existing partnerships, and enhancing capacity for marine mammal stranding response in Louisiana. This alternative would include hiring a Stranding Coordinator in Louisiana to focus on initial partnership building and outreach tasks, identify new partners, increase the capacity of the MMSN in Louisiana, and fill gaps in capabilities and coverage along the coast. The alternative would provide support to the Stranding Coordinator and authorized partners for the necessary trainings and resources (e.g., personnel, equipment, supplies), to enhance capabilities to collect, store, and analyze samples collected from stranded cetaceans, and to improve diagnosis of illness and cause of death for marine mammals in Louisiana.

In addition to hiring and training personnel, this alternative would provide the infrastructure, equipment, and supplies needed to facilitate stranding response and improve rehabilitation capabilities. The new Stranding Coordinator would establish a centrally located base of operations in Louisiana with all appropriate office equipment (e.g., computer, desk, phone, copier) to promote timely stranding responses. In addition, new trucks, boats, and boat trailers would be provided to facilitate stranding response on remote beaches, marshes, and islands. Additional freezers and other sample collection and storage supplies would also be provided to enhance the MMSN's capabilities to store and analyze samples collected from stranded cetaceans. Additional resources and equipment would enhance Audubon's ability to respond to and care for live stranded marine mammals, thus increasing their chances of survival. A centrally located base of operations and the increasing capacity to respond would improve the timeliness of response throughout the Louisiana. Enabling a more rapid response to a live stranded cetacean, increasing that animal's chance of survival by reducing stranding time, reducing stress on the animal, and providing rapid treatment and, if appropriate, transport to an authorized rehabilitation facility for additional treatment and care. The Audubon marine mammal rehabilitation facility also increases the likelihood of survival of transported animals once they reach the facility. This alternative would ensure that there are trained and authorized MMSN partners in Louisiana with the necessary equipment and supplies to enable rapid response to reports of live, entangled, injured, and out-of-habitat cetaceans in the state, increasing the likelihood of survival for those animals.

Improving the timeliness of response would also increase the quality and quantity of data that could be collected from dead stranded cetaceans by decreasing decomposition time and ensuring that fresher carcasses are recovered for necropsy. Examining fresher carcasses would improve the ability to diagnose causes of illness and death in cetaceans to better understand natural and anthropogenic threats, which would inform future restoration efforts, monitoring, and adaptive management.

Dead animal stranding response typically involves response to animals floating in water or stranded in a marsh or on land, recovery of carcasses, and either in situ sampling/necropsy or transport to a necropsy facility for examination. Burial may occur on site or the animal may be disposed of using other methods if transported for examination (e.g., rendering, incineration, landfill). Live animal stranding response, including interventions for entangled or out-of-habitat animals, can involve assessment and triage, capture using nets set by hand or a boat, disentanglement, relocation, transport to an authorized rehabilitation facility, euthanasia, and/or immediate release of the animal (e.g., for animals that may be tidally stranded or relocated from an out-of-habitat area). These activities may include chemical agents (e.g., sedatives, antibiotics, euthanasia solution), temporary in-water nets, and/or other interventions in the water or on the beach. Hazing methods may be used to deter or herd animals (i.e., to avert a mass stranding); these methods include acoustic and visual deterrents (e.g., pingers, pipe banging) and vessels. If animals are released, the National Marine Fisheries Service (NMFS) may require that the animal be marked or tagged for identification/monitoring via freeze branding and/or dorsal fin tag. If the live stranded animal dies or is euthanized, every effort would be made to retain the animal for a complete necropsy; however, if this is not possible, burial may occur on site or, if chemically euthanized, removal to another location to prevent environmental contamination. Areas of the beach may be temporarily closed off to limit public access during stranding response for animal and human safety purposes.

This restoration alternative includes funding for an annual report to be provided to the Louisiana TIG. This report would include the number of total strandings reported by location/geographic area, the number of live strandings and their outcomes (e.g., transported for rehabilitation, final disposition, died, or euthanized), the number of necropsies (partial and full), and significant findings or cause of illness or death, if determined. This information may be used by the Louisiana TIG to monitor the success of the restoration alternative, improve response to threats facing marine mammals, and inform future restoration efforts.

Implementation of the alternative is anticipated to commence within three months of the notice to proceed, with a five-year total duration.

Monitoring Requirements

Monitoring for Louisiana's Marine Mammal Stranding Response alternative would consist of tracking the hiring and performance of the Stranding Coordinator, the size and distribution of the network of MMSN personnel in Louisiana, the percentage of responses to reported stranded, entangled, entrapped, or out-of-habitat animals, average response time, proportion of stranded animals that are necropsied (partial or full), the number of samples analyzed that meet sample quality objectives and the significant findings or cause of illness and death, if determined. Information in each annual report would be reported by location/geographic area and statewide total. Monitoring would be conducted annually for five years. See Table 2 in the MAM plan in Appendix D for additional information on monitoring objectives and performance criteria.

Maintenance Requirements

Maintenance activities are anticipated for infrastructure, including office space, office equipment, vehicles, boats, boat trailers, freezers, and other equipment that require maintenance. Anticipated maintenance costs are included in the project budget. Additional maintenance needs may be identified later based on monitoring results.

Costs

The estimated cost of the alternative is $3,095,628 summarized in TABLE 3-1. These funds are for project implementation, stranding personnel support, equipment, maintenance, supplies, training, outreach materials, sample storage and analysis, and contingency.

TABLE 3-1. Estimated costs for Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts.

Project Management, Planning, & Monitoring	NOAA Louisiana-based Stranding coordinator salary and travel expenses	$700,000
	NOAA South East Regional Office Project Manager	$135,200
	Stranding coordinator office expenses	$195,000
	MMSN travel	$25,000
	Contracting support	$92,290
Project Implementation	MMSN personnel and trainings	$362,500
	Supplies and equipment	$560,500
	Sample analyses	$200,000
	Outreach and education	$100,000
Oversight & Administration		$321,360
Contingency		$403,778
Total project cost		$3,095,628

3.5.1.2. OPA Evaluation

Cost-Effectiveness

The estimated costs represent NOAA's best estimates and are comparable with the costs of similar Stranding Network projects.[8] Some variability in MMSN costs can be attributed to the level of effort required to cover vastly different areas of coastline. For example, Alabama's coastline is 607 miles, while Louisiana's coastline is 7,721 miles (NOAA, 2019a). Variability in cost can also be attributed to differing minimum salary requirements for federal versus state supported Stranding Coordinator positions. The

[8] The budget for the Alabama TIG's "Enhancing Capacity for the Alabama Marine Mammal Stranding Network" alternative was $2,432,389 (Alabama TIG, 2018). The budget for the Open Ocean TIG's "Reducing Impacts to Cetaceans during Disasters by Improving Response Activities" alternative was $4,287,000 (Open Ocean TIG, 2019).

Louisiana TIG found the cost to implement this alternative to be reasonable, appropriate, and comparable to the other restoration alternatives. Furthermore, the cost effectiveness of this alternative is likely to increase over time as opportunities for improved efficiency are identified based on stakeholder input, monitoring data, and adaptive management.

Trustee Restoration Goals and Objectives

This alternative meets the Trustee programmatic restoration goals of replenishing and protecting LCMR, and restoration type-specific goals as described in the Final PDARP/PEIS (DWH Trustees, 2016) to (1) implement an integrated portfolio of restoration approaches to restore injured Bay, Sound, and Estuary (BSE); coastal; shelf; and oceanic marine mammals across the diverse habitats and geographic ranges they occupy; (2) identify and implement restoration activities that mitigate key stressors to support resilient populations; (3) collect and use monitoring information, such as population and health assessments and spatiotemporal distribution information; (4) identify and implement actions that support ecological needs of the stocks; (5) improve resilience to natural stressors; and (6) address direct human-caused threats such as bycatch in commercial fisheries, vessel collisions, noise, industrial activities, illegal feeding and harassment, and hook-and-line fishery interactions.

Louisiana Trustees have determined that the DWH spill adversely affected Louisiana marine mammals in several ways, having contaminated marine mammal habitats, caused adverse health effects, reproductive failure, and triggered UMEs. This alternative has a strong nexus to the DWH marine mammal injury because it consists of increasing coordination, identifying and developing new and existing partnerships, and enhancing capacity for marine mammal stranding response in Louisiana, all of which would increase marine mammal survival through better understanding of causes of illness and death as well as early detection and intervention of anthropogenic and natural threats. The proposed alternative is fully consistent with OPA objectives for compensatory restoration.

Likelihood of Success

The nationwide MMSN is a well-established program with a history of successful operation across the Gulf Coast. Thus, the Louisiana TIG expects this alternative would have a high likelihood of success. The alternative is technically feasible and uses best available science, proven techniques, and established methods.

Avoids Collateral Injury

This alternative would minimize collateral injury to other resources by evaluating environmental consequences of techniques during planning and design activities and by identifying the BMPs necessary to minimize potential collateral injury (DWH Trustees, 2016). Proposed activities would be conducted under the long standing MMSN, with successful regulatory requirements, permits, and best practices in place to avoid collateral injury to natural resources. Further, BMPs described in environmental compliance documents would be implemented to minimize impacts on species and critical habitat. Should any potential effects be identified, the implementing Trustee would ensure proper coordination and protective measures are put in place.

Benefits Multiple Resources

This alternative would benefit multiple species of marine mammals. Expected benefits would include increasing marine mammal survival through better understanding of causes of illness and death as well as early detection of and intervention for anthropogenic and natural threats.

Public Health and Safety

Adverse impacts on public health and safety are not expected from the proposed alternative. However, relevant safety measures and practices in handling and responding to marine mammal incidents would be followed during implementation. The alternative would involve data collection and analysis activities that include field monitoring by trained scientists, with no involvement of the public.

3.5.1.3. Summary

This alternative is anticipated to satisfy all the OPA evaluation factors. The OPA evaluation indicates that implementation of this alternative would advance the Trustees' overall goal of 'Replenish and Protect LCMR' (DWH Trustees, 2016).

If implemented properly, this approach would enhance marine mammal survival and would contribute to returning injured natural resources to baseline conditions. The proposed alternative has a strong nexus to the injury caused by the DWH oil spill and can reasonably be expected to provide benefits over an extended timeframe.

3.5.2. Region-wide Marine Mammal Conservation Medicine and Health Program

3.5.2.1. Project Description

Marine mammal populations in the Gulf of Mexico are at risk from natural and man-made threats, such as biotoxins, pollution runoff, and increased freshwater exposure that can cause illness and death and limit recovery. This alternative would develop and implement a region-wide marine mammal conservation medicine and health program (herein, health program) to identify risks for illness and death for these species and mitigate potential impacts. This alternative would provide support for federal and state agency coordination to identify new capabilities needed for the MMSN and its partners and would support marine mammal health researchers to identify causes of illness and death in both stranded and free-ranging marine mammals.

Specifically, this alternative would fund a working group, consisting of federal and state agency scientists and other marine mammal health researchers. This working group would identify Louisiana-specific risks for marine mammal illness and death, including possible impacts from natural causes (e.g., Brucella, toxoplasmosis, biotoxins) and man-made threats (e.g., chemical and oil spills). The group would also assess and implement future marine mammal health intervention techniques. Examples of such techniques might include, vaccination against common outbreak causing diseases (e.g., morbillivirus), development of rapid point of care tools, and development of improved real-time diagnostic instrumentation (such as remotely deployed electrocardiogram [ECG] tags to detect heart abnormalities

and/or tools and tags for remotely collecting blood for diagnostics). These new techniques would enhance the capabilities of marine mammal health researchers to rapidly diagnose causes of marine mammal illness and death and evaluate the impacts of these threats, including freshwater disease.

This alternative would establish regular training sessions and workshops for the MMSN and marine mammal health researchers in advanced health monitoring techniques and capabilities and would disseminate information about causes of illness and death and new health monitoring techniques in marine mammals with partners in Louisiana.

Lastly, this alternative would develop and implement a study plan for capture and release health assessments (e.g., via hoop-netting) of free-ranging cetaceans, including pelagic species, by establishing both case and control study sites to evaluate population-level health changes over time and the identification of possible new, emerging threats and diseases. By identifying, monitoring, and mitigating potential new natural and man-made threats to marine mammals, this alternative could identify mitigation opportunities, minimizing the number of animals that become ill or die from these threats, and increasing recovery of marine mammal species.

Implementation Methodology and Schedule

This alternative would support Louisiana's marine mammal health program for approximately five years. During year one, activities would focus on identifying risks of illness and death to focal species of marine mammals (e.g., bottlenose dolphins) by researching past stranding reports, and facilitating coordination of federal and state agency personnel, Stranding Network personnel, and researchers to evaluate the available information. This activity would provide support for facilitated workshops where participants would work towards identifying high priority risks of illness for marine mammals, with an emphasis on injured stocks in Louisiana.

Also, during year one, this alternative would support the development of a five-year study plan for conducting health assessments on a region-wide scale, including identifying an appropriate control site for capture and release of focal species. This plan would include detailed methodologies, analyses, outcomes, and integration of new technologies. Approximately two to three health assessments would be conducted each year (totaling approximately 4 weeks of health assessments per year), rotating through approximately four to five health assessment target sites and a control site. Once the priorities, target species, locations, and timings for health assessments are identified and outlined in the study plan, the field work would be conducted, and analyses would be completed in years two through five.

Field work for health assessments typically involves capture and in-water assessment. Assessments require a suite of procedures including venipuncture, ultrasound, morphometric measurements, a complete physical examination, photographic documentation, microbiologic sampling, urine and fecal samples, and blubber/skin biopsies. These activities may include chemical agents (e.g., sedatives, antibiotics), temporary in-water nets, and/or other in-water interventions. Hazing methods may be used to herd animals into areas necessary for assessment activities; these methods include acoustic and visual deterrents (e.g., fast moving vessels). All activities would follow NOAA's Capture-Release Standard Operating Protocols (NOAA, 2006). When animals are released, NMFS may mark or tag the

animal for identification/monitoring via freeze branding and/or dorsal fin tag. Areas of the beach may be closed off to prohibit public access for human and animal safety purposes throughout the duration of the health assessment.

During years one and two, the expert working group would be convened to identify and further assess, develop, test, and implement health intervention techniques. The group would evaluate current technologies and determine how to move those from testing to implementation based on priority needs and species in the Gulf of Mexico. For example, this could include (but not be limited to) refinements to short-term duration digital acoustic recording tags (i.e., DTAGs) with ECGs or remote blood sampling. Some of these technologies are further along than others. Tag attachment methods vary with tag type, species, and circumstances. Tags may be affixed to an animal in hand (e.g., during the health assessment) or deployed remotely on a free-swimming animal. Specific tags and methods of attachment would be evaluated for each situation in consultation with biologists, veterinarians, and others experienced with a particular type of tag to determine optimal attachment protocols and compliance with MMPA permit requirements. Overall, this group would work collaboratively to enhance development of tools that enable and enhance real time diagnostic capabilities. In addition, the expert working group would work towards developing new approaches to conservation medicine for cetaceans.

Lastly, during years four and five of the marine mammal health alternative, the project lead would facilitate trainings for health assessment practitioners as new technologies become viable.

Implementation of the alternative is anticipated to commence within three months of the notice to proceed, with a five-year total duration.

Monitoring Requirements

Monitoring for the Region-wide Marine Mammal Conservation Medicine and Health Program would consist of tracking the number of techniques and protocols developed by the expert working group and adopted by the MMSN partners and marine mammal researchers; measuring the number of MMSN and other appropriate personnel trained to support conservation medicine activities; and evaluating alternative outcomes against those described in the five-year study plan.

Maintenance Requirements

Maintenance activities are anticipated for infrastructure, such as the potential use of DTAGs and ECGs, as well for sample analyses. Anticipated maintenance costs are included in the project budget. Additional maintenance needs may be identified later based on project monitoring results.

Costs

The estimated cost of the alternative is $6,334,000, summarized in TABLE 3-2. These funds are for implementation, personnel support, planning and implementation of trainings, conducting health assessments, equipment, sample storage and analysis, and contingency.

TABLE 3-2. Estimated costs for Region-wide Marine Mammal Conservation Medicine and Health Program.

Activity 1	Workshops	$30,000
Activity 2	Convene working group	$150,000
	Development of techniques	$500,000
Activity 3	Project Lead	$750,000
	Trainings	$80,000
Activity 4	Write study plan	$50,000
	Conduct Health Assessments	$3,500,000
	DTAGs/ECG Tags	$400,000
	Remote tag development, deployment, and analyses	$500,000
	Analyses of dolphin samples	$250,000
Contingency		$124,000
Total project cost		$6,334,000

3.5.2.2. OPA Evaluation

Cost-Effectiveness

The estimated costs represent NOAA's best estimates and are comparable with the costs of similar alternatives.[9] However, other activities, such as the expansion of Louisiana's MMSN and Open Ocean Marine Mammal Disaster Response planning, would inform potential project techniques and, therefore, improve targeting of project activities and increase cost-effectiveness for this alternative if initiated prior to implementation. Delaying this alternative would lead to more targeted research and improved cost-effectiveness once additional information is gathered from other ongoing efforts.

Trustee Restoration Goals and Objectives

This alternative meets the Trustee programmatic restoration goal of replenishing and protecting LCMR and restoration type-specific goals as described in the Final PDARP/PEIS (DWH Trustees, 2016) to (1) implement an integrated portfolio of restoration approaches to restore injured BSE; coastal; shelf; and oceanic marine mammals across the diverse habitats and geographic ranges they occupy; (2) identify and implement restoration activities that mitigate key stressors to support resilient populations; (3) collect and use monitoring information, such as population and health assessments and spatiotemporal distribution information; (4) identify and implement actions that support ecological needs of the stocks; (5) improve resilience to natural stressors; and (6) address direct human-caused threats such as bycatch in commercial fisheries, vessel collisions, noise, industrial activities, illegal feeding and harassment, and hook-and-line fishery interactions.

[9] The budget of Alabama TIG's "Assessment of Alabama Estuarine Bottlenose Dolphin Populations and Health" alternative was $3,245,129 (Alabama TIG, 2018). The budget of the Open Ocean TIG's "Compilation of Environmental, Threats, and Animal Data for Cetacean Population Health Analyses" alternative was $5,808,500 (Open Ocean TIG, 2019).

Louisiana Trustees have determined that the DWH oil spill adversely affected Louisiana marine mammals in several ways, having contaminated marine mammal habitats, caused adverse health effects, reproductive failure, and triggered UMEs. This alternative has a strong nexus to the DWH marine mammal injury because it consists of identifying impacts from natural and/or anthropogenic diseases and threats and developing diagnostic and intervention tools that could reduce the number of animals that become ill or die from these threats, both of which would increase marine mammal survival through better understanding of causes of illness and death as well as early detection and intervention of anthropogenic and natural threats. The proposed alternative is fully consistent with OPA objectives for compensatory restoration.

Likelihood of Success

This alternative would be more successful with prior implementation of the preferred alternative (i.e., Louisiana MMSN) which would collect information that can be used to inform the methodologies, approaches, and targeted needs proposed for this conservation medicine and health alternative. Additionally, other alternatives currently being planned or implemented by other DWH TIGs would inform the approaches and methods used to develop and implement marine mammal conservation medicine and health assessments.[10] The likelihood of success of this alternative would be greater once these other alternatives are underway.

Avoids Collateral Injury

This alternative would minimize collateral injury to other resources by evaluating environmental consequences of techniques during project planning and design activities and by identifying the BMPs to minimize potential collateral injury (DWH Trustees, 2016). Proposed activities would be conducted with successful regulatory requirements, permits, and best practices in place to avoid collateral injury to natural resources. Further, BMPs described in environmental compliance documents would be implemented to minimize impacts on species and critical habitat. Should any potential impacts be identified, the implementing Trustee would ensure proper coordination and that protective measures are put in place.

Benefits Multiple Resources

This alternative would benefit multiple species of marine mammals. Expected benefits would include increasing marine mammal survival through better understanding of causes of illness and death as well as early detection and intervention for anthropogenic and natural threats.

[10] The Alabama TIG chose "Assessment of Alabama Estuarine Bottlenose Dolphin Populations and Health" as a preferred alternative in the Alabama Restoration Plan II/Environmental Assessment (Alabama TIG, 2018). The Open Ocean TIG chose "Compilation of Environmental, Threats, and Animal Data for Cetacean Population Health Analyses" as a preferred alternative in the Open Ocean Restoration Plan II/Environmental Assessment (Open Ocean TIG, 2019). The projects are currently being implemented.

Public Health and Safety

Adverse impacts on public health and safety are not expected from the proposed alternative. However, relevant safety measures and practices in handling and responding to marine mammal incidents would be followed during alternative implementation. The alternative would involve data collection and analysis activities that include field monitoring by trained scientists, with no involvement of the public.

3.5.2.3. Summary

This alternative is anticipated to satisfy most of the OPA evaluation factors. The OPA evaluation indicates that implementation of this alternative would advance the Trustees' overall goal of 'Replenish and Protect LCMR' (DWH Trustees, 2016).

If implemented properly, this approach would enhance marine mammal survival and would contribute to returning injured natural resources to baseline conditions. The proposed alternative has a strong nexus to the marine mammal injury caused by the DWH oil spill and can reasonably be expected to provide benefits over an extended timeframe. However, other projects, including significant enhancements to the Louisiana Marine Mammal Stranding Network, are being planned or are underway through other DWH TIGs and results from those activities are expected to increase the cost-effectiveness and likelihood of success of this alternative in the future.

3.5.3. Natural Recovery Alternative

Pursuant to the OPA regulations, the Final PDARP/PEIS considered a "natural recovery alternative in which no human intervention would be taken to directly restore injured natural resources and services to baseline" (15 CFR §990.53[b][2]; DWH Trustees, 2016). Under a natural recovery alternative, the Trustees would not implement any restoration to accelerate the recovery of oysters in the Louisiana restoration area. This could produce one of four outcomes for injured resources: (1) gradual recovery, (2) partial recovery, (3) no recovery, or (4) further deterioration. Although injured resources could presumably recover to baseline or near baseline conditions, recovery would take much longer under the natural recovery alternative compared to a scenario in which restoration actions were undertaken. However, since technically feasible restoration approaches are available, the Trustees rejected this alternative from further OPA evaluation for the marine mammal restoration type.

3.5.4. Marine Mammal Restoration Type OPA Conclusions

The Louisiana TIG completed the OPA evaluation of the reasonable range of alternatives. One preferred marine mammal alternative, Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts, is anticipated to satisfy all the OPA evaluation factors. The Region-wide Marine Mammal Conservation Medicine and Health Program alternative is not preferred for implementation at this time due to the likelihood of improving success and cost effectiveness once other projects currently being planned or implemented by other DWH TIGs have begun to refine relevant methodologies.

3.6. OPA Evaluation for the Oyster Restoration Type

The Louisiana TIG's screening process resulted in the identification of a reasonable range of alternatives, including four oyster alternatives.[11] A description of each alternative is provided below followed by the OPA evaluation of the alternative.

3.6.1. Enhancing Oyster Recovery Using Brood Reefs

3.6.1.1. Project Description

The objective of the brood reef oyster restoration alternative is to construct a network of spawning stock oyster reefs to increase spawning oyster populations and offset impacts resulting from exposure to DWH oil, dispersant, and response activities.

Reef material, when placed in oyster spawning areas, provides a substrate on which free floating oyster larvae can attach and grow. Brood reefs are composed of both cultch material (e.g., limestone rock, oyster shell, or fossilized oyster shell) that is clean and free of contaminants, and non-harvestable vertical artificial reef material (e.g., boulders), which provide substrate to support dense populations of oysters (FIGURE 3-1). Areas suitable for brood reef restoration typically have good spat production and appropriate bottom composition (i.e., hard substrate) to allow for reef expansion but are limited in vertical relief. The goal of this alternative is to develop a network of brood reefs that would serve as spawning stock to improve and maintain oyster production on Louisiana's Public Oyster Seed Grounds (POSG) and Public Oyster Seed Reservations (POSR). Brood reefs would be closed to harvest for as long as they remain functioning spawning stock reserves.

The proposed alternative entails constructing multiple brood reefs east of the Mississippi River, including four in the Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux area, and would programmatically plan for inclusion of up to 20 additional brood reefs in Chandeleur Sound (FIGURE 3-2) and also within the footprints of other POSG or POSR in the future (FIGURE 3-3). For efficiency, Section 4.5 provides a programmatic NEPA evaluation for several broader potential project areas. At the time that specific additional brood reef locations are identified, the Louisiana TIG would confirm the OPA and NEPA evaluations are consistent with those in this document and will be made available to the public. Thus, the programmatic OPA and NEPA site evaluations conducted now would support efficient implementation in the future.

One planned component of the brood reef alternative would establish four reefs: two in the Lake Machais/Mozambique Point area and two in the Petit Pass/Bay Boudreaux area (FIGURE 3-2). Reef locations for this alternative were selected based on trends in salinity, observed population response from previous mortality events, proximity to living shoreline projects, and available larval transport models (e.g., ADCIRC; Murray et al., 2015). In addition, these areas have been historically productive for

[11] The oyster restoration type addressed in this subsection is a type of restoration designed to address specific injuries to oysters and support the overall goal from the Final PDARP/PEIS of "Replenish and Protect LCMR" (DWH Trustees, 2016).

oysters. Relic reefs at and surrounding each site, indicate that conditions at these locations have been suitable for oyster reefs previously. These areas provide optimum hydrologic conditions, except for extreme events, but recruitment has been low. Enhancing the existing oyster resources with structurally complex brood reefs would provide resiliency and benefit the local systems by providing a source of larvae for surrounding areas.

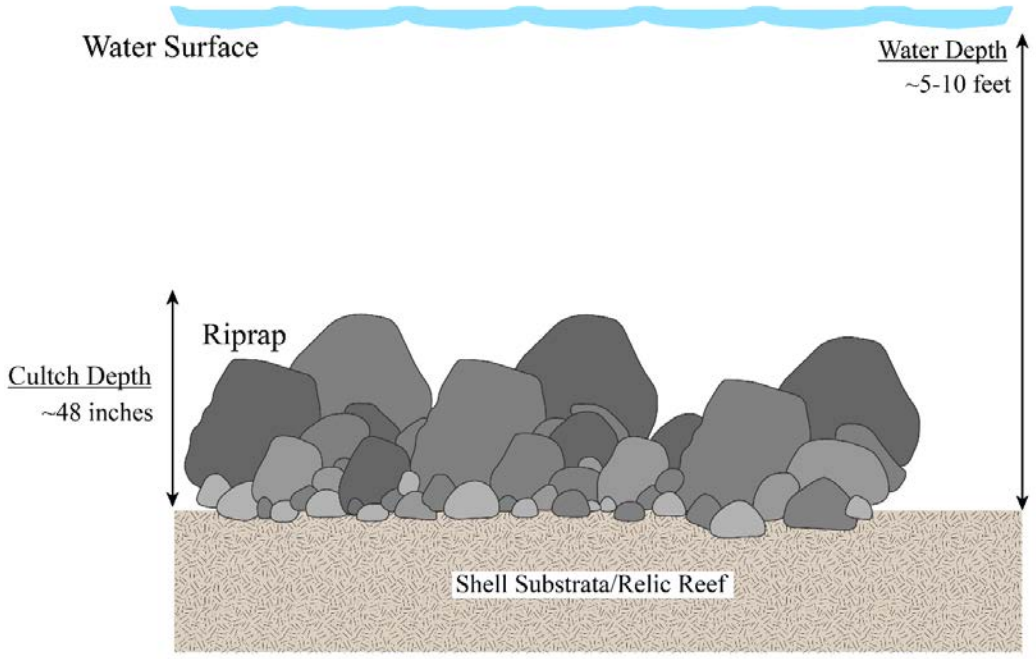

FIGURE 3-1. Conceptual diagram of brood reef with cultch material and un-harvestable vertical artificial reef material composed of riprap (adapted from: LDWF; Karako Bay Oyster Broodstock Reef – Riprap Cultch Material Deposition Final Plan-View Drawing).

In addition to the planned component described above, this alternative would include a programmatic component. Potential sites for additional brood reefs would be located in Chandeleur Sound and on any other state managed POSG or POSR in Louisiana.

The programmatic brood reef component would include constructing up to 20 reefs in Chandeleur Sound (FIGURE 3-2). The 2009 closure of the Mississippi River Gulf Outlet (MRGO) shipping channel has improved surface water salinities in Biloxi Marsh and Chandeleur Sound, which is beneficial for oyster propagation. In the last decade, large investments of cultch have been made in this region, and landings from many private leases have been high; however, stocks on the POSG remain at record lows, possibly due to seasonal hypoxia at relic reefs. As part of the broader programmatic approach, surveys and ground-truthing would be conducted in Chandeleur Sound and at other potential sites on POSG and POSR to identify sediment types, monitor dissolved oxygen levels, and assess availability of larvae in order to confirm suitability for brood reef construction at specific sites.

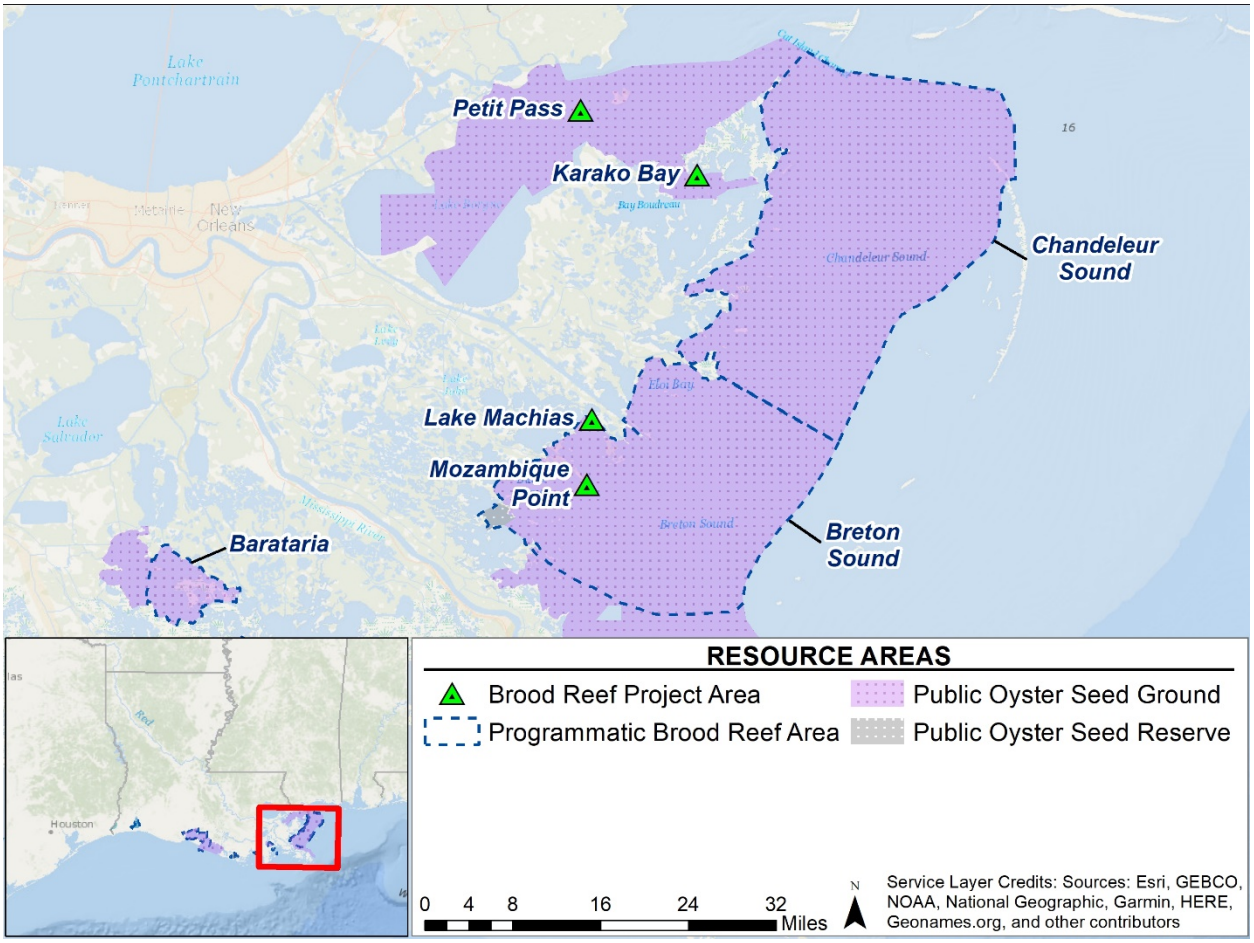

FIGURE 3-2. Brood reef areas.

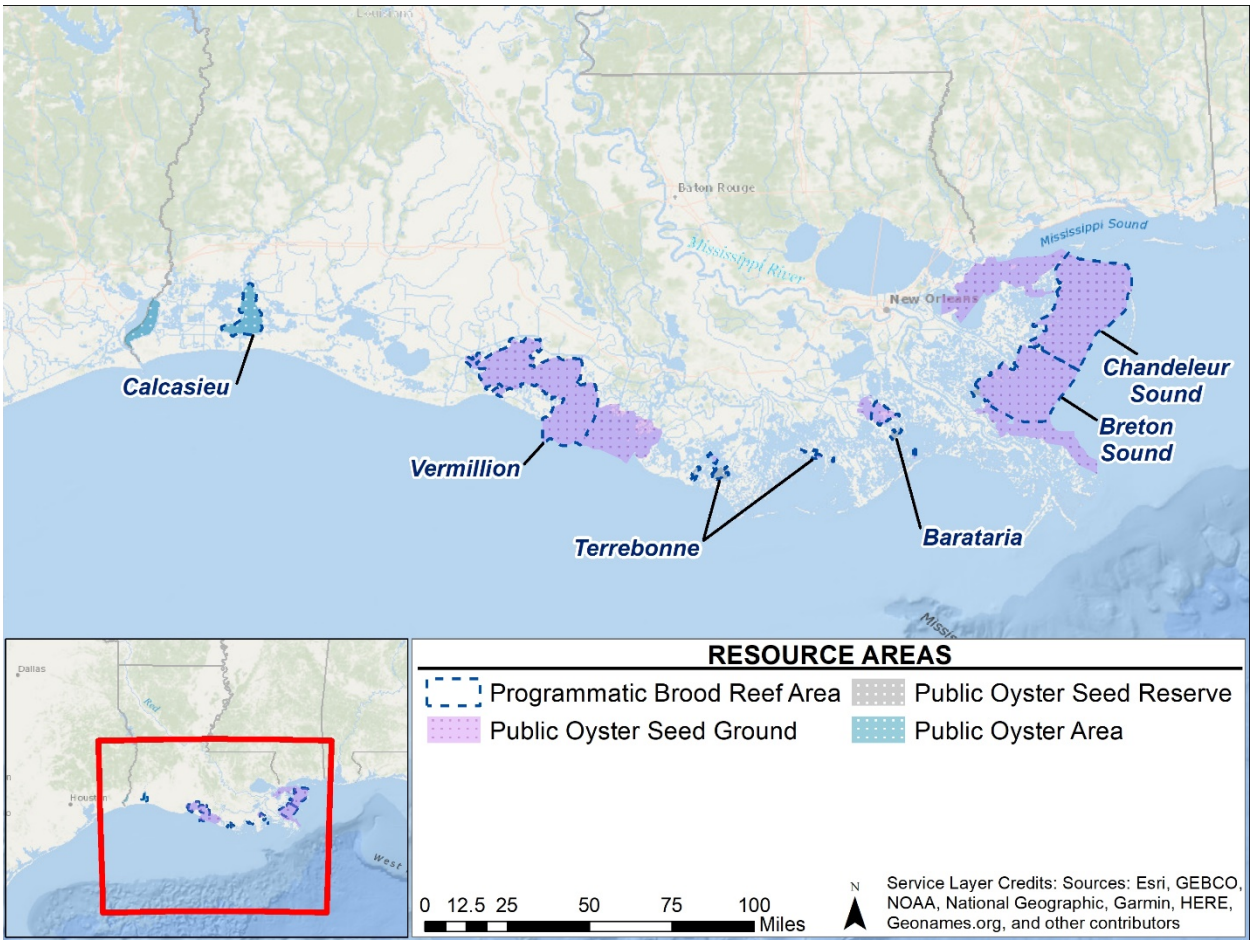

FIGURE 3-3. Programmatic brood reef areas.

Given the past success of oyster reef restoration[12] in the proposed areas it is likely the proposed spawning stock reefs would be similarly successful; however, rates of oyster production vary over time and by location. Potential short-term benefits for the brood reef alternative includes creating new substrate on which oysters can settle and grow. Potential long-term benefits include increasing oyster production and improving ecosystem services that result from high oyster abundance, including potential reduction of shoreline erosion, improved water quality, and recycling of nutrients. Brood reef projects may also improve oyster population connectivity, resilience, and stability.

The brood reef restoration approach incorporates multiple oyster restoration approaches identified in the Strategic Framework for Oyster Restoration Activities (DWH Trustees, 2017b), including increasing oyster abundance and improving oyster population connectivity, resilience, and stability in Louisiana. Potential projects that would interact with the proposed spawning stock reefs include the 2018 Grand Banks cultch plant and the 2017 Lake Fortuna cultch plant, which would benefit from the increased reproductive potential provided by adjacent spawning stock reefs. In addition to the currently planned sites described, additional brood reefs can be added to expand existing reef sites that are closed to harvest and within the footprints of POSG and POSR (FIGURE 3-3) in the future to improve coverage and connectivity of the spawning stock reef network in Louisiana. Depending on site location, the programmatic brood reefs could also increase recruitment potential to nearshore areas, which would support oyster propagation in nearshore, fringing oyster reef, which is another oyster restoration goal in the Final PDARP/PEIS (DWH Trustees, 2016).

Construction Methodology and Schedule

Each of the four planned reefs in the Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux areas would be up to 10 acres in size, closed to oyster harvest for as long as they remain functioning spawning stock reserves, and constructed out of large, un-harvestable materials. Riprap cultch material, which is clean and free of contaminants, would be deposited by barge and excavator at a height of approximately 1.2 meters above the bottom to promote survival through bottom hypoxia. The size of the cultch material would reduce illegal harvest attempts, and LDWF would enforce the non-harvest designation. Brood reefs would generally be constructed upstream in the estuary to allow for transport of oyster larvae downstream to existing oyster reefs.

The programmatic brood reefs proposed in Chandeleur Sound would be approximately one-half acre in size and would be composed of cultch on the bottom and vertical reef material on the perimeter. The brood reefs would be constructed within the POSG on relic reef or existing shell substrate, where environmental conditions are suitable, and would be closed to harvest for as long as they remain functioning spawning stock reserves. The vertical reefs would be 0.5 to 1.2 meters in height to promote oyster survival by reducing bottom hypoxia. In addition, the proposed size of the cultch material would

[12] The Biloxi Marsh area features several living shorelines created by agencies such as CPRA (Living Shoreline Demonstration project, 2016), the Coalition to Restore Coastal Louisiana, and Nature Conservancy (Coalition to Restore Coastal Louisiana, 2019). CPRA is currently implementing the Biloxi Marsh Living Shoreline project, funded by the RESTORE Act, which proposes to create nine to 11 miles of living shoreline along Eloi Bay (CPRA, 2018).

reduce illegal harvest attempts, and LDWF would enforce the non-harvest designation. Reefs would be aligned in multiple directions to account for seasonal and annual variation in salinity. Brood reef designs would vary by site location based on local conditions (e.g., proximity to marsh edge). Brood reefs would be spaced sufficiently to allow for movement of aquatic species. Reefs would also be constructed near commercial private oyster leases to promote connectivity with existing oyster reefs.

Potential sites for the Chandeleur Sound brood reefs and other additional programmatic brood reef locations on state managed POSG or POSR would be identified using several information sources to identify sites with optimal conditions. The Lake Pontchartrain Basin Foundation (LPBF) Hydrocoast maps of isohaline lines (FIGURE 3-4; Connor et al., 2019), the Coastwide Reference Monitoring System (CRMS) and U.S. Geological Survey (USGS) hydrologic sampling station data, and LDWF discrete hydrological measurements collected during fisheries independent sampling would all be used to map the isohaline lines and identify optimal site locations within the potential programmatic areas. Available larval models (e.g., ADCIRC; Murray et al., 2015) would be referenced during additional site selections, where coverage allows, as further evidence to the suitability of proposed sites. Additional data acquisition (i.e., bottom surveys) may be conducted using funding for the alternative to identify potential locations for additional brood reef areas. The programmatic brood reefs would be constructed within POSG or POSR on relic reef or existing shell substrate, where environmental conditions are suitable, and would be closed to harvest for as long as they remain functioning spawning stock reserves. In all cases, site selection would be coordinated with the Louisiana TIG, and compliance with the programmatic action of this RP/EA would be affirmed ahead of final site selection and implementation. The size of the cultch material at programmatic sites would reduce illegal harvest attempts, and LDWF would enforce non-harvest designations.

For each of the planned brood reefs, implementation is anticipated to commence within three months of the notice to proceed. Construction is anticipated to be completed in approximately two years, with monitoring extending at least four years post-construction. The construction schedule for programmatic brood reefs are to be determined.

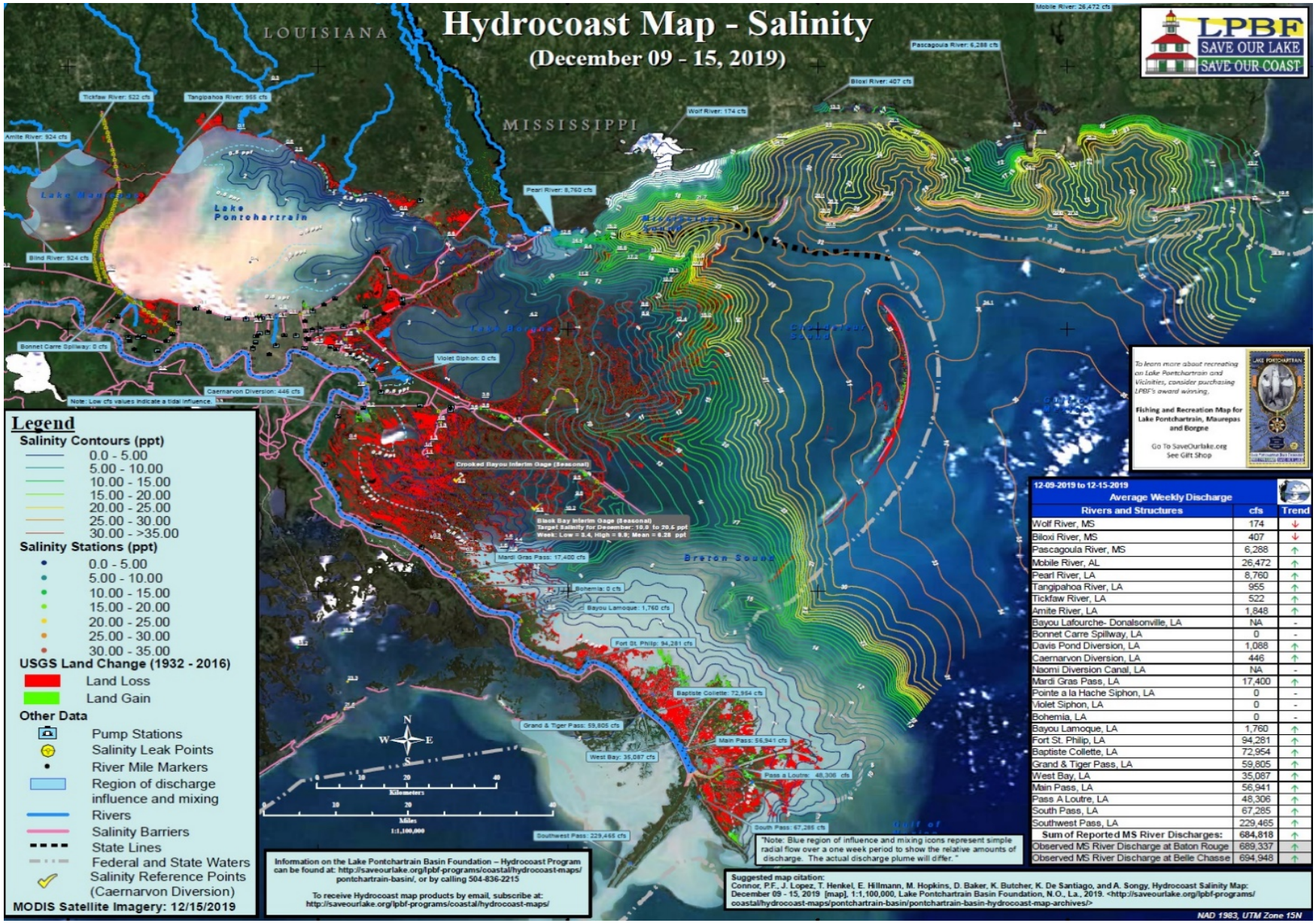

FIGURE 3-4. Example LPBF Hydrocoast map with isohaline lines used to identify programmatic brood reef locations (Connor et al., 2019).

Monitoring Requirements

Monitoring of each brood reef would consist of a survey of the reef's spatial extent, annual quadrat sampling in summer, and annual recruitment sampling. Monitoring would be conducted annually for four years post construction. See Table 3 in the MAM plan in Appendix D for additional information on monitoring objectives and performance criteria.

The survey of the reef's spatial extent would include pre- and post-reef construction measurements of subtidal extent and reef height to evaluate both acreage and vertical relief, to ensure that the desired artificial reef dimensions are achieved and maintained. Quadrat sampling would entail collecting all live and recently dead oysters within each sample for enumeration and analysis, before being returned to the water. Quadrat sampling data would be used to calculate oyster density, mortality, and size distribution to ensure that the desired oyster demography is achieved. Crew members would also record observations of reef condition and the surrounding environment by conducting readings of dissolved oxygen, salinity, water temperature, and turbidity levels. To assess oyster recruitment, settlement tiles would be placed prior to anticipated spawning and maintained annually. Tiles would be sampled every three to four weeks. Data from the settlement tiles would inform an understanding of regional spawning stock productivity and the potential to achieve connectivity of regional oyster reefs.

Maintenance Requirements

Short- and long-term maintenance activities are not anticipated but may be identified later based on monitoring results. Maintenance may be required following severe weather events, and if the brood reefs were disturbed, they would need to be repaired.

Costs

The total cost of the alternative is $9,701,447 (TABLE 3-3). These funds are for permitting, construction, oversight, supervision, monitoring, supplies, reporting, and other associated project costs. The estimated project cost for the Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux area reefs is $1,295,000. As part of the programmatic approach, up to $8,406,447 would be used to collect data needed to optimize programmatic site selection (e.g., to conduct bottom surveys on areas of interest with side-scan/multi-beam sonar), project management and oversight, and for constructing programmatic reefs in Chandeleur Sound and additional locations selected in POSG and POSR. Contingency for any necessary monitoring and repairs following storms would be covered by the alternative's programmatic budget.

TABLE 3-3. Estimated costs for Enhancing Oyster Recovery Using Brood Reefs.

Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux area	Individual reef construction cost	$300,000
	Reef construction subtotal	$1,200,000
	Project management/monitoring	$95,000
	Project subtotal	*$1,295,000*
Chandeleur Sound and Programmatic components	Additional brood reefs/data acquisition for site selection	$8,406,447
Total cost		$9,701,447

3.6.1.2. OPA Evaluation

Cost-Effectiveness

The cost for the brood reef alternative represents LDWF's best estimates and is comparable with the costs of similar brood reef projects in Louisiana.[13] The Louisiana TIG found the cost to implement this alternative to be reasonable, appropriate, and comparable to other equivalent restoration alternatives. Furthermore, the cost effectiveness of this alternative is likely to increase over time as opportunities for improved efficiency are identified based on monitoring data.

Trustee Restoration Goals and Objectives

This alternative meets the Trustee programmatic restoration goal of replenishing and protecting LCMR and restoration type-specific goals as described in the Final PDARP/PEIS (DWH Trustees, 2016) to (1) restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs; (2) restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time; and (3) restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities.

The Louisiana Trustees have determined that the DWH oil, dispersant and response activities have significantly impacted the state's nearshore and subtidal oysters. This alternative has a strong nexus to the DWH nearshore marine ecosystem injury, and the oyster recruitment injury in particular, because it would create oyster reefs through placement of brood reef material in nearshore and subtidal areas. The alternative would enhance oyster reef productivity through spawning stock enhancement and would support the development of a network of oyster reef spawning reserves, all of which would help restore oyster abundance and associated ecosystem services and promote resiliency for oyster populations across the northern Gulf of Mexico. The proposed alternative is fully consistent with OPA objectives for compensatory restoration.

Likelihood of Success

The Louisiana TIG expects this alternative would have a high likelihood of success. The alternative is technically feasible and uses best available science, proven techniques, and established methods. For example, the DWH Trustees have successfully implemented brood reef oyster projects in similar environments.[14] The Louisiana Artificial Reef Program has successfully implemented several low-profile inshore oyster reefs in Louisiana waters using shell and limestone materials (LDWF, 2018).

[13] The budget of CPRA's Living Shoreline Demonstration Project was $9,033,570 (Cycle Construction, 2020).

[14] The Alabama TIG selected "Oyster Grow-Out and Restoration Reef Placement" as a preferred alternative in the Alabama RP II/EA (Alabama TIG, 2018). The project is currently being implemented. The Mississippi TIG chose "Artificial Reef Habitat Project" as a preferred alternative in Early Restoration Phase 1 (Mississippi TIG, 2018). The project was completed between 2013 and 2015.

Oysters, because of their sessile nature, are susceptible to hypoxic conditions, making hypoxia one of the largest uncertainties for success of this alternative. However, the brood reefs as designed would be between 0.5 to 1.2 meters in height, which would promote oyster survival despite potential episodic bottom hypoxia. The brood reefs would be closed to harvest for as long as they remain functioning spawning stock reserves, increasing the likelihood of continued oyster recruitment and survival.

Avoids Collateral Injury

This alternative would minimize collateral injury to other resources by evaluating environmental consequences of techniques during planning and design activities and by identifying the BMPs to minimize potential collateral injury (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Unintended impacts on benthic invertebrates could occur; however, any potential impacts are expected to be short term and result in temporary displacement or loss. Measures to avoid such impacts would be part of design development and implementation. Should any potential impacts be identified, the implementing Trustee would ensure proper coordination and protective measures are put in place. Environmental consequences are discussed further in Section 4 of this RP/EA.

Benefits Multiple Resources

Over the long term, this alternative has the broad potential to benefit the health of Louisiana's coastal and estuarine ecosystems. Oysters are an ecological keystone species, and successful restoration of oyster reefs would provide habitat and food sources for a diversity of marine organisms over time. Mussels, barnacles, sea anemones, and other animals settle on oyster reefs and create abundant food sources for fish species. Oyster reefs provide habitat to forage fish, invertebrates, and other shellfish, as well as nursery grounds for commercially valuable species such as crab, flounder, herring, and striped bass (NOAA, 2019b) and recreationally important species such as red drum and spotted seatrout (LDWF, 2019). Oyster reefs also have the potential to reduce shoreline erosion and improve water quality, which directly benefit other coastal and estuarine species.

Public Health and Safety

Adverse impacts on public health and safety are not expected from the proposed alternative. However, relevant safety measures and practices would be followed during implementation. Any potential impacts on public safety (e.g., recreational boating) would be fully mitigated during implementation through construction workers' observance of appropriate safety practices such as construction BMPs and informational signage (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

3.6.1.3. Summary

This alternative is anticipated to satisfy all the OPA evaluation factors. The OPA evaluation indicates that implementation of this alternative would advance the Trustees' overall goal of 'Replenish and Protect LCMR' (DWH Trustees, 2016). If implemented properly, this alternative would enhance ecosystem services provided by restored oyster habitats and resources and would contribute to returning injured natural resources and services to baseline conditions. The proposed alternative has a strong nexus to

the injury caused by the DWH oil spill and can reasonably be expected to provide benefits over an extended timeframe.

3.6.2. Cultch Plant Oyster Restoration

3.6.2.1. Project Description

The objective of the cultch plant alternative is to create oyster reefs through the placement of cultch, thereby increasing oyster abundance and spawning stocks and offsetting impacts resulting from exposure to DWH oil, dispersant, and response activities. Constructing cultch plants entails placing cultch material (e.g., limestone rock, oyster shell, or fossilized oyster shell) that is clean and free of contaminants. When placed in suitable oyster habitat, cultch provides a substrate for free floating oyster larvae to attach and grow, which in time results in a mature productive oyster reef.

This alternative would entail placing cultch at several Louisiana locations with relic reefs. Targeted sites include one on POSG in the Grand Banks area of Mississippi Sound (FIGURE 3-5), one on the Caillou Lake (also known locally as Sister Lake) POSR in Terrebonne Parish (FIGURE 3-6), and would programmatically plan for inclusion of additional cultch plants within the Biloxi Marsh Complex in St. Bernard Parish (FIGURE 3-7) and also within the footprints of other POSG or POSR in the future (FIGURE 3-8). Where opportunities exist, cultch material would be placed as close to the shoreline as possible to promote restoration of shallow water fringing oyster reefs.

All sites currently proposed for cultch plant construction exhibit suitable hydrology for oyster production and experience regular spatfall; however, current oyster recruitment appears to be primarily limited by the availability of suitable substrate at sufficient height or density. Therefore, cultch planting has been identified as the highest priority oyster restoration activity for these areas.

Potential long-term benefits from increasing available cultch material include increased oyster production as well as oyster population connectivity, resilience, and stability. Healthy, interconnected oyster populations form reefs that provide the hard substrate needed for oyster larvae to settle, grow, and sustain the population. In addition to providing habitat for oysters, these reefs serve as habitat for a variety of marine organisms, from small invertebrates to large recreationally and commercially important species. Oyster reefs provide structural integrity, improve water quality, and depending on proximity to the shoreline, potentially reduce coastal erosion (DWH Trustees, 2017b). The proposed cultch plants may also potentially provide benefit to and derive benefit from other oyster restoration projects in the region. For example, spawning stock reefs in the Petit Pass area may provide a source of oyster larvae for the Grand Banks cultch plant.

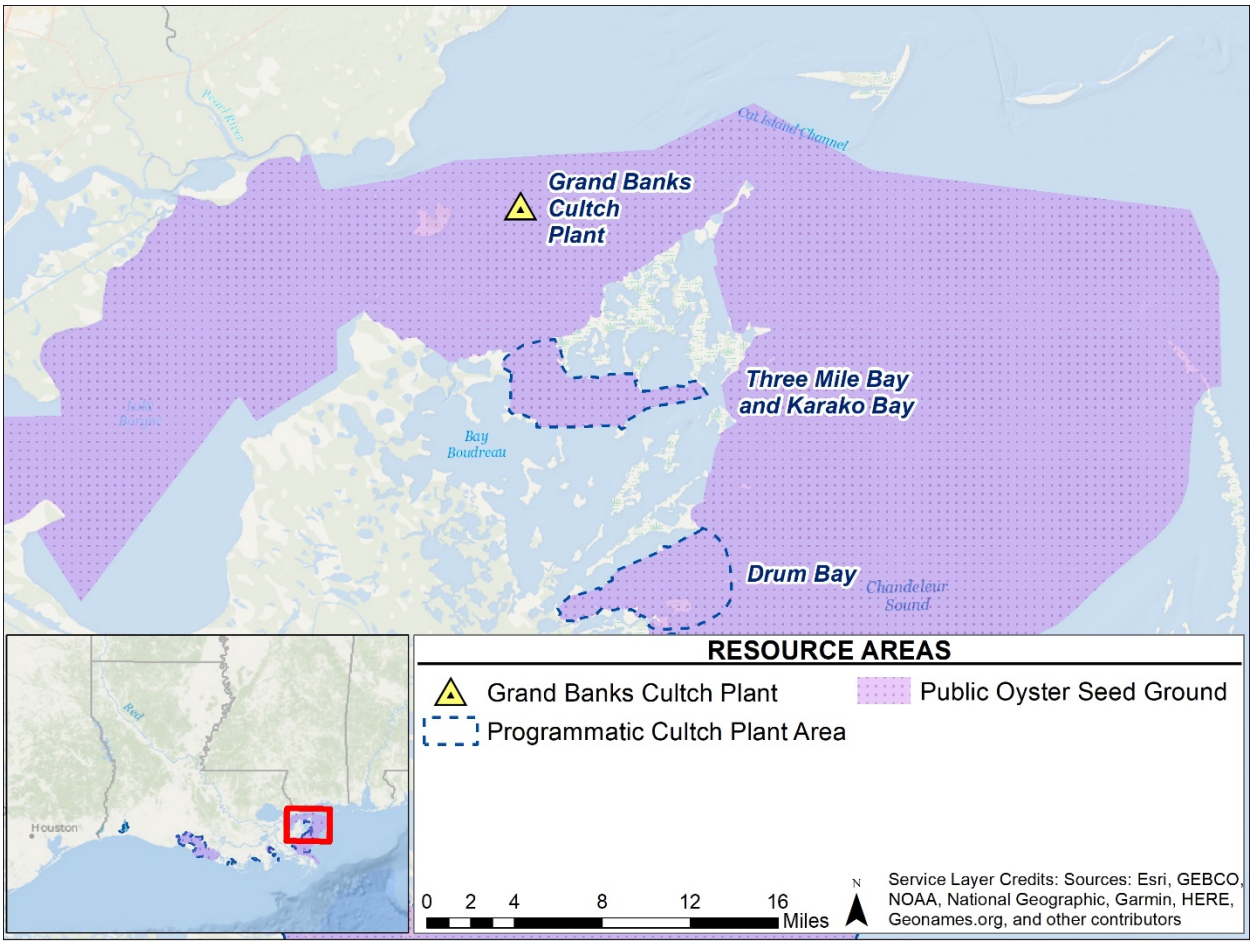

FIGURE 3-5. Grand Banks cultch plant area.

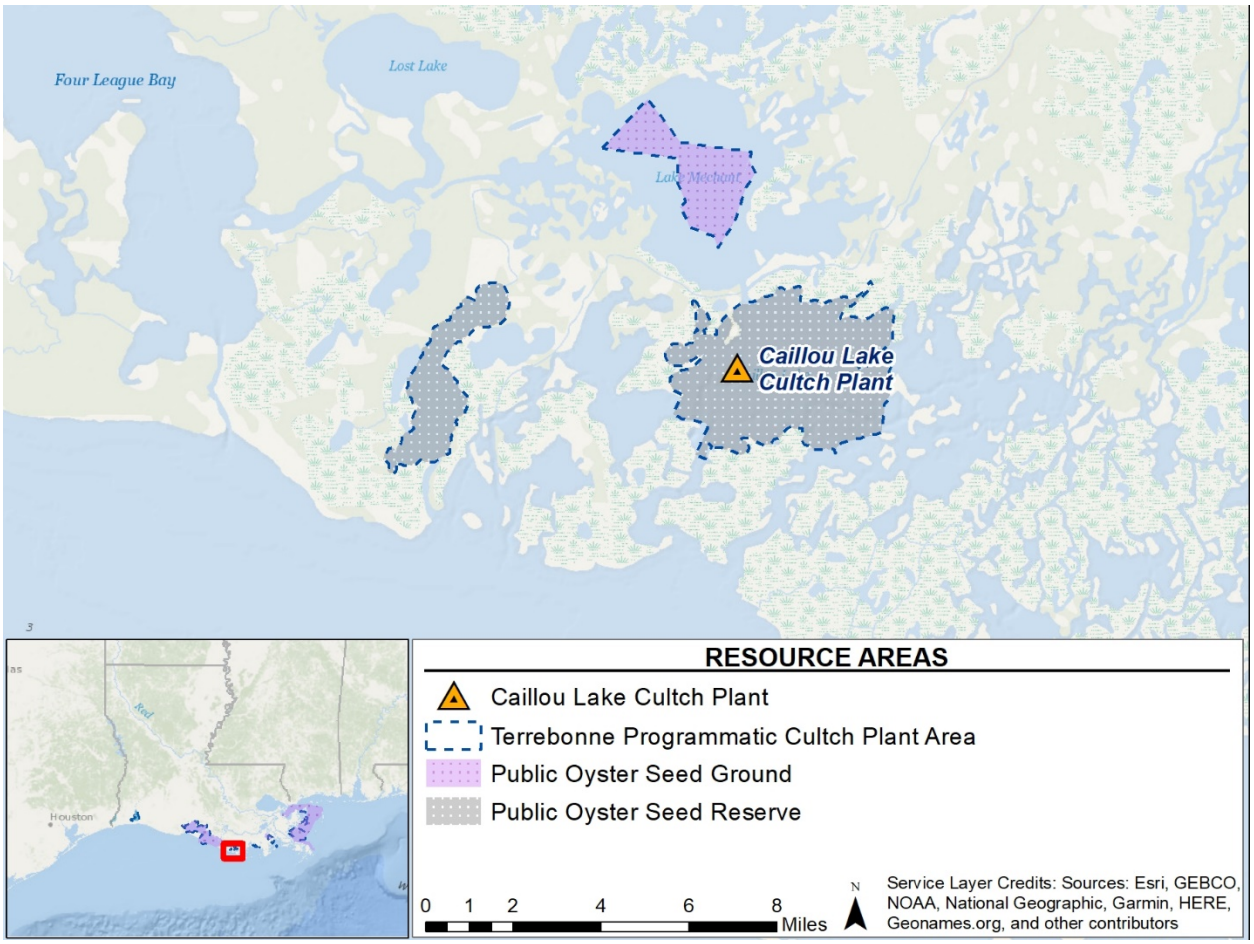

FIGURE 3-6. Caillou Lake cultch plant area.

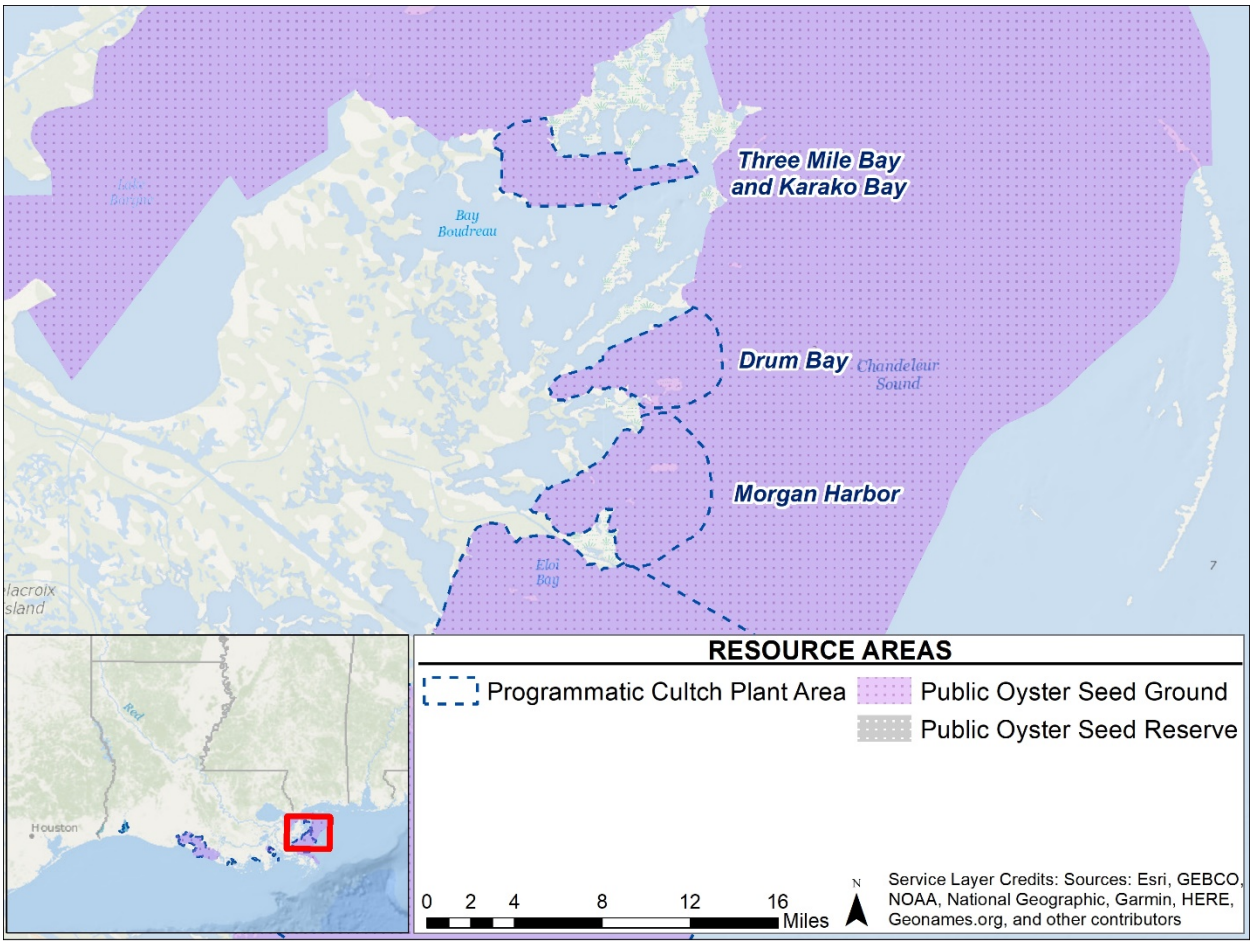

FIGURE 3-7. Biloxi Marsh programmatic cultch plant areas.

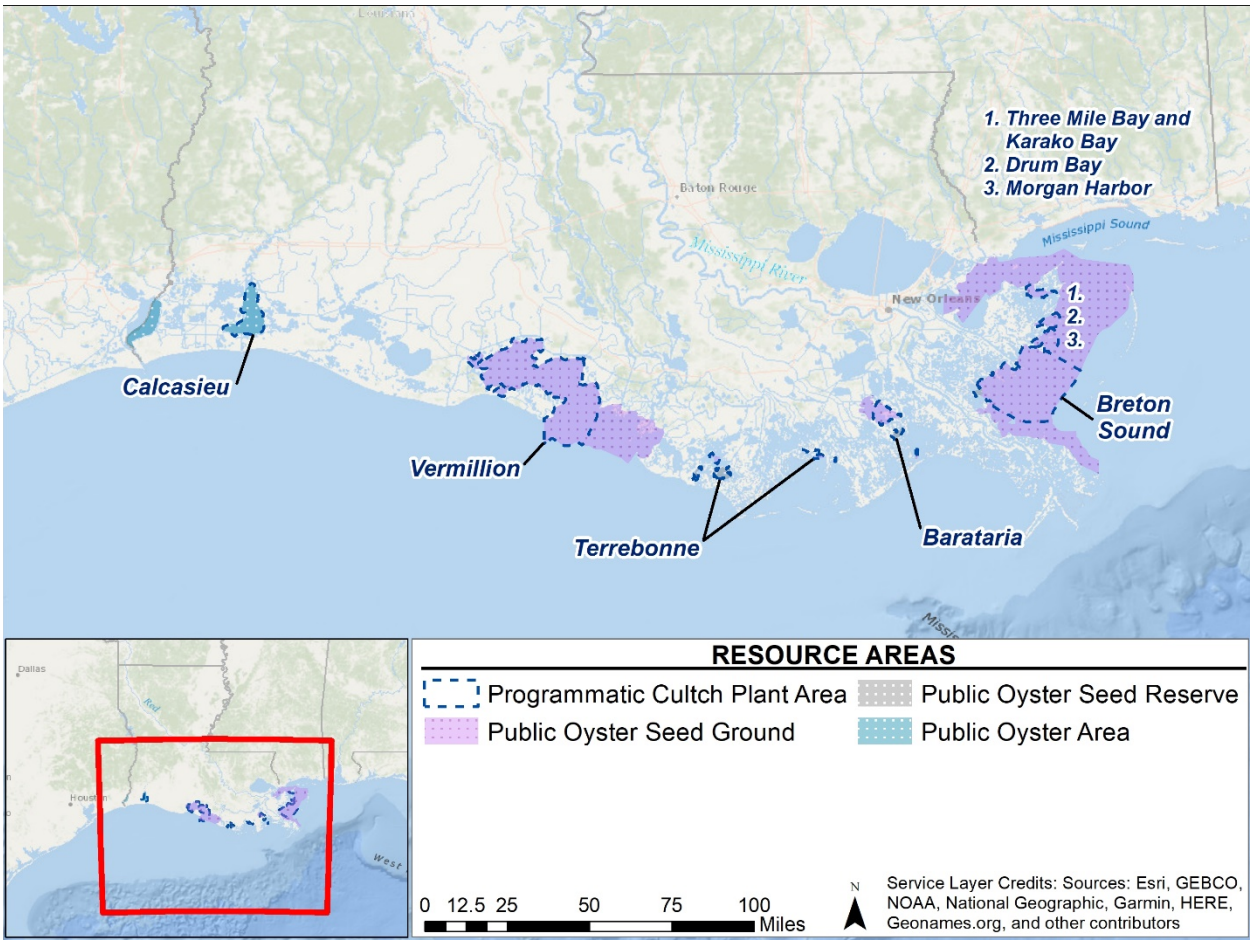

FIGURE 3-8. Programmatic cultch plant areas.

The approach and methods proposed for the cultch plant alternative are well established and closely align with recently implemented, successful projects such as the Louisiana Oyster Cultch Phase I project. Many other cultch plants in Louisiana have demonstrated success. Since 1917, LDWF has placed over 1.5 million cubic yards of cultch material on nearly 30,000 acres with positive results, with 20 seed oysters per square meter typically observed as early as 17 months after cultch placement. The 2012 Caillou Lake cultch plant continues to be one of the most productive in Louisiana, containing 48 percent of the available oyster resources west of the Mississippi. Estimated oyster stock on the Caillou Lake POSR increased 347 percent between 2016 and 2017 when the area was closed for harvest (LDWF, 2017). The Grand Banks and Biloxi Marsh areas are located in Coastal Study Area (CSA) 1 North, which is east of the Mississippi River and north of the MRGO; oyster stock decreased in this area by 76.5 percent between 2016 and 2017. However, cultch plants in this area, including the 2013 Drum Bay plant and Three Mile Pass plant, contribute the majority of production within CSA 1 North. In 2017, the highest density estimates of seed stock and market-size oysters were found at the Drum Bay cultch plant (9.6 per square meter) and Three Mile Pass cultch plant (2.2 per square meter), respectively (LDWF, 2017). Rates of oyster production vary over time and location.

The cultch plant restoration approach incorporates multiple oyster restoration approaches identified in the Strategic Framework for Oyster Restoration Activities (DWH Trustees, 2017b), including increasing oyster abundance and improving oyster population connectivity, resilience, and stability in Louisiana. In addition, the Louisiana TIG anticipates that additional cultch plant restoration projects may be constructed at additional sites on POSG and POSR within Louisiana in the future.

For efficiency, Section 4.5 provides a programmatic NEPA evaluation for several broader potential project areas. At the time that specific additional cultch plant locations are identified, the Louisiana TIG would confirm the OPA and NEPA evaluations are consistent with those in this document and will be made available to the public. Thus, the programmatic OPA and NEPA site evaluations conducted now would support efficient implementation in the future (FIGURE 3-8).

Construction Methodology and Schedule

The planned component of the cultch plant alternative would construct two cultch plants, one on the POSG in the Grand Banks area of Mississippi Sound (FIGURE 3-5), and another on the POSR in Caillou Lake (FIGURE 3-6). Mississippi Sound and Biloxi Marsh are home to the most productive and extensive public oyster areas (POA) in the state that are open to harvest. Caillou Lake is also one of the most productive oyster seed grounds in Louisiana. Oyster reproduction in these areas was most severely affected by the DWH spill (DWH Trustees, 2017b). Natural growth of existing habitat occurs at a very slow rate in these systems (i.e., centimeters per year), and the recovery of oyster habitat due to losses from the DWH spill is not expected to occur without restoration actions. Therefore, LDWF proposes to contract for the placement of cultch material onto POSG in the Grand Banks reef area of Mississippi Sound and the POSR in Caillou Lake. LDWF intends to place cultch material on approximately 200 acres at both sites (i.e., 400 acres), with cultch materials placed at a planting density up to 200 tons per acre, resulting in a depth of two to ten centimeters of substrate. Clean limestone would be acquired (the source to be determined following contract bidding) and used as cultch material. Because the cultch

plants proposed for construction are large, the most cost-efficient method to deploy the cultch materials would be from an oyster barge with a high-pressure water spray. Measures would be implemented to reduce sediment disturbance and water turbidity during use of a high-pressure water spray. The cultch plants would be closed to harvest until oyster demography performance criteria are met. See the Table 3 in the MAM plan in Appendix D for additional information on performance criteria and harvest opportunities.

In addition to the planned components described above, this alternative would include a programmatic component. Potential sites for additional oyster cultch plants would be located in the Biloxi Marsh Complex and on any other state managed POSG or POSR in Louisiana.

Potential programmatic sites in the Biloxi Marsh Complex would build upon Phase I of the Louisiana Oyster Cultch Project, which was selected as an early restoration alternative by the Louisiana TIG in 2012 (Louisiana Natural Resource Trustees, 2015). An additional 800 to 1600 acres of cultch would be placed on POSG in the Biloxi Marsh Complex (FIGURE 3-7) in order to support productive oyster reefs. Up to 400 acres of clean limestone cultch material would be constructed at each of four historic reefs on POSG within Drum Bay, Three Mile Bay, Karako Bay, and Morgan Harbor. Limestone that is clean and free of contaminants would be placed at a planting density not to exceed 200 tons per acre.

Additional programmatic locations would be identified using several information sources to determine optimal site conditions. The LPBF Hydrocoast maps of isohaline lines (FIGURE 3-8; Connor et al., 2019), the CRMS and USGS hydrologic sampling station data, available larval transport models (e.g., ADCIRC; Murray et al., 2015), and LDWF discrete hydrological measurements collected during fisheries independent sampling would all be used to map the isohaline lines and identify optimal site locations within these potential programmatic areas. Additional data acquisition (i.e., bottom surveys) may be conducted using funding for the alternative to site additional cultch plant areas. In all cases, site selection would be coordinated with the Louisiana TIG, and compliance with the programmatic action of this RP/EA would be affirmed ahead of final site selection and implementation.

All cultch plants constructed would be closed to harvest until the oyster demography performance criteria are met. See Table 3 in the MAM plan in Appendix D for additional information on performance criteria and harvest opportunities. If performance criteria have not been met after four years, the TIG would consider opening the cultch plants to harvest.

For each of the planned oyster cultch projects, implementation is anticipated to commence within three months of the notice to proceed. Construction is anticipated to be completed in approximately two years, with monitoring extending at least four years post-construction. The construction schedule for programmatic components are to be determined.

Monitoring Requirements

Monitoring of each cultch plant would consist of surveys of the cultch plant's spatial extent and quarterly biological sampling, with quadrats in summer, and dredges in the winter, spring, and fall. Monitoring would be conducted annually for four years post-construction.

The survey of each cultch plant's spatial extent would include pre- and post-construction measurements of subtidal extent and cultch plant height to evaluate both acreage and vertical relief, to ensure that the desired cultch plant dimensions are achieved and maintained. During quadrat sampling, divers would collect oysters, surficial shell/cultch, and associated organisms from the quadrat area for enumeration and analysis. Field crews count and measure all live and recently dead oysters within each sample before returning them to the water. Quadrat sampling would be used to calculate oyster density, mortality, and size distribution to evaluate whether the desired oyster demography is achieved. Crew members also record observations of cultch condition and the surrounding environment, and measure dissolved oxygen, salinity, water temperature, and turbidity levels. Dredge samples would be evaluated to provide information on oyster recruitment, mortality, growth, and the presence or absence of reef-associated animals.

The cultch plants would initially be closed to harvest for a minimum of two years. After year two, if performance criteria are met, the implementing Trustee would consider whether potential corrective actions are necessary or if the cultch plant may be open to harvest. To ensure goals outlined in the Final PDARP/PEIS are met, management of harvest on cultch plants would include use of a shell budget model (Soniat et al., 2014) and restriction of bedding loads to 15 percent or less for cultch material. The shell budget model uses no-net-shell-loss as a sustainability reference point to determine sustainable harvest of oysters. Sustainable harvest is the volume of live oysters that can be removed without diminishing reef shell mass. The model has practical application in identifying areas for closure to oyster fishing, determining total allowable catch, and managing shell planting on oyster reefs. Performance criteria includes bimodal population size distribution and average second-generation oyster density at or above 20 seed oysters per square meter. If, however, performance criteria are still not met by year four, the Trustees may consider opening the cultch plant to harvest. As part of LDWF's annual oyster reef monitoring, cultch plants would be monitored beyond year four and may be closed to harvest if criteria are not maintained.

Maintenance Requirements

Short- and long-term maintenance activities are not anticipated but may be identified later based on monitoring results. Maintenance may be required following severe weather events. Sediments may be deposited on the cultch plant, which could bury the oysters; therefore, re-exposure of cultch material may be required following storms.

Costs

The total cost of the alternative is $10,070,000 (TABLE 3-4). Funds are for permitting, construction, oversight, supervision, monitoring, supplies, reporting and other associated project costs The estimated cost for Grand Banks is $2,535,000. The estimated cost for Caillou Lake is $2,535,000. The estimated cost for programmatic components, including the Biloxi Marsh Complex, is $5,000,000 and would be used to collect data needed to optimize programmatic site selection (e.g., bottom surveys on areas of interest with side-scan/multi-beam sonar), project management and oversight, and for constructing programmatic reefs. Contingency for any necessary monitoring and repairs following storms would be covered by the alternative's programmatic budget.

TABLE 3-4. Estimated costs for Cultch Plant Oyster Restoration.

Grand Banks	Implementation/construction costs	$2,400,000
	Management/monitoring	$135,000
	Subtotal	*$2,535,000*
Caillou Lake	Implementation/construction costs	$2,400,000
	Management/monitoring	$135,000
	Subtotal	*$2,535,000*
Biloxi Marsh Complex and Programmatic components	Additional cultch plants/data acquisition for site selection	$5,000,000
Total cost		$10,070,000

3.6.2.2. OPA Evaluation

Cost-Effectiveness

The cost for the cultch plant alternative represents LDWF's best estimates and is comparable with the costs of similar cultch plant projects.[15] The Louisiana TIG found the cost to implement this alternative to be reasonable, appropriate, and comparable to other equivalent restoration alternatives. Furthermore, the cost effectiveness of this alternative is likely to increase over time as opportunities for improved efficiency are identified based on monitoring data.

Trustee Restoration Goals and Objectives

This alternative meets the Trustee programmatic restoration goal of replenishing and protecting LCMR and restoration type-specific goals as described in the Final PDARP/PEIS (DWH Trustees, 2016) to (1) restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs; (2) restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time; and (3) restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities.

The Louisiana Trustees have determined that the DWH oil, dispersant and response activities have significantly impacted the state's nearshore and subtidal oysters. This alternative has a strong nexus to the DWH nearshore marine ecosystem injury, and the oyster recruitment injury in particular, because it would create oyster reefs through placement of cultch in nearshore and subtidal areas. The alternative would enhance oyster abundance and spawning stocks and help promote resiliency for oyster

[15] The budget for the Alabama TIG's "Oyster Cultch Restoration Project" was $3,046,368 (Alabama TIG, 2018). The budget for the Florida TIG's "Oyster Cultch Placement Project" was $4,561,800 (Florida TIG, 2018). The budget for the Louisiana TIG's "Oyster Cultch Project" was $12,134,299 (Louisiana TIG, 2018c). The budget for the Mississippi TIG's "Oyster Cultch Restoration Project" was $9,549,139 (Mississippi TIG, 2017).

populations across the northern Gulf of Mexico. To ensure goals outlined in the Final PDARP/PEIS (DWH Trustees, 2016) are met, cultch plants would be managed for harvest using a shell budget model and through restriction of bedding loads to 15 percent or less for cultch material (see Monitoring Requirements above). The use of a shell budget model and restriction on removal of cultch material during harvest would permit the growth of new generations of oysters, keeping the cultch plants productive into the foreseeable future. The proposed alternative is fully consistent with OPA objectives for compensatory restoration.

Likelihood of Success

The Louisiana TIG expects this alternative would have a high likelihood of success. The alternative is technically feasible and uses best available science, proven techniques, and established methods. For example, the Louisiana Trustees have successfully implemented and managed oyster cultch projects in similar environments.[16] Since 1917, LDWF has placed over 1.5 million cubic yards of cultch material on nearly 30,000 acres with positive results, with 20 seed oysters per square meter typically observed as early as 17 months after cultch placement. Furthermore, the 2012 Caillou Lake cultch plant continues to be one of the most productive in Louisiana, containing 48 percent of the available oyster resources west of the Mississippi. The estimated oyster stock on the Caillou Lake POSR increased 347 percent between 2016 and 2017 while the area was closed to harvest (LDWF, 2017). Cultch plants in CSA 1 North, including the 2013 Drum Bay plant and Three Mile Pass plant, contribute most of the production within the area. In 2017, the highest density estimates of seed stock and market-size oysters were found at the Drum Bay cultch plant (9.6 per meter square) and Three Mile Pass cultch plant (2.2 per meter square), respectively (LDWF, 2017). Rates of oyster production can vary over time and by location due to a variety of factors such as storm events, illegal harvest, disease, or predation.

Avoids Collateral Injury

This alternative would minimize collateral injury to other resources by evaluating environmental consequences of techniques during the planning and design activities and by identifying the BMPs to minimize potential collateral injury (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Unintended impacts to benthic invertebrates could occur; however, any potential impacts are expected to be short term and result in temporary displacement or loss. Measures to avoid such impacts would be part of design development and implementation. Should any potential impacts be identified, the implementing Trustee would ensure proper coordination and protective measures are put in place. Environmental consequences are discussed further in Section 4 of this RP/EA.

Benefits Multiple Resources

Over the long term, this alternative has the broad potential to benefit the health of Louisiana's coastal and estuarine ecosystems. Oysters are an ecological keystone species, and successful restoration of

[16] The Louisiana TIG selected "Oyster Cultch Project" as a preferred alternative in Early Restoration Phase 1 (Louisiana TIG, 2018c). The project is currently being implemented.

oyster reefs would provide habitat and food sources for a diversity of marine organisms over time. Mussels, barnacles, sea anemones, and other animals settle on oyster reefs and create abundant food sources for fish species. Oyster reefs also provide habitat to forage fish, invertebrates, and other shellfish, as well as nursery grounds for commercially valuable species such as crab, flounder, herring, and striped bass (NOAA, 2019b) and recreationally important species such as red drum and spotted seatrout (LDWF, 2019). Oyster reefs also have the potential to reduce shoreline erosion and improve water quality, which directly benefit other coastal and estuarine species.

Public Health and Safety

Adverse impacts on public health and safety are not expected from the proposed alternative. However, relevant safety measures and practices would be followed during implementation. Any potential impacts on public safety (e.g., recreational boating) would be fully avoided during implementation through construction workers' observance of appropriate safety practices such as construction BMPs and informational signage (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

3.6.2.3. Summary

This alternative is anticipated to satisfy all the OPA evaluation factors. The OPA evaluation indicates that implementation of this alternative would advance the Trustees' overall goal of 'Replenish and Protect LCMR' (DWH Trustees, 2016). If implemented properly, this alternative would enhance ecosystem services provided by restored oyster habitats and resources and would contribute to returning injured natural resources and services to baseline conditions. The proposed alternative has a strong nexus to the injury caused by the DWH oil spill and can reasonably be expected to provide benefits over an extended timeframe.

3.6.3. Hatchery-based Oyster Restoration

3.6.3.1. Project Description

The objective of the Hatchery-based Oyster Restoration project is to enhance Louisiana oyster reef productivity and spawning stock, offsetting impacts resulting from exposure to DWH oil, dispersant, and response activities. Spawning stock enhancement projects include hatchery production of oyster larvae, planting hatchery-raised oysters, and relocating oysters to restoration sites. Hatchery-produced oysters offer the opportunity to artificially increase oyster production in areas with suitable hydrology and substrate, and once the planted oysters mature, contribute to a network of spawning stock reefs to enhance the overall oyster population. In addition, maintaining a regional hatchery production capacity for spat-on-shell also supports other oyster restoration projects in the region that depend on the availability of spat.

This alternative includes (1) providing funding to support 10 years of operations at an existing and currently operating hatchery; and (2) providing larvae and seed resources for POSG restoration and water-based oyster culture. This alternative would contribute to the enhancement of natural oyster reefs and increased oyster abundance which may provide some ecosystem services that result from high

oyster abundance, such as reduction in shoreline erosion, improved water quality, increased biodiversity of reef-dependent organisms, and recycling of nutrients.

More specifically, the hatchery-based alternative would provide up to 10 years of operational funds for the Michael C. Voisin Oyster Hatchery in Grand Isle, Louisiana (FIGURE 3-9) and support deployment monitoring of hatchery-produced product. Construction of the hatchery began in 2013 and was completed in 2015. The facility is jointly operated by LDWF and Louisiana State University (LSU) to produce oysters for use in rehabilitating POA. From 2015 to 2017, the hatchery produced approximately 651 million oyster larvae and 4.6 million seed oysters. LDWF estimates that 80 to 99 percent of the oysters produced were used by LDWF for oyster population rehabilitation or restoration purposes.

FIGURE 3-9. Michael C. Voisin oyster hatchery in Grand Isle, Louisiana (Source: https://seagrant.noaa.gov/News/Article/ArtMID/1660/ArticleID/482/National-Seafood-Month-Grand-Isle-Oyster-Hatchery-to-Produce-Year-Round).

The deployment of hatchery-produced oysters to areas with low oyster abundance is a technique described in the DWH PDARP/PEIS Strategic Framework (DWH Trustees, 2017b). Hatchery-produced oysters offer the opportunity to artificially increase oyster production in areas with suitable hydrology and substrate. The proposed operation of the hatchery and subsequent spat-on-shell deployment is one component of a larger oyster restoration plan for the POA of the state. Potential short-term benefits of

spat-on-shell deployment include directly increasing oyster abundance and improving the reproductive potential for oysters regionally. Potential long-term benefits include increasing oyster production and associated ecosystem services resulting from high oyster abundance, and improved oyster population connectivity, resilience, and stability.

The hatchery-based restoration alternative incorporates multiple DWH PDARP/PEIS Strategic Framework oyster restoration activities to increase oyster abundance and improve oyster population connectivity, resilience, and stability in Louisiana (DWH Trustees, 2017b). Many current and future restoration projects would benefit from the continued production of oyster larvae and seed oysters. Areas that would benefit from spat-on-shell deployments include areas with existing shell substrate, such as relic reefs, cultch plants on POSG, along with un-harvestable brood reefs and inshore artificial reef structures. In addition to supporting continued hatchery production of oysters, this alternative would support programs to increase commercial production of off-bottom oysters, which would increase oyster production and reduce commercial pressure on natural oyster reefs into the foreseeable future.

Construction Methodology and Schedule

Through support of the Michael C. Voisin Oyster Hatchery, LDWF would work with Louisiana Sea Grant to continue producing oyster larvae for use in oyster rehabilitation activities. These larvae would be placed into tanks and induced to set on oyster shell or other cultch material. The oyster shell would be provided through a partnership with the Coalition to Restore Coastal Louisiana's Oyster Shell Recycling Program.[17] Shells collected from the recycling program are stored in Buras, Louisiana where they are dried for a minimum of six months before being transported to the hatchery for setting purposes. Once developed, the live oyster spat would be transported for deployment onto POSG or POSR in need of rehabilitation (FIGURE 3-10).

The hatchery would produce at least 500 million diploid oyster larvae per year, of which a minimum of 25 percent would be dedicated for use in oyster restoration activities within areas protected from harvest (i.e., brood and artificial reefs, or living shorelines). Planting locations and monitoring would vary based on oyster population needs and the amount and type of available spat, but placement would be on a POSG or POSR with suitable oyster habitat (i.e., existing shell substrate).

An additional potential benefit of maintaining hatchery operations is the production of diploid oyster larvae and seed resources for oyster farming. While not included in funding for this alternative, hatchery-raised oysters could be used to support an existing effort led by LDWF and Louisiana Sea Grant to train Louisiana residents interested in pursuing commercial oyster farming.

[17] More information about the Coalition to Restore Coastal Louisiana is available on their website: https://www.crcl.org/.

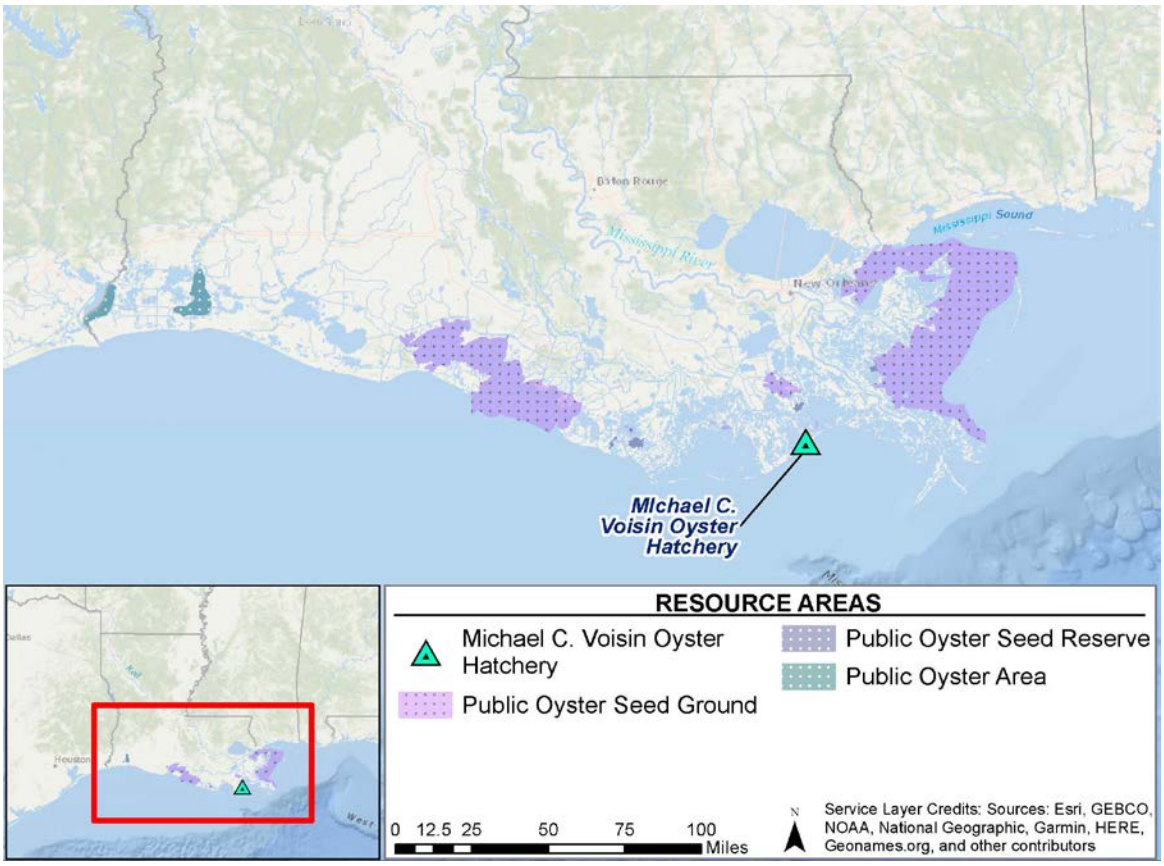

FIGURE 3-10. Public Oyster Seed Grounds and Public Oyster Seed Reservations in Louisiana.

The availability of hatchery-raised oysters could also help support the establishment of a state program for off-bottom oyster culture. Although setting up such a program is not included in this alternative, the success of such a program would depend on the availability of oyster larvae. Funding for continued operations of the hatchery facility is likely to support local job creation and increased oyster production throughout Louisiana.

Implementation of the alternative is anticipated to commence immediately; implementation and execution is anticipated to be completed in approximately ten years. Funds would be distributed to the hatchery annually.

Monitoring Requirements

Monitoring would consist of on-site monitoring of the Michael C. Voisin Oyster Hatchery facility's operations and production and post-deployment monitoring of the growth and survival of hatchery-raised oysters. Hatchery production would be monitored annually with a goal of producing 500 million diploid oyster larvae per year. Deposition of hatchery-produced oysters would be monitored to confirm that 25 percent of diploid oyster larvae produced annually are allocated to oyster restoration activities on areas protected from harvest. At select deployment sites, the number of spat deployed would be monitored for a period of 18 months to evaluate success of hatchery-raised oyster deployment. All monitoring would be reported annually and continue for 10 years following initial execution. See Table 3

in the MAM plan in Appendix D for additional information on monitoring objectives and performance criteria.

Maintenance Requirements

Short- and long-term maintenance activities beyond routine facility maintenance are not anticipated but may be identified later based on monitoring results. Maintenance may be required following severe weather events. If the hatchery or deployment sites were disturbed, they would need to be repaired.

Costs

The total cost of the alternative is $5,850,000, summarized in TABLE 3-5. These funds are for implementation, monitoring, oversight, supervision, operations, maintenance, supplies, unexpected implementation costs, storm-related monitoring repairs, and other related project costs.

TABLE 3-5. Estimated costs for Hatchery-based Oyster Restoration.

Hatchery operations	Annual hatchery operations cost	$500,000
	Annual monitoring	$85,000
Total cost (for 10 years)		$5,850,000

3.6.3.2. OPA Evaluation

Cost-Effectiveness

The cost for the hatchery-based oyster restoration alternative represents LDWF's best estimate and is consistent with the recent operational costs for the existing hatchery. No significant changes to the hatchery's operational costs are anticipated throughout the duration of this alternative. The Louisiana TIG found the cost to implement this alternative to be reasonable, appropriate, and comparable to other restoration alternatives.[18] Furthermore, the cost effectiveness of this alternative is likely to increase over time as opportunities for improved efficiency are identified based on monitoring data.

Trustee Restoration Goals and Objectives

This alternative meets the Trustee programmatic restoration goal of replenishing and protecting LCMR and restoration type-specific goals as described in the Final PDARP/PEIS (DWH Trustees, 2016) to (1) restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs; (2) restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time; and (3) restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities.

[18] The budget for the Alabama TIG's "Oyster Hatchery at Claude Peteet Mariculture Center—High Spat Production with Study" was $2,947,472 over the 4-year project duration (Alabama TIG, 2018).

The Louisiana Trustees have determined that the DWH oil, dispersant and response activities have significantly impacted the state's nearshore and subtidal oysters. This alternative has a strong nexus to the DWH nearshore marine ecosystems injury, and the oyster recruitment injury in particular, because it would enhance oyster reef productivity through spawning stock support. The locations proposed for deployment of hatchery-raised oysters have the potential to promote resiliency for oyster populations across the northern Gulf of Mexico. The implementing Trustee would ensure that 25 percent of diploid oyster larvae produced annually are dedicated to oyster restoration in areas protected from harvest, which would help ensure the Trustees' programmatic restoration goals are met. The proposed alternative is fully consistent with OPA objectives for compensatory restoration.

Likelihood of Success

The Louisiana TIG expects this alternative would have a high likelihood of success. The alternative is technically feasible and uses best available science, proven techniques, and established methods. The DWH Trustees have successfully implemented hatchery enhancement projects in similar environments.[19] Construction of the Michael C. Voisin hatchery began in 2013 and was completed in 2015. The facility is jointly operated by LDWF and LSU to produce oysters for use in rehabilitating POA. From 2015 to 2017, the hatchery produced approximately 651 million oyster larvae and 4.6 million seed oysters. LDWF has deployed more than 162 million oyster larvae at sites in Black Bay and Lake Machias, and more than 32 million oysters were used for alternative oyster culture operations and research purposes. LDWF estimates that 80 to 99 percent of the oysters produced were used by LDWF for oyster rehabilitation. Continued support of the hatchery would enable more efficient deployment of hatchery-raised oysters set onto oyster shell or other materials (LDWF, 2017). Specifically, for this alternative, the hatchery would produce at least 500 million diploid oyster larvae per year, of which a minimum of 25 percent would be dedicated for use in oyster restoration activities within areas protected from harvest (i.e., brood and artificial reefs, or living shorelines).

Avoids Collateral Injury

This alternative would minimize collateral injury to other resources by evaluating environmental consequences of techniques during the planning and design activities and by identifying the BMPs to minimize potential collateral injury (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Unintended impacts to benthic invertebrates could occur during deployment of hatchery-raised oysters; however, any potential impacts are expected to be short term and result in temporary displacement or loss. Measures to avoid such impacts would be part of design development and implementation. Should any potential impacts be identified, the implementing Trustee would ensure proper coordination and protective measures are put in place. Environmental consequences are discussed further in Section 4 of this RP/EA.

[19] The Alabama TIG chose "Oyster Hatchery at Claude Peteet Mariculture Center – High Spat Production with Study" as a preferred alternative in the Alabama Restoration Plan II/Environmental Assessment (Alabama TIG, 2018). The project is currently being implemented.

Benefits Multiple Resources

Over the long term, this alternative has broad potential to benefit the health of Louisiana's coastal and estuarine ecosystems. Oysters are an ecological keystone species, and successful restoration of oyster reefs would provide habitat and food sources for a diversity of marine organisms over time. Mussels, barnacles, sea anemones, and other animals settle on oyster reefs and create abundant food sources for fish species. Oyster reefs also provide habitat to forage fish, invertebrates, and other shellfish, as well as nursery grounds for commercially valuable species such as crab, flounder, herring, and striped bass (NOAA, 2019b), and recreationally important species such as red drum and spotted seatrout (LDWF, 2019). Oyster reefs also have the potential to reduce shoreline erosion and improve water quality, which directly benefit other coastal and estuarine species.

Public Health and Safety

Adverse impacts on public health and safety are not expected from the proposed alternative. However, relevant safety measures and practices would be followed during implementation. The hatchery would continue to be operated in a manner that is consistent with any state and federal requirements.

3.6.3.3. Summary

This alternative is anticipated to satisfy all the OPA evaluation factors. The OPA evaluation indicates that implementation of this alternative would advance the Trustees' overall goal of 'Replenish and Protect LCMR' (DWH Trustees, 2016). If implemented properly, this alternative would enhance ecosystem services provided by restored oyster habitats and resources and would return injured natural resources and services to baseline conditions. The proposed alternative has a strong nexus to the injury caused by the DWH oil spill and can reasonably be expected to provide benefits over an extended timeframe.

3.6.4. Caillou Lake Artificial Oyster Reef

3.6.4.1. Project Description

The objective of the Caillou Lake Artificial Oyster Reef alternative is to create an artificial oyster reef in Caillou Lake (FIGURE 3-11), thereby offsetting impacts resulting from exposure to DWH oil, dispersant, and response activities. The alternative would also armor the shoreline, providing not only a substrate to which oysters can attach, grow, and reproduce, but also adding vertical structure to attenuate wave energy. In Louisiana's Atchafalaya and Vermilion Bays, loss of historical, vertical oyster reefs has been found to be a key contributor to the increase in wave energy and subsequent loss of coastal marshes (Stone et al., 2005). As such, artificial oyster reef structures are being constructed across the Gulf Coast to mitigate coastal erosion. A goal of this alternative is to engineer an oyster reef that would produce oysters, absorb wave energy, protect the adjacent shoreline, and minimize water column turbidity between the reef and the shoreline, fostering sediment accretion.

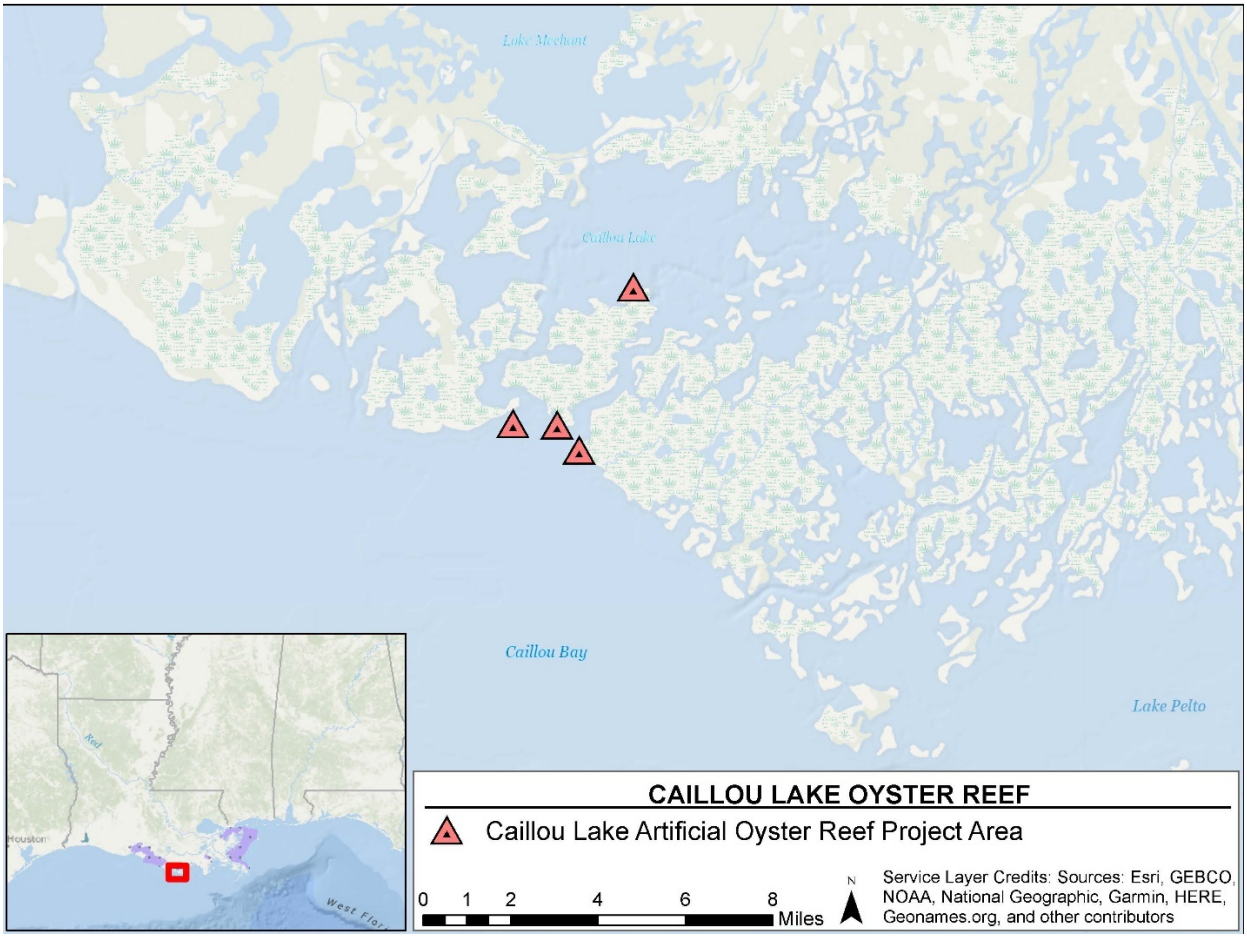

FIGURE 3-11. Caillou Lake artificial reef area.

Caillou Lake is in Terrebonne Parish and is one of the most productive oyster seed grounds in Louisiana. A land bridge, or series of salt marsh islands that separate the lake from the Gulf of Mexico, is being lost at a rapid rate, like many marshes in Louisiana. Loss of this land bridge would open Caillou Lake directly to the Gulf of Mexico, resulting in substantially increased wave heights and increased salinity. These changes would likely increase rates of erosion and marsh loss and precipitate a decline in oyster production. To protect the land bridge between Caillou Lake and the Gulf of Mexico, the proposed alternative would construct approximately 21 miles of artificial oyster reef along the shorelines most susceptible to erosion.

Potential short-term benefits of the Caillou Lake Artificial Reef include shoreline protection, damped wave energy to reduce shoreline erosion, and new substrate for oyster recruitment and growth. Potential long-term benefits of the alternative include preservation of marsh habitat and the land bridge protecting Caillou Lake, increased oyster production and associated ecosystem services resulting from high oyster abundance such as improved water quality, oyster population connectivity, resilience, and stability.

Construction Methodology and Schedule

Project designs would be based on proven engineered reef technology. Artificial reef material would likely consist of gabions (i.e., cages, cylinders, or boxes that are filled with limestone or shell that is clean and free of contaminants (FIGURE 3-12)). Gabions and required signage would be deployed by airboat.

FIGURE 3-12. Gabion filled with oyster shell
(Source: https://www.brproud.com/news/fighting-coastal-erosion-a-louisiana-tribe-banks-on-oyster-shells/).

This alternative would be executed in three phases. During Phase I, approximately seven miles of reef would be constructed, mostly along the northern end of the central island in the land bridge. Since this area is along the southern end of the lake, it is subject to higher wave energy during the winter months when frontal systems produce strong northerly winds. The engineered oyster reef would be placed along a bathymetric contour so that the tops of the structures are at the mean high tide line.

During Phase II, another seven miles of reef would be constructed. A four-mile section would be split into two, two-mile sections to the east and west of the Phase I reef, and these sections would be arranged in the same manner as the Phase I reef. The remaining three miles would be placed along the southern shoreline of the central island in the land bridge. These reefs would be exposed to constant wave energy from the Gulf and would be fabricated such that the reefs are greater in height than reefs constructed within Caillou Lake: the approximate height of these reefs would be between eight and 10 feet, and they would be situated such that the tops of the structures remain above the water during all annual tide events, creating a much lower energy environment for the Gulf-facing shoreline of the land bridge.

Phase III of this alternative would construct approximately five miles of reef to the west of the southern, three-mile section of Phase II, and another two miles of reef to the east. This configuration, along with Phase II, would protect much of the south-facing side of the land bridge separating Caillou Lake from the Gulf. The height of the Phase III artificial reefs would be similar to those used in the three-mile section of Phase II.

Intermittent breaks between reef segments would be constructed to allow for movement of aquatic species between the marine habitat, shoreline, and freshwater spawning and rearing habitats, and to prevent entrapment.

Implementation of the alternative is anticipated to commence immediately; implementation and execution is anticipated to be completed in approximately two and a half years.

Monitoring Requirements

Monitoring of the Caillou Lake artificial reef would consist of an annual survey of the reef's spatial extent, annual sampling of oyster abundance on and around the gabions in summer, and annual surveys of the adjacent shoreline. Monitoring would be conducted annually for four years post-construction.

Surveys of the reef's spatial extent would include pre- and post-construction measurements of subtidal extent and reef height to evaluate reef acreage, vertical relief, and ensure that the desired artificial reef dimensions are achieved and maintained. Reef monitoring would also include quadrat sampling in which, divers would collect oysters, surficial shell/cultch, and associated reef organisms from the quadrat areas for enumeration and analysis. Field crews count and measure all live and recently dead oysters within each sample before returning them to the water. Measurements of oyster density, mortality, and size distribution evaluate whether the desired oyster demography is achieved. Crew members would also record observations of reef condition. The shoreline survey would involve walking the shoreline while taking continuous GPS measurements to quantify loss or gain of shoreline protected

by the Caillou Lake artificial reef. Shoreline change in the area of the alternative would be compared to shoreline change in an adjacent unprotected area.

Maintenance Requirements

Short- and long-term maintenance activities are not anticipated but may be identified later based on monitoring results. Maintenance may be required following severe weather events. If the artificial reef structures were disturbed, they would need to be repaired or reinstalled.

Costs

The total cost of the alternative is $21,450,000, summarized in TABLE 3-6. These funds are for permitting, construction, oversight, supervision, monitoring, reporting, any unexpected construction or implementation costs, storm-related monitoring repairs, and other related project costs.

TABLE 3-6. Estimated costs for Caillou Lake Artificial Oyster Reef.

Phase I	Permit acquisition (for all 3 phases)	$30,000
	Management	$70,000
	Restoration monitoring and reporting	$70,000
	Fabrication and field placement of reefs	$7,000,000
Phase II	Management	$70,000
	Restoration monitoring and reporting	$70,000
	Fabrication and field placement of reefs	$7,000,000
Phase III	Management	$70,000
	Restoration monitoring and reporting	$70,000
	Fabrication and field placement of reefs	$7,000,000
Total Cost		$21,450,000

3.6.4.2. OPA Evaluation

Cost-Effectiveness

The cost for the Caillou Lake artificial oyster reef represents the Louisiana TIG's best estimates; however, the cost-effectiveness of this alternative is not fully known at this time. Uncertainties remain regarding the most cost-effective materials and techniques needed for this alternative. No commensurate projects are known for comparison.

Trustee Restoration Goals and Objectives

This alternative meets the Trustee programmatic restoration goal of replenishing and protecting LCMR and restoration type-specific goals as described in the Final PDARP/PEIS (DWH Trustees, 2016) to (1) restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time; and (2) restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities.

The Louisiana Trustees have determined that the DWH oil, dispersant and response activities have significantly impacted the state's nearshore and subtidal oysters. The alternative does have a nexus to the DWH nearshore marine ecosystem injury; creating oyster reefs through placement of artificial reef in nearshore or subtidal areas and constructing living shorelines have the potential to restore oyster abundance and the associated ecosystem services which would offset impacts resulting from exposure to DWH oil, dispersant, and response activities. However, when compared to the other oyster restoration alternatives considered in this RP/EA, this alternative does not sufficiently address the DWH oyster recruitment injury.

Likelihood of Success

The Louisiana TIG expects this alternative would have a moderate likelihood of success. The alternative is technically feasible and uses best available science, proven techniques, and established methods; however, recruitment of oysters on the artificial reef after is it constructed does introduce some uncertainty for alternative success. The likelihood of oyster spat setting on the artificial reef is reasonably high; Caillou Lake is one of the most productive POSRs in Louisiana. Between 2016 and 2017, Caillou Lake saw an over 500 percent increase in availability of seed oysters and total oyster reef acreage for Caillou Lake is estimated to be 2,375 acres (LDWF, 2017).

Avoids Collateral Injury

This alternative would minimize collateral injury to other resources by evaluating environmental consequences of techniques during the planning and design phase and by identifying the BMPs to minimize potential collateral injury (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Unintended impacts on benthic invertebrates could result; however, any potential impacts are expected to be short term and result in temporary displacement or loss. Measures to avoid such impacts would be part of design development and implementation. Should any potential impacts be identified, the implementing Trustee would ensure proper coordination and protective measures are put in place. Environmental consequences are discussed further in Section 4.

Benefits Multiple Resources

Over the long term, this alternative has the potential to broadly benefit the health of Louisiana's coastal and estuarine ecosystems. Oysters are an ecological keystone species, and successful restoration of oyster reefs would provide habitat and food sources for a diversity of marine organisms over time. Mussels, barnacles, sea anemones, and other animals settle on oyster reefs and create abundant food sources for fish species. Oyster reefs also provide habitat to forage fish, invertebrates, and other shellfish, as well as nursery grounds for commercially valuable species such as crab, flounder, herring, and striped bass (NOAA, 2019b). Oyster reefs also have the potential to reduce shoreline erosion and improve water quality, which directly benefit other coastal and estuarine species.

Public Health and Safety

Adverse impacts on public health and safety are not expected from the proposed alternative. However, relevant safety measures and practices would be followed during implementation. Any potential

impacts on public safety would be avoided during implementation through construction workers' observance of appropriate safety practices such as construction BMPs and informational signage (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

3.6.4.3. Summary

This alternative is anticipated to satisfy most OPA evaluation factors. The OPA evaluation indicates that implementation of this alternative would advance the Trustees' overall goal of 'Replenish and Protect LCMR' (DWH Trustees, 2016). If implemented successfully, this alternative would enhance ecosystem services provided by restored oyster habitats, including protection of the adjacent shoreline, and would contribute to returning injured natural resources and services to baseline conditions. The proposed alternative has a nexus to the injury caused by the DWH oil spill; however, the alternative's likelihood of success is dependent on local recruitment of oysters to settle on the artificial reef structure. Further, the Caillou Lake Artificial Reef Project costs are higher than the other action alternatives and the cost-effectiveness has not been demonstrated by comparable projects.

3.6.5. Natural Recovery Alternative

Pursuant to the OPA regulations, the Final PDARP/PEIS considered a "natural recovery alternative in which no human intervention would be taken to directly restore injured natural resources and services to baseline" (15 CFR §990.53[b][2]; DWH Trustees, 2016). Under a natural recovery alternative, the Trustees would not implement any restoration to accelerate the recovery of oysters in the Louisiana restoration area. This could produce one of four outcomes for injured resources: (1) gradual recovery, (2) partial recovery, (3) no recovery, or (4) further deterioration. Although injured resources could presumably recover to baseline or near baseline conditions, recovery would take much longer under the natural recovery alternative compared to a scenario in which restoration actions were undertaken. However, since technically feasible restoration approaches are available, the Trustees rejected this alternative from further OPA evaluation for the oyster restoration type.

3.6.6. Oyster Restoration Type OPA Conclusions

The Louisiana TIG completed the OPA evaluation of the reasonable range of alternatives. Three preferred oyster alternatives (Enhancing Oyster Recovery Using Brood Reef, Cultch Plant Oyster Restoration, and Hatchery-based Oyster Restoration) are anticipated to satisfy all the OPA evaluation factors. The Caillou Lake Artificial Oyster Reef alternative is not preferred for implementation at this time as it is less cost-effective than the other oyster alternatives and does not address the recruitment injury to nearshore and subtidal oysters. The cost effectiveness of the non-preferred alternative may increase in the future and the non-preferred alternative may be considered for future implementation.

4. AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

This section describes the affected environment and the anticipated environmental impacts of the reasonable range of alternatives. The NEPA analysis presented in this RP/EA is consistent with the Final PDARP/PEIS and incorporates by reference that document where applicable (DWH Trustees, 2016).

4.1.1. Overview of NEPA Approach

This RP/EA incorporates by reference relevant information from existing plans, studies, and other material to streamline the NEPA process and to determine whether to prepare an environmental impact statement (EIS) or finding of no significant impact (FONSI). All source materials are available to the public. As stated in the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act [40 CFR §§ 1500-1508 (CEQ regulations)], agencies should "focus on significant environmental issues" and for other than significant issues there should be "only enough discussion to show why more study is not warranted" (40 CFR §§ 1502.1 and 1502.2).

To determine whether an alternative has the potential to result in significant impacts, the context and intensity of the alternative must be considered. Context refers to area of impacts (e.g., local, regional, state-wide) and duration (e.g., short- or long-term). Intensity refers to the severity of impact and could include information on the timing of impacts (e.g., more intense impacts could occur during construction). Intensity is also described in terms of whether the impact would be beneficial or adverse. The analysis of beneficial impacts focuses on the duration without attempting to specify the intensity of the benefit. "Adverse" is used in this section only to describe the Trustees' evaluation under NEPA. That term is defined and applied differently in consultations conducted pursuant to the Endangered Species Act (ESA) and other protected resource statutes. The results of any completed protected resource consultations are included in the administrative record and will be discussed in the Final RP/EA.

Resources and impact definitions (e.g., minor, moderate, major) align with the Final PDARP/PEIS Section 6.3.2 (DWH Trustees, 2016). Specifically, minor impacts are generally those that might be detectable but, in their context, may nonetheless not be measurable because any changes they cause are so slight as to be impossible to define. Moderate impacts are those that are more detectable and, typically, more quantifiable or measurable than minor impacts. Major impacts are those that, in their context and due to their severity, have the potential for significant impacts. Appendix C of this RP/EA provides additional details about NEPA impact thresholds.

Pursuant to NEPA, a no action alternative is considered in this section as a basis for comparison of potential environmental consequences of the action alternatives. In this case, "no action" would mean that the Louisiana TIG would not, at this time, select and implement any of the restoration alternatives identified for proposed restoration actions in this RP/EA. The resulting environmental impacts from taking no action are compared with the impacts of each of the alternatives, grouped by restoration type.

4.2. Minimally Affected Resources Common to All Alternatives

NEPA and CEQ regulations direct agencies preparing EISs or EAs to "avoid useless bulk… and concentrate effort and attention on important issues" (40 CFR § 1502.15) and to "identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review" (40 CFR § 1506.3). The resources that are either not anticipated to be adversely affected, or where negligible, short-term impacts are expected to be common among all alternatives are described briefly below, with the rationale for their elimination from further analysis.

4.2.1. Physical Environment

4.2.1.1. Air Quality

The Clean Air Act (CAA) and its amendments require the EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment including sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, carbon monoxide (CO), ozone (O_3), and lead (Pb). Primary NAAQS are intended to protect public health, while secondary NAAQS are intended to protect the environment (e.g., crops, wildlife), and infrastructure (e.g., buildings). The CAA also allows states to adopt additional ambient air quality standards. The state of Louisiana has established Ambient Air Quality Standards in Louisiana Administrative Code, Title 33, Part III, Chapter 7, for the same criteria pollutants set by EPA. All potentially affected parishes in this RP/EA are considered in attainment for the NAAQS and the state Ambient Air Quality Standards, except for St. Bernard Parish, which is in non-attainment for sulfur dioxide (LDEQ, 2018).

The marine mammal alternatives involve local transportation of personnel responding to strandings, attending meetings and trainings, collecting samples and data, transporting injured marine mammals, and otherwise facilitating stranding network and health program development. These activities rely on vehicle and boat transportation for temporary periods of time which could result in short-term, minor adverse impacts on air quality because of the small amount of criteria pollutants emitted. No construction activities are involved, and no long-term impacts on air quality are anticipated.

The oyster alternatives involve limited construction activities and vehicle and boat transportation for implementation and construction. These activities could result in short-term, minor adverse impacts on air quality. Under three oyster alternatives (Enhancing Oyster Recovery Using Brood Reef, Caillou Lake Artificial Oyster Reef, Cultch Plant Oyster Restoration), short-term, minor adverse impacts on air quality may occur during construction from dust and fumes from equipment and earthwork activities. These localized temporary impacts would not be expected to exceed the EPA's *de minimis* criteria for general conformity determination under the CAA regulations (40 CFR § 93.153). Emission-reduction measures to mitigate for short-term air quality impacts could include the use of ultra-low sulfur diesel fuel in construction equipment, limiting unnecessary idling time of diesel-powered engines, controlling dust related to construction site activities, and covering trucks hauling loose materials.

No long-term impacts on air quality are anticipated from any of the marine mammal or oyster alternatives; therefore, this resource area was not carried forward for detailed analysis.

4.2.1.2. Noise

Noise is commonly defined as unwanted sound, and it can interfere with normal activities such as speech, concentration, or sleep. Existing and variable levels of natural ambient sounds (i.e., the existing background noise environment) include those created by wind, water (e.g., rainfall, streams, oceans), wildlife, and other sources, and these are seldom considered to be "noise." In contrast, human activities generate noise. Specific sources include mobile sources such as cars, jets, boats, trains, etc., and/or stationary sources such as construction sites, machinery, or industrial operations.

The sound levels and noise characteristics for each alternative would vary based on location. Ambient sounds at the sites are typically dominated by waves, wind, and birds. Watercraft traffic and recreational activities of people may influence noise levels at proposed sites located in or near water bodies.

The marine mammal alternatives involve local transportation of personnel by boat responding to strandings, collecting samples and data, transporting injured marine mammals, and otherwise facilitating stranding network and health program development. These activities rely on boat transportation for temporary periods of time which could result in short-term, minor adverse impacts on the local soundscape. No construction activities are involved, and no long-term impacts on soundscape are anticipated.

The oyster alternatives involve the use of boats to conduct site assessments and construction (e.g., cultch placement, brood reef construction). These activities could result in short-term, minor adverse impacts. The noise generated from the operation of boats and other equipment would attract attention and contribute to the soundscape in local areas. However, the severity of impacts would depend to a large degree on the actual project site, distance to sensitive receptors (e.g., recreational users or wildlife), and the level of ambient noise. Vessel use would be short-term and temporary in nature. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). In all cases, the noise would cease once equipment use is complete.

No long-term impacts from noise are anticipated under any of the marine mammal or oyster alternatives; therefore, this resource area was not carried forward for detailed analysis.

4.2.2. Biological Environment

4.2.2.1. Invasive Species

Many invasive plant and animal species have had an extensive impact on Louisiana's coastal and aquatic habitats. Of particular concern, hydrilla (*Hydrilla verticillata*), water hyacinth (*Eichhornia crassipes*), and giant salvinia (*Salvinia molesta*) reduce flow through waterways, displace native plant communities, and degrade aquatic habitats. Aquatic invasive animals include mollusks (e.g., zebra mussel, Asian clam, apple snail), at least one crustacean species (Asian tiger shrimp), and numerous invasive fish species (e.g., several species of carp; Holcomb et al., 2015). The State Management Plan for Aquatic Invasive Species in Louisiana identifies several established finfish that may spread via aquatic pathways (Kravitz et al., 2005). Established invasive finfish in the region include Rio Grande cichlid (*Cichlasoma*

cyanoguttatum), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), and bighead carp (*Hypophthalmichthys nobilis*).

The marine mammal alternatives involve stranding response and health program activities. These activities are not anticipated to promote growth or increase the risk of introducing invasive species. The oyster alternatives involve construction and implementation (e.g., cultch placement, brood reef construction). These activities are also not anticipated to promote introduction or spread of invasive species.

Oyster shell used for reef and/or cultch plant construction is expected to be quarantined and dried for at least six months and washed prior to transplant in order to reduce the risk of introducing invasive species (NOAA, 2012). The MAM plans (Appendix D) provide for monitoring of the biological communities in each alternative site prior to and following construction and would provide for early identification and control of any potential invasive species.

No adverse impacts to resources from invasive species are anticipated from any of the marine mammal or oyster alternatives; therefore, this resource area was not carried forward for detailed analysis.

4.2.3. Socioeconomic Environment

4.2.3.1. Socioeconomics and Environmental Justice

Since communities beyond the footprint of each alternative may be affected, the analysis area for socioeconomic resources spans the nine coastal parishes where the six alternatives would occur. For example, an oyster restoration alternative may affect a parish's overall employment level by attracting new fishing users and increasing employment and revenue for the oyster industry.

Under EO 12898, as amended, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations, evaluations need to be conducted to identify communities and groups that meet environmental justice criteria and strategies to reduce potential adverse impacts on affected groups. This requires lead federal agencies to perform environmental justice evaluations during the preparation of alternatives that are proposed, funded, or licensed by federal agencies. Using the EPA's Environmental Justice Screening and Mapping Tool (EPA, 2019), the nine parishes affected by the alternatives were evaluated against environmental justice and demographic indicators. TABLE 4-1 provides the parish ranking for environmental justice indicators within Louisiana and across the U.S. For example, Terrebonne Parish is in the 82nd percentile in Louisiana and the 79th percentile in the U.S. for proximity to hazardous waste. TABLE 4-2 provides the parish rankings for demographic characteristics within Louisiana and across the U.S. For example, Jefferson Parish is in the 88th percentile in Louisiana and the 73rd percentile in the U.S. for linguistically isolated populations.

As defined by the Environmental Justice Guidance Under NEPA (EPA, 1998), "minority populations" include those with greater than 50 percent of persons who identify themselves as Asian or Pacific Islander, Native American or Alaskan Native, Black (not of Latino origin), or Latino (EPA, 1998). The National Guidance under NEPA recommends that the threshold for determining a low-income

population be based on nationally determined poverty thresholds. As presented in TABLE 4-2, several of the potentially affected parishes have low-income, minority populations.

The marine mammal alternatives are not anticipated to contribute to the status of any of the environmental justice indicators presented in TABLE 4-1. Additionally, the alternatives are not anticipated to adversely impact and/or disproportionately affect minority or low-income populations. Implementation of either of the alternatives could benefit surrounding communities by potentially creating job opportunities. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009).

The oyster alternatives are not anticipated to contribute to the status of any of the environmental justice indicators presented in TABLE 4-1. The oyster alternatives could cause short-term, minor adverse impacts on recreation during the implementation of the activity. However, these impacts would not disproportionally affect minority or low-income populations. Implementation of any of the oyster alternatives may result in short-term, beneficial economic impacts on local employment during any construction or implementation period. Over the long term, oyster restoration alternatives may result in moderate, beneficial impacts on the Louisiana economy due to increased oyster abundance. Between 1998 and 2008, Louisiana accounted for an average of 34 percent of the nation's oyster landings, and among Gulf of Mexico states, Louisiana consistently ranks highest in oyster landings, accounting for over 50 percent of the region's total. Louisiana was the top producer of oysters in 2008 with approximately 12.8 million pounds of oysters. In 2009, the dockside value of oysters was over $50 million (LDWF, 2010). In the long term, oyster alternatives may support Louisiana's oyster industry.

No long-term, adverse impacts on socioeconomics and environmental justice are anticipated from any of the oyster or marine mammal alternatives; therefore, this resource area was not carried forward for detailed analysis.

TABLE 4-1. Environmental justice indicators in affected parishes.

	Environmental Justice Indicators (state percentile, U.S. percentile)											
Parish	Particulate Matter (PM)	Ozone	National-Scale Air Toxics Assessment (NATA) Diesel PM	NATA Air Toxics Cancer Risk	NATA Respiratory Hazard Index	Traffic Proximity and Volume	Lead Paint Indicator	Superfund Proximity	Risk Management Plan (RMP) Proximity	Hazardous Waste Proximity	Wastewater Discharge Indicator
Terrebonne	52, 59	53, 60	54, 61	54, 62	52, 60	70, 68	66, 71	73, 73	58, 64	82, 79	88, 89
St. Bernard	55, 62	55, 62	62, 67	54, 62	55, 63	68, 67	56, 64	67, 69	75, 78	72, 72	80, 86
Plaquemines	44, 51	43, 52	32, 37	43, 48	43, 47	10, 17	32, 41	31, 38	37, 43	7, 15	18, 17
Lafourche	33, 39	31, 42	33, 38	31, 27	32, 28	26, 28	26, 38	28, 35	25, 28	19, 29	6, 8
St. Mary	57, 64	57, 63	56, 63	56, 65	57, 66	65, 65	68, 72	54, 61	38, 44	70, 70	83, 88
Vermilion	37, 44	37, 47	42, 49	39, 40	36, 34	62, 63	33, 41	40, 47	63, 67	64, 65	28, 27
Cameron	28, 33	26, 36	36, 41	29, 24	23, 16	54, 59	20, 32	28, 35	33, 37	27, 36	0, 1
Iberia	58, 65	58, 64	57, 64	57, 66	59, 67	69, 68	75, 77	54, 61	74, 77	68, 69	14, 13
Jefferson	60, 66	61, 66	67, 71	61, 69	60, 68	83, 77	54, 63	69, 70	78, 81	79, 77	81, 86

TABLE 4-2. Demographic characteristics of affected parishes.

	Demographic Indicators (state percentile, U.S. percentile)					
Parish	**Minority Population**	**Low Income Population**	**Linguistically Isolated Population**	**Population with Less than High School Education**	**Population under Age 5**	**Population over Age 64**
Terrebonne	49, 53	57, 68	73, 56	73, 80	61, 65	48, 47
St. Bernard	53, 56	61, 71	76, 59	63, 75	64, 69	31, 33
Plaquemines	51, 54	47, 60	70, 53	62, 74	59, 64	41, 42
Lafourche	38, 42	44, 58	76, 59	78, 83	53, 58	55, 53
St. Mary	59, 62	59, 69	73, 56	70, 78	57, 62	60, 57
Vermilion	36, 40	53, 65	80, 64	79, 84	58, 63	56, 54
Cameron	13, 19	37, 51	83, 67	68, 78	41, 44	63, 60
Iberia	57, 60	59, 70	73, 56	73, 80	61, 66	52, 51
Jefferson	62, 64	44, 58	88, 73	54, 68	52, 56	63, 60

4.2.3.2. Cultural Resources

Cultural resources are evidence of past human activity and may include pioneer homes, buildings, or old roads; structures with unique architecture; prehistoric village sites; historic or prehistoric artifacts or objects; rock inscription; human burial sites; or earthworks such as battlefield entrenchments, prehistoric canals, or mounds.

Alternatives implemented under tiered NEPA analyses consistent with the Final PDARP/PEIS would undergo consultations for all necessary state and federal permits, authorizations, or other regulatory processes concerning the protection of cultural and historical resources (DWH Trustees, 2016). If any culturally or historically important resources were identified during preparation or predevelopment surveys, the appropriate state and/or federal agencies would be notified, and further work in that area may be avoided until additional guidance is provided.

The marine mammal alternatives are near several cultural resources along the Louisiana coastline (TABLE 4-3; Stutts, 2014). These cultural resources areas are located on land and are not anticipated to be impacted by coastal or in-water stranding response or health program activities. Additionally, none of the trainings or workshops affiliated with the marine mammal alternatives would interfere with these locations, nor would Audubon's marine mammal rehabilitation facility. Therefore, no short- or long-term adverse impacts are anticipated from the marine mammal alternatives.

TABLE 4-3. Cultural resources potentially affected by marine mammal alternatives.

NRHP Listing	Resource Type	Location
Fort Jackson	Building	2.5 miles southeast of Triumph on Louisiana 23, west bank of Mississippi River
Fort Livingston	Structure	West tip of Grand Terre Island
Fort Macomb	Building	East of New Orleans at Chef Menteur Pass on U.S. 90
Fort Pike	Building	North of New Orleans, off U.S. 90 E
Fort St. Philip	Structure	2.5 miles southeast of Triumph on Louisiana 23, east bank of Mississippi River
Golden Meadow High School	Building	630 S. Bayou Drive
Harlem Plantation House	Building	W of Pointe a la Hache on Louisiana 39
St. Patrick's Catholic Church	Building	28683 Louisiana 23
Woodland Plantation	Building	21997 Louisiana 23

The oyster alternatives are within close proximity to two cultural resources. Chandeleur Light and Fort Livingston are within one mile of the Breton Sound POSG and Programmatic Brood Reef and Cultch Plant areas in Barataria Bay (Stutts, 2014). Both areas are potential sites for oyster restoration under the Enhancing Oyster Recovery Using Brood Reefs and Cultch Plant Oyster Restoration alternatives.

However, these cultural resource areas are located on land and are not anticipated to be impacted by the in-water work proposed for either of the oyster alternatives.

No adverse impacts on cultural resources are anticipated from any of the oyster or marine mammal alternatives; therefore, this resource area was not carried forward for detailed analysis. However, the State Historic Preservation Office (SHPO) will be consulted to ensure the proposed projects comply with Section 106 of the National Historic Preservation Act (NHPA).

4.2.3.3. Tourism and Recreation

The analysis area for tourism and recreation includes the parishes in coastal Louisiana, all of which offer unique coastal and water-based recreation activities including fishing, hunting, boating, and nature/wildlife viewing. These activities are an important component of coastal Louisiana's recreational and economic setting.

The marine mammal alternatives involve boat operations in recreational areas. These activities could impact active and passive recreational opportunities such as boating, fishing, and beachgoing. However, since alternative activities would not substantially increase boat traffic or restrict access to waters, no short- or long-term adverse impacts are anticipated.

The oyster alternatives involve in-water construction (e.g., cultch placement, brood reef construction). These activities have limited potential to impact tourism and recreation. For proposed project sites where no recreational use currently occurs, no short- or long-term adverse impacts would occur. In areas where recreational use currently does occur, there may be short-term disruptions to existing boating use while alternative implementation and construction are occurring, but any disruption is expected to be short-term, minor, and limited to the project area. BMPs would be followed to minimize disruptions (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

No long-term adverse impacts on tourism and recreation are anticipated from any of the marine mammal or oyster alternatives. Alternatives proposed under the oyster restoration type could have long-term beneficial impacts on tourism and recreation; oyster alternatives that create or enhance oyster reefs may provide increased opportunities for recreational oyster harvest and fishing. Based on the limited potential for adverse impacts and the potential beneficial impacts, this resource area was not carried forward for detailed analysis.

4.2.3.4. Public Health and Safety

Coastal land loss is an ongoing challenge in Louisiana resulting from a combination of factors including river channelization that alters important wetland flooding and sedimentation regimes; oil and gas channelization within marshes; land subsidence; and sea-level rise. Numerous additional anthropogenic impacts such as dredging, filling, and residential development have also limited the sustainability and resiliency of many coastal habitats.

Coastal land loss reduces the area of shorelines, marshes, and swamps that serve as vital barriers and a first line of defense against storm surge and flooding. Coastal flooding has become a common occurrence in Louisiana due to an increase in powerful storm surges associated with tropical events that have recently been made worse by subsidence, sea-level rise, and coastal land loss (CPRA, 2017). Projected land loss estimates in Louisiana for the next 50 years range from 1,207 square miles to 4,123 square miles in addition to the nearly 1,900 square miles of land area lost between 1932 and 2010 (CPRA, 2017). Land loss has severe impacts on flood protection as infrastructure becomes increasingly vulnerable. Many of Louisiana's urban centers such as New Orleans, the North Shore, and Lake Charles are projected to encounter significant increases in flood depths, and the low-lying areas of the coast are expected to see the most pronounced changes (FIGURE 4-1; CPRA, 2017).

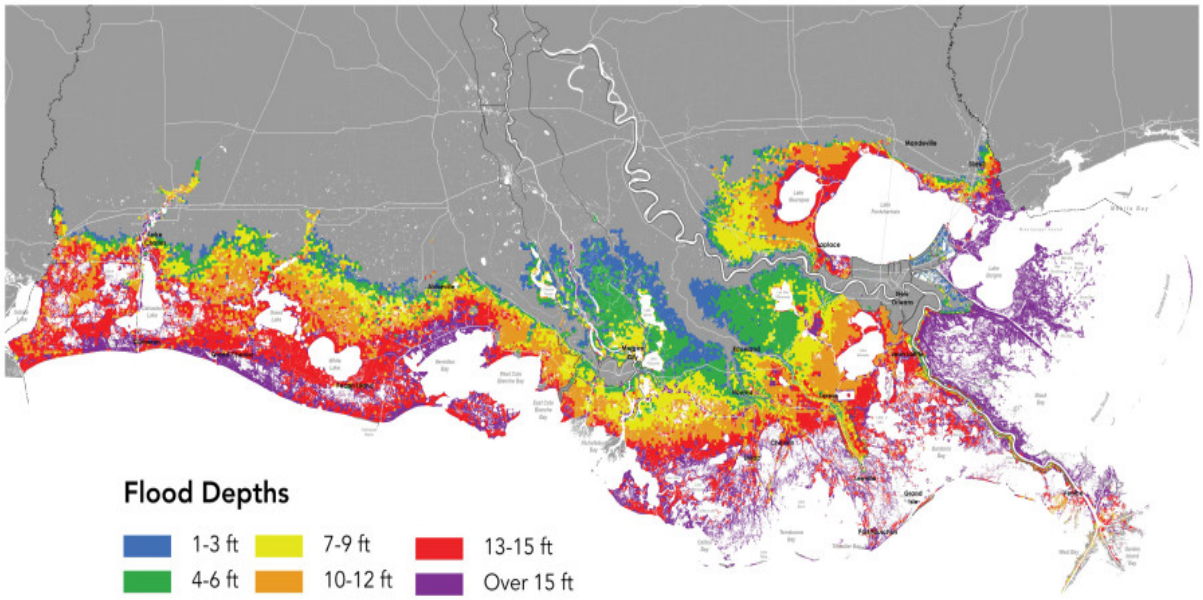

FIGURE 4-1. Projected flood depths in 2067 under modeled scenarios (CPRA, 2017).

The marine mammal alternatives are not anticipated to have beneficial or adverse impacts on the general public's health and safety; however, they could impact the safety of stranding network and health program personnel engaged in implementation activities. Responding to injured animals, rehabilitation, and health program activities have the potential to cause physical injury, and/or result in exposure to hazardous materials (e.g., chemicals used for sample preservation) and zoonotic diseases. However, only experienced personnel would participate in these activities, and appropriate training would be conducted prior to implementation to ensure that all personnel have the knowledge to avoid or minimize health and safety risks.

The oyster alternatives involve deployment of different types of material in various configurations to facilitate positive settlement and growth of oysters. These activities would likely have long-term, beneficial impacts to the health and safety of nearby communities because reefs dissipate wave and storm energy and may ultimately prevent erosion of the shoreline and surrounding estuarine wetland

systems. Flood control would also be improved. The oyster alternatives could impact the safety of personnel engaged in construction activities. However, only experienced personnel would participate in these activities, and health and safety plans would be developed and implemented for all alternatives. Personal protective equipment would also be used by construction personnel where appropriate.

No long-term, adverse impacts on public health and safety are anticipated from any of the marine mammal or oyster alternatives; therefore, this resource area was not carried forward for detailed analysis.

4.2.3.5. Infrastructure and Transportation

All of the marine mammal and oyster alternatives are located along the Gulf Coast, south of the Interstate 10 (I-10) corridor. Infrastructure within or around the proposed restoration sites includes traffic and transportation infrastructure, utility infrastructure (for power and water resources) including pipelines, and structures such as public restrooms or fishing piers. Federal interstates and U.S. highways are present in several of the parishes where the alternatives are located. Numerous state highways, local roadways, canals, and navigable waterways are present in each parish.

None of the marine mammal or oyster alternatives would create increased demands on area infrastructure that could not be accommodated by existing infrastructure, nor would they have long-term impacts on traffic, transportation, or infrastructure in these areas. None of the alternatives involve digging in soil or sediment, so no impacts on pipelines are anticipated. No long-term impacts on infrastructure and transportation are anticipated from any of the marine mammal or oyster alternatives; therefore, this resource area was not carried forward for detailed analysis.

4.2.3.6. Aesthetics and Visual Resources

Visual resources are the visible, physical features of a landscape that have an aesthetic value to viewers. The marine mammal and oyster alternatives are located along the coastline where the landscape is classified as wetland. The visual character of the landscape is often natural in undeveloped and protected areas; however, portions of the coastline support industrial land uses and exhibit a more developed aesthetic.

The marine mammal alternatives involve stranding response and health program activities. These activities are not anticipated to have any impacts on aesthetics and visual resources. The oyster alternatives involve construction and implementation activities (e.g., cultch placement, brood reef construction) which could result in short-term, minor adverse impacts on aesthetics and visual resources because of the presence of construction personnel and equipment. However, impacts would be temporary in nature and localized to the restoration site area. No long-term impacts on aesthetics and visual resources are anticipated from any of the marine mammal or oyster alternatives; therefore, this resource area was not carried forward for detailed analysis.

4.3. Resources Analyzed in Detail

This section provides detailed descriptions of each of the resources that the alternatives have the potential to adversely impact, and it provides descriptions of resources for which impacts could differ between the alternatives. The full evaluations of impacts anticipated for each of the alternatives are provided in Section 4.4 for the marine mammal restoration type and Section 4.5 for the oyster restoration type.

4.3.1. Physical Resources

4.3.1.1. Geology and Substrates

Ecoregions are areas that share similar ecological attributes such as vegetation, soils, geology, climate, hydrology, and wildlife and are designed to serve as the spatial framework for the management and monitoring of ecosystems (Lester et al., 2005). Level III ecoregions in Louisiana include the Western Gulf Coastal Plains, South Central Plains, Southeastern Plains, Mississippi Alluvial Plains, Mississippi Valley Loess Plains, and Southern Coastal Plains (Daigle et al., 2006). The affected parishes in this RP/EA are in the Western Gulf Coastal Plains and Mississippi Alluvial Plains ecoregions.

The Western Gulf Coastal Plains consist of relatively flat topography with underlying Quaternary-age alluvial deposits that include Northern Humid Gulf Coastal Prairies, Floodplains and Low Terraces, Texas-Louisiana Coastal Marshes, and Lafayette Loess Plains (Daigle et al., 2006). Potentially affected areas occur within Texas-Louisiana Coastal Marshes, which are characterized by extensive saltwater coastal marshes, bays, and lack of barrier islands.

The Mississippi Alluvial Plain contains the Southern Holocene Meander Belts, Inland Swamps, and Deltaic Coastal Marshes and Barrier Islands ecoregions (Daigle et al., 2006). The Southern Holocene meander belts are a series of Quaternary-age point bars, oxbows, natural levees, and abandoned channels. The Inland Swamps are transitional from the backswamps at the northern extent of the basins to the fresh, brackish, and saline waters of the deltaic marshes. Brackish and saline marshes dominate the Deltaic Coastal Marshes and Barrier Islands ecoregion, where extensive organic deposits result in the development of mucky-surfaced Histosols of sediments, silts, clays, and peats (Daigle et al., 2006). Inorganic sediments deposited in these marshes are soft with high water contents that create a severe shrink-swell potential upon draining (Daigle et al., 2006).

A number of substrates occur throughout the marine mammal and oyster alternatives' project areas and are primarily associated with physiographic setting and geologic processes. Substrates potentially impacted by the alternatives may include mucky, sediment depositions along shorelines rich in organic and inorganic minerals, including clays with a varying amount of silt, sand, and organic content (muck); mud-dominant marginal-deltaic environments capped with organic-rich, mucky sediments in fluid marshes (muck); tidal and eolian depositions of sandy substrates across coastal beaches of the Gulf shores (sands); and silty-dominated, eolian depositions across floodplains and uplands (loess) (NRCS, 2019). Substrates throughout these regions are critical components to alluvial, deltaic, fluvial, and tidal

biogeochemical processes, including carbon storage, microbial health, nutrient cycling, and water quality, and these substrates are critical in providing habitat for terrestrial and aquatic wildlife.

Soils in the potentially affected parishes are primarily from a variety of Quaternary-age depositional geologies, which have resulted in a diversity of soils across the coastal plains and terraced floodplains of southern Louisiana. Soils and substrates have been classified based on their primary geomorphic class (NRCS, 2019). Primary geomorphic groups identified in the alternatives include coastal marshes and inland swamps, which are composed of several secondary geomorphic subgroups that more closely define the physiographic positioning of these geomorphic subgroups.

Maximum elevations in Louisiana are in the northwest portion of the state where the oldest geologic formations are found; the highest elevation is 535 feet. The lowest elevation in the state is found in the Coastal Marsh region, which extends across the south portion of Louisiana. Because of levee construction, marsh filling, and subsidence, portions of southern Louisiana are below sea level (LDEQ, 2016).

4.3.1.2. Hydrology and Water Quality

Louisiana has 12 major basins comprising 11 river watersheds and the Lake Pontchartrain watershed. The Mississippi River is the most significant source of freshwater in coastal Louisiana, and salinity is one of the primary environmental factors for oyster habitat suitability.

Louisiana has a humid subtropical climate influenced by the extensive landmass to the north, the Gulf of Mexico to the south, and the subtropical latitude. Prevalent winds from the south-southeast bring in warm, moist air from the Gulf, resulting in abundant rainfall. The statewide average precipitation varies from 48 inches in the northwest near Shreveport to 64 inches in the southeast coastal plains near Thibodaux. Rainfall influences the volume of runoff entering coastal waters, which influences salinity and impacts habitat suitability for various marine organisms, and oysters in particular.

Basins and Impaired Water Bodies

The marine mammal and oyster alternatives are located throughout coastal Louisiana in nearshore and coastal environments, including waters of the U.S. (according to the Federal Water Pollution Control Act, or the Clean Water Act (CWA), 33 U.S.C. §§ 1151 et. seq., and its implementing regulations, 40 C.F.R §§ Parts 100-140, 401-471, and 501-503) and navigable waterways (regulated by the Rivers and Harbors Act, 33 U.S.C §§ 400 et. seq.). Section 404 of the CWA requires the U.S. Army Corps of Engineers (USACE) authorization before discharging dredged or fill material into waters of the U.S., including wetlands and special aquatic sites (33 U.S.C. § 1344). Under Section 401 of the CWA, projects that entail discharge to wetlands or other waters within federal jurisdiction must obtain state certification of compliance with applicable state water quality standards (33 U.S.C. § 1341). Under Section 401, states can review and approve, condition, or deny all federal permits or licenses that might result in a discharge to state waters, including wetlands (*Id.*).

Wetlands and Floodplains

EO 11990: Protection of Wetlands, as amended, is intended to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. To meet these objectives, the EO requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

Wetlands and floodplains provide habitat for oysters and support many aquatic organisms that are preyed upon by marine mammals and improve water quality by removing organic and inorganic toxic materials, suspended sediments, and nutrients via soil processes and assimilation by plants. Wetlands also help to attenuate waves and storm surge, protecting shorelines, potentially reducing erosion, and providing flood control.

Louisiana has more than three million acres of coastal wetlands that constitute approximately 40 percent of the remaining coastal marsh in the lower 48 states (USGS, 2014). Louisiana's coastal zone can be divided into two distinct regions: the Chenier Plain and the Deltaic Plain, both of which were formed by influences from the Gulf of Mexico and historic patterns of sedimentation and erosion from the Mississippi River and its distributaries.

EO 11988: Floodplain Management, as amended, requires federal agencies to avoid, to the extent possible, the adverse, long- and short-term impacts associated with the occupancy and modification of floodplains and avoid direct and indirect support of floodplain development wherever there is a practicable alternative. This EO does not apply to the proposed action as none of the alternatives proposed for implementation include floodplain development.

4.3.2. Biological Resources

4.3.2.1. Habitats

The Louisiana Gulf Coast includes numerous estuaries and bays, tidal marshes and creeks, and barrier islands, in addition to open marine waters. These coastal areas and nearshore waters are important for nesting, feeding, and migration to a variety of commercial and recreational fisheries, crustaceans, shellfish, marine mammals, sea turtles, and birds. The information provided below is summarized from the Final PDARP/PEIS (DWH Trustees, 2016), as well as the Louisiana Natural Heritage Program (LNHP) and LDWF report, *The Natural Communities of Louisiana* (2009).

Estuarine Habitats

The estuarine system consists of deep-water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open Gulf, and in which Gulf water is at least occasionally diluted by freshwater runoff from the land. Salinity may vary based on freshwater inputs or evaporation. Along some low-energy coastlines there is appreciable dilution of sea water. Offshore areas with typical estuarine plants and animals, such as black mangroves (*Avicennia germinans)* and eastern oysters (*Crassostrea virginica*), are also included in the estuarine

system. The estuarine system extends (1) upstream and landward to where Gulf-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow; (2) to an imaginary line closing the mouth of a river, bay, or sound; and (3) to the seaward limit of wetland emergent plants, shrubs, or trees where they are not included in (2). The estuarine system also includes offshore areas of continuously diluted sea water. The estuarine system includes both estuaries and lagoons. It is more strongly influenced by its association with land than is the marine system. In terms of wave action, estuaries are generally considered to be low-energy systems. Estuarine water regimes and water chemistry are affected by one or more of the following forces: tides, precipitation, freshwater runoff from land areas, evaporation, and wind (LNHP, 2009).

Marsh

The northern Gulf of Mexico is recognized for its vast coastal tidal wetlands, which are estimated to represent half of the total saltwater intertidal wetland habitat in the lower 48 states (Dahl & Stedman, 2013). Louisiana alone contains nearly 40 percent of coastal wetlands in the continental U.S. (USGS, 2014). These marshes play a critically important role as a nitrogen and phosphorus sink (at least seasonally), thereby improving the quality of water that passes through them. In addition, marshes can modify the impacts of storms and flooding by acting as a buffer and providing storage for large amounts of water.

Types of marsh found in Louisiana include salt marsh, brackish marsh, and intermediate marsh. Intrusion of saline water may influence the configuration of the various marsh types. The mean salinity of salt marsh is 16 parts per thousand, but salinity may reach 35 parts per thousand when inundated by sea water (America's Wetland Foundation, 1991). Brackish marsh salinity ranges between ten and 20 parts per thousand, and intermediate marsh salinity ranges from two to ten parts per thousand (America's Wetland Foundation, 1991). Soil and water conditions regulate plant growth, but salinity appears to be the primary factor determining species composition.

In particular, salt marsh serves as a critical and highly productive transition zone between the emergent marsh vegetation and open water, aiding the movement of organisms and nutrients between intertidal and subtidal estuarine environments (Levin et al., 2001). The salt marsh community is often totally dominated by smooth cordgrass (*Spartina alterniflora),* while brackish and intermediate marsh are dominated by wiregrass (*Aristida stricta).* Significant associated species in marsh habitat include salt grass *(Distichlis spicata*), black rush (*Juncus roemarianus)*, salt wort (*Batis maritima*), three-cornered grass (*Schoenoplectus olneyi*), dwarf spike sedge (*Eleocharis parvula*), widgeon grass (*Ruppia maritima*), seashore paspalum (*Paspalum vaginatum)*, coastal water hyssop (*Bacopa monnieri*), big cordgrass (*S. cynosuroides)*, Roseau cane or common reed (*Phragmites australis*), bulltongue (*Sagittaria lancifolia*), giant bulrush (*S. californicus*), common threesquare *(S. pungens*), deer pea *(Vigna luteola*), switch grass *(Panicum virgatum*), bearded sprangletop *(Leptochloa fascicularis*), camphor-weed *(Pluchea camphorata*), walter millet *(Echinochloa walteri*), fragrant flatsedge *(Cyperus odoratus*), alligator weed *(Alternanthera philoxeroides*), southern naiad *(Najas guadalupensis*), and Gulf cordgrass *(S. spartineae*). Two other major groups of autotrophs found in marsh communities are microscopic algae on the surface of the vascular plants and benthic algae (usually diatoms) living on or in the marsh sediment.

Marshes in general are also important habitats for terrestrial animals, including amphibians, reptiles, and mammals, and support extraordinary bird species diversity. These habitats are especially important for birds, because many different species nest, forage, or loaf in the varying types of marshes in Louisiana.

Coastal Mangroves

Coastal mangroves are estuarine communities dominated by black mangrove (*A. germinans*), and also include smooth cordgrass (*S. alterniflora)*, saltwort (*Salsola*), creeping glasswort (*Salicornia virginica*), and other herbaceous species in the understory. Although sometimes considered a swamp, the physiognomy of the community in Louisiana more closely resembles a shrub thicket. The coastal region of Louisiana delimits the northern range of this community due to mangrove's inability to tolerate temperatures much below freezing. Coastal mangroves have several important ecological functions: the extensive root systems stabilize the shoreline and reduce erosion; the cover and food they provide create excellent habitat for many species of fish, shellfish, and wildlife; the community improves surrounding water quality by filtering nutrients and suspended sediments; and many colonial waterbirds (e.g., herons, egrets, pelicans) use the mangroves as nesting areas. An estimated total of 4,000 to 6,000 acres of mangroves in Louisiana have been identified along the fringes of coastal marshes and islands with some more extensive thickets on barrier islands. The winters of 1983 and 1984 seriously reduced the extent of the community in coastal Louisiana. Their importance in erosion control has been documented by the extreme erosion of Queen Bess Island since the dieback (LNHP, 2009).

Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV) consists of rooted vascular plants that grow in fresh, brackish, and saltwater, and are extremely productive habitats within the marine and estuarine waters of coastal Louisiana. SAV beds provide important foraging grounds and nursery habitat for many marine and estuarine species in the Gulf of Mexico, including nearly all managed fisheries. SAV communities also support many threatened and endangered species, including sea turtles and manatees. In Louisiana, SAV occurrence is most prevalent throughout interior estuarine habitats with lower salinity and turbidity, and is likely absent in the saline and brackish marsh areas located in exposed, down-estuary regions of coastal Louisiana (DeMarco et al., 2018). Common SAV species that occur across fresh to saline marsh zones in Louisiana include coontail (*Ceratophyllum demersum*), waterweed (*H. verticillata*), Carolina fanwort (*Cabomba caroliniana*), spiked water-milfoil (*Myriophyllum spicatum*), eelgrass (*Vallisneria americana*), small pondweed (*Potamogeton pusillus*), southern waternymph (*N. guadalupensis*), sago pondweed (*Stuckenia pectinata*), and tasselweed (*R. maritima*; DeMarco et al., 2018).

Oyster Habitat

Commercial oysters are predominantly harvested from subtidal areas that state management agencies have designated as open to harvest. Oyster reefs in nearshore or subtidal waters designated as closed to harvest can act as sanctuary areas for oysters spawning stock. In some areas, oysters and other bivalves can colonize human-made reefs, which provide oyster habitat that is not subject to commercial harvest. Oysters are integrated throughout the coastal ecosystem in both nearshore and subtidal areas, creating

habitat for other aquatic organisms (e.g., shellfish, crabs, and finfish), stabilizing shoreline areas, and improving water quality and clarity through their filtering action (Grabowski and Peterson, 2007). The reefs are formed by the living and non-living portions of structures formed by oysters, clams, marine worms, and macrophytic algae. The living assemblage exists on top of a dead reef base, all of which occurs on a consolidated surface. Oyster reefs are primarily built by eastern oysters (*C. virginica)* but hooked mussels *(Ischadium recurvum)* and eastern white slippersnails (*Crepidula plana)* are also present and may form a high percentage of the reef fauna. Green algae (*Chlorophyta*) can be found in abundance attached to these reefs. LDWF manages approximately 1.7 million acres of public oyster habitat, which includes POA, POSG, and POSR in several locations along the Louisiana coastline (LDWF, 2018). In Louisiana, the area of leased water bottoms in which private entities produce and harvest oysters totals approximately 400,000 acres (LDWF, 2018). The largest areas of public oyster reef habitat in Louisiana currently include the Vermilion Bay/West Cote Blanche Bay/Atchafalaya Bay area and Lake Borgne/Chandeleur Sound/Black Bay area (LDWF, 2019).

Beaches and Dunes

A beach is an unconsolidated, regularly inundated deposition of sand, shell, or mud that is subject to high-energy tides and wave action. Dunes are mounds or ridges of sand located behind a beach that have been formed by the wind. Normally there is little vegetation on beaches, although a few species may be present on dunes in the higher beach zone where tidal inundation is relatively infrequent. Undisturbed or minimally disturbed beaches are typically very rich in animal life and serve as important breeding, nesting, wintering, and foraging habitats. Animals may include “sand-dwellers” such as crabs and snails, as well as shorebirds that feed along the coastline (e.g., heron, egret) and nesting sea turtle species (e.g., loggerhead).

In addition to serving as habitat, beaches and dunes play a key physical role in the ecosystem, acting as a buffer from storms and hurricanes for other habitats and human communities. They also provide a diverse array of recreational opportunities, including swimming, fishing, and sunbathing.

Shallow Water

This habitat consists of the relatively shallow (i.e., three feet), permanently inundated subtidal zone beginning immediately below the lowest tide level mark and is subjected to high-energy tidal and wave action. It also includes shallow water unvegetated flats and wash over fans and bars on the bayward side of barrier islands. The bottom is composed of loose sand/sediment/mud/shell/organic debris mixed in various combinations. Unconsolidated bottoms are characterized by the lack of stable surfaces for plant and animal attachment and may be very unstable. Exposure to wave and current action, temperature, salinity, and light penetration determine the composition and distribution of organisms. Flowering plants (i.e., seagrass) can successfully root if wave action and currents are not too strong. Most animals in unconsolidated sediments live within the substrate; however, seagrass communities also host a diverse assemblage of plant and animal species. This community transitions gulfward into submerged algae, submerged vascular vegetation, marine deep water, and shoreward into intertidal sand/mud/shell beach/bar (LNHP, 2009).

4.3.2.2. Terrestrial Wildlife

The marine mammal and oyster alternatives' action areas contain habitat for hundreds of resident and migratory terrestrial species that is characterized by the swamplands, bayous, coastal marshlands, beaches, and barrier islands of the region. Various species of mammals, birds, amphibians, and reptiles can be found across these diverse habitats, and common species include North American river otter (*Lontra canadensis*), white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), squirrel (*Sciurus* spp.), cottontail rabbit (*Sylvilagus* spp.), and American alligator (*Alligator mississippiensis*), as well as numerous species of frogs, turtles, and snakes. Non-native wildlife in the analysis area include nutria (*Myocastor coypus*) and wild boar (*Sus scrofa*).

Migratory birds include neotropical (long-distance) and temperate (short-distance) migrants, as well as resident species. The habitat in the analysis area provides suitable breeding, nesting, feeding, foraging, resting, and/or roosting habitat for a number of migratory bird species groups. These groups include wading birds (e.g., egrets and herons), shorebirds (e.g., sandpipers and plovers), seabirds (e.g., gulls and terns), marsh birds (e.g., rails and coots), waterfowl (e.g., ducks and geese), and land birds, which include raptors (e.g., eagles, hawks, falcons, and owls) and numerous passerines (e.g., sparrows, warblers, flycatchers, jays, and wrens). The marine mammal and oyster alternatives' action area supports a high diversity of birds during breeding, wintering, and migration as a result of the varied habitats.

The Migratory Bird Treaty Act of 1908 (MBTA) is the primary legislation in the U.S. protecting migratory birds (16 U.S.C. §§ 701 *et seq*.). The statute makes it unlawful without a waiver to pursue, hunt, take, capture, kill, or sell birds or the parts, nests, or eggs of migratory birds. Non-native bird species, such as European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*), are not covered under the MBTA. Another statute, the Bald and Golden Eagle Protection Act of 1940 (BGEPA), further protects eagles within the U.S. In addition to similar protections afforded migratory birds, the BGEPA also protects eagles from disturbance and human-induced alterations that may impact nesting areas (16 U.S.C. §§ 668-668(d)). Bald eagles (*Haliaeetus leucocephalus*) are not known to breed and winter in the action area.

4.3.2.3. Marine and Estuarine Fauna

Marine and estuarine aquatic fauna and fishery resources are federally managed or protected by several statutes including, as amended: the Fish and Wildlife Coordination Act of 1958, (16 U.S.C. §§ 661-666c); the ESA (16 U.S.C. §§ 1531 et. seq.); the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSA),(16 U.S.C. §§ 1801); the MSA Reauthorization of 2006 (*Id.* and P.L. 109-479); the Coastal Zone Management Act (CZMA, 16 U.S.C. §§ 1451 *et seq*.); and the Estuary Protection Act (16 U.S.C. §§ 1221-1226). Marine and estuarine aquatic fauna and fishery resources hold ecological and socioeconomic importance due to the following:

- They are critical elements of many valuable estuarine and marine habitats.
- They are indicators of the health of various estuarine and marine habitats.
- Many species are commercially and recreationally important.

The marine mammal and oyster alternatives' action areas are located along the Louisiana coastline and are within tidally influenced areas that support a wide variety of living aquatic resources including resident and migratory fishes, mammals, crustaceans, mollusks, reptiles and benthic invertebrates. Examples of these species include: diamond-backed terrapin (*Malaclemys terrapin*), saltmarsh snake (*Nerodia clarkii*), Atlantic croaker (*Micropogonias undulatus*), Gulf killifish (*Fundulus grandis*), Gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), white shrimp (*Litopenaeus setiferus*), blue crab (*Callinectes sapidus*), eastern oyster (*C. virginica*), oyster drill (*Stramonita haemastoma*), and various polychaete worms. These estuarine-dependent species often serve as prey for other coastal and aquatic species, including sport fish in managed fisheries such as red drum (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), southern flounder (*Paralichthys lethostigma*), billfishes, snappers and sharks, avian predators such as the brown pelican (*Pelecanus occidentalis*), and mammalian predators like the American mink (*Mustela vison*) and river otter (*L. canadensis*). Habitats in these regions typically include estuarine wetlands (e.g., marsh edge, inner marsh, marsh ponds, and tidal creeks); SAV and seagrass beds; mud, sand, shell, and rock substrates (e.g., oyster reefs and barrier island flats); mangroves; and the water column. Marine and estuarine fauna occur in coastal parishes throughout Louisiana.

4.3.2.4. Essential Fish Habitat

Fishery resources are publicly significant because of the high priority placed on their recreational and commercial value. Habitat is the foundation for the commercial and recreational saltwater fishing industries that provided more than 1.6 million full- and part-time jobs and over $200 billion in economic activity across the U.S. in 2015. The estuarine-dependent Louisiana fishery is an $875 million industry (Louisiana TIG, 2018). Aquatic fauna requires a healthy environment to survive and reproduce. The MSA defines Essential Fish Habitat (EFH) as "those waters and substrates necessary for fish to spawn, breed, feed, or grow to maturity," and includes several aquatic habitat types, including wetlands, coral reefs, seagrasses, and mangroves.

The MSA is the primary law governing marine fisheries management in federal waters of the U.S. and fosters long-term biological and economic sustainability of the nation's marine fisheries out to 200 nautical miles. The key objectives of MSA are to prevent overfishing, rebuild overfished stocks, increase long-term economic and social benefits, and ensure a safe and sustainable supply of seafood. The act provides a transparent and robust process of science, management, innovation, and collaboration with the fishing industry to evaluate and determine if a stock status is experiencing overfishing or is overfished (NOAA Fisheries, 2018).

EFH is defined in the MSA as "those waters and substrates necessary for fish to spawn, breed, feed, or grow to maturity." The designation and conservation of EFH seeks to minimize adverse impacts on habitat caused by fishing and non-fishing activities. Any federal agency that takes an action that could adversely affect EFH by reducing the quantity or quality of habitat must work with NMFS to identify impacts and steps for conserving the habitat and reducing the impact of the action. NMFS has identified EFH habitats for the Gulf of Mexico in its Fisheries Management Plan Amendments. These habitats include estuarine emergent wetlands; seagrass beds; algal flats; mud, sand, shell, and rock substrates;

and the estuarine water column. All marine mammal and oyster alternatives' action areas contain EFH. The EFH components within the areas of these alternatives include emergent wetlands, mud substrate, and estuarine water columns.

The water bodies and wetlands within and adjacent to the oyster and marine mammal restoration sites provide essential nursery and foraging habitats that support a variety of aquatic fauna, including economically important estuarine and saltwater species. The marine mammal alternatives include activities that would occur in all coastal waters of Louisiana and the oyster alternatives also cover large areas of coastal Louisiana. As a result, activities overlap with EFH for several managed fisheries. The collective list of EFH that overlap with the marine mammal and oyster alternatives is provided in TABLE 4-4. Section 4.4.2.5 and 4.5.2.5 provide detailed EFH analysis for each of the marine mammal and oyster alternatives individually.

TABLE 4-4. EFH that overlaps with the proposed marine mammal and oyster alternatives.

Restoration type	Essential Fish Habitat
Marine Mammal	Brown shrimp, white shrimp, pink shrimp, red drum, gray snapper, lane snapper, red snapper, vermilion snapper, gray triggerfish, Spanish mackerel, king mackerel, almaco jack, greater amberjack, cobia, hammerhead shark, scalloped hammerhead shark, blacktip shark, bull shark, spinner shark, Atlantic sharpnose shark, blacknose shark, and finetooth shark.
Oyster	Same as above.

4.3.2.5. Protected Species

Protected species include wildlife and plant species that are protected from harm or harassment by law. The ESA protects all federally listed wildlife and plant species, and designated critical habitat of these species (16 U.S.C. §§ 1531 et. seq.). The ESA requires that federal agencies ensure that any action authorized, funded, or carried out by an agency is not likely to jeopardize the continued existence of any listed species, or result in the destruction or adverse modification of designated critical habitat. Other protected species include marine mammals, protected by the MMPA (16 U.S.C. §§ 1361-2, 1371-1389, 1401-7, 1411-8, 1421-1421h, 1423-1423h), and migratory birds, protected by the MBTA (16 U.S.C. §§ 701 *et seq*.). To fulfill requirements and obligations under the ESA and the MMPA, the Louisiana TIG is engaged in technical assistance for each of the preferred alternatives with the U.S. Fish and Wildlife Service (USFWS) and NOAA for compliance with Section 7 of the ESA of 1973, 16 U.S.C. § 1536, as amended, and Section 101 of the MMPA, 16 U.S.C. § 1361, as amended.

ESA Listed Species

Federally protected species listed as threatened or endangered within the marine mammal and oyster alternatives' action area are included in TABLE 4-5 (USFWS, 2018).

TABLE 4-5. Protected species under the ESA in inshore waters of Louisiana (USFWS, 2018).

Listed Species (common name)	Listed Species (scientific name)	ESA Status
Atlantic Sturgeon (Gulf Subspecies)*	*Acipenser oxyrinchus desotoi*	Threatened
Green Sea Turtle	*Chelonia mydas*	Threatened
Giant manta ray	*Manta birostris*	Threatened
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered
Loggerhead Sea Turtle	*Caretta*	Threatened
Pallid Sturgeon	*Scaphirhynchus albus*	Endangered
Piping Plover*	*Charadrius melodus*	Threatened
Red Knot	*Calidris canutus rufa*	Threatened
West Indian Manatee	*Trichechus manatus*	Endangered
*Species with designated critical habitat in inshore waters of Louisiana.		

Critical habitat, designated under the ESA, is defined as areas containing the physical or biological features essential to a listed species' conservation and is designated when it is both "prudent and determinable." These features are referred to as primary constituent elements (PCEs). Any action authorized, funded, or carried out by an agency is prohibited from destroying or adversely modifying designated critical habitat. Atlantic sturgeon (Gulf subspecies) and piping plover have designated critical habitat that occurs within or in close proximity to where the alternatives are located.

Critical habitat for the Atlantic sturgeon (Gulf subspecies) was designated in 2003 (USFWS, 2003) and is restricted to the eastern half of Lake Pontchartrain and the entirety of Lake Borgne, located in the eastern portion of the marine mammal and oyster alternatives' action area. This critical habitat contains habitat identified as estuarine and marine habitat of the species, and provides juvenile, subadult, and adult feeding, resting, and passage habitat from the Pascagoula and the Pearl River subpopulations. Lake Pontchartrain is thought to provide important wintering habitat for juveniles and subadults (USFWS, 2003). Additionally, critical habitat for wintering populations of piping plover in Louisiana was designated in 2001 and consists of "coastal areas that support intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide" (USFWS, 2001). The marine mammal and oyster alternatives occur along the Louisiana coastline and are within or are in close proximity to critical habitat for these species. FIGURE 4-2 illustrates critical habitat within close proximity of the oyster alternatives. FIGURE 4-3 illustrates critical habitat along the Louisiana coastline, which may be in close proximity to the marine mammal alternatives. Sections 4.4.2.4 and 4.5.2.4 provide detailed protected species analyses for each of the marine mammal and oyster alternatives individually.

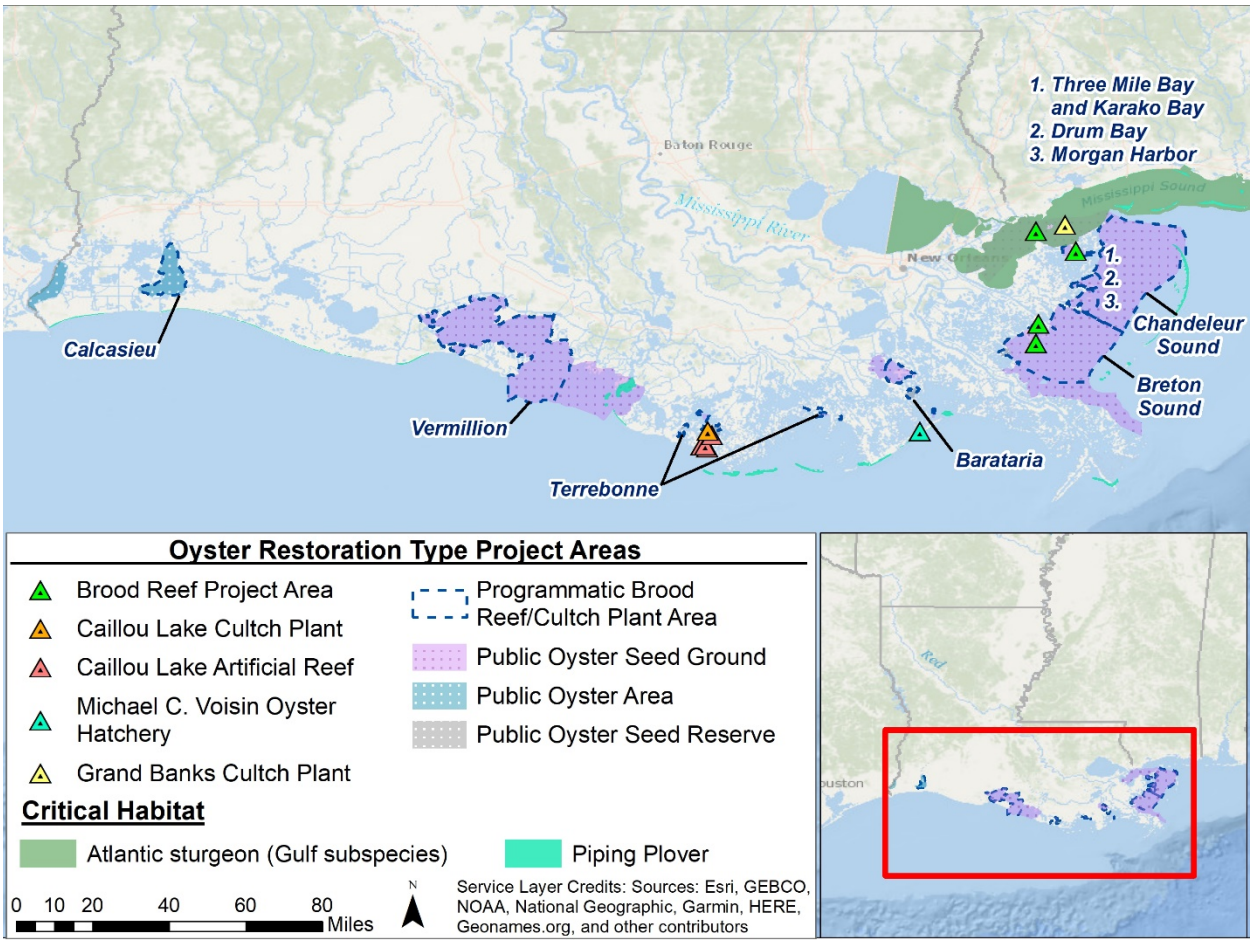

FIGURE 4-2. Critical habitat for Atlantic sturgeon (Gulf subspecies) and piping plover near proposed oyster alternatives.

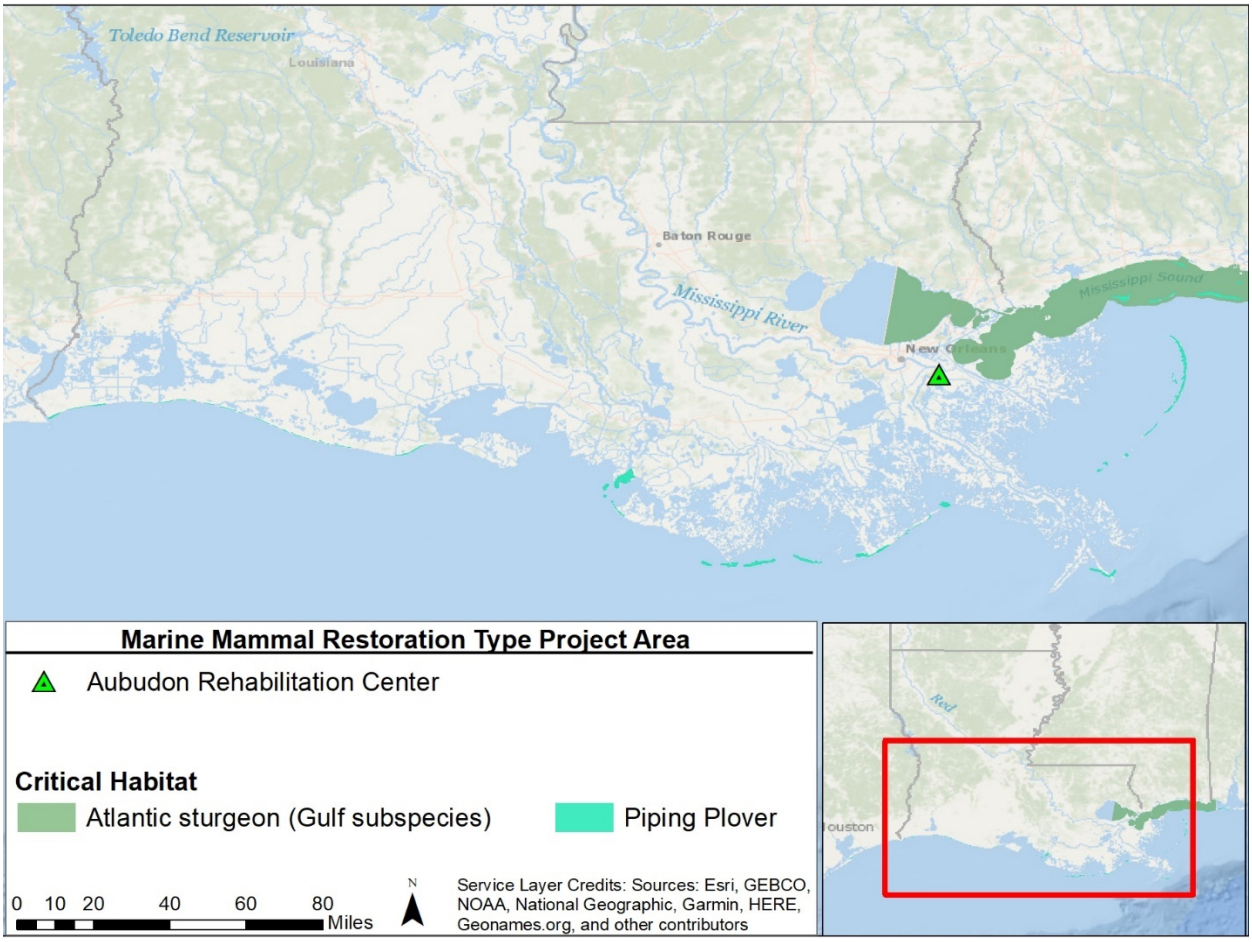

FIGURE 4-3. Critical habitat for Atlantic sturgeon (Gulf subspecies) and piping plover near proposed marine mammal alternatives.

Federally Protected Marine Mammals

The MMPA, enacted on October 21, 1972, prohibits the take of marine mammals in U.S. waters or by U.S. citizens on high seas and forbids the importation of marine mammals or marine mammal products into the U.S. Jurisdiction for MMPA is shared between USFWS and NMFS. Marine mammals that may occur near the proposed alternatives include the West Indian manatee, also an ESA listed species, discussed above, and bottlenose dolphin. Sections 4.4.2.4 and 4.5.2.4 provide detailed evaluations for potential impacts to protected species for each of the marine mammal and oyster alternatives individually.

4.3.3. Socioeconomic Resources

4.3.3.1. Land and Marine Management

The CZMA is a federal act that encourages states to develop coastal management programs for preserving statewide coastal resources. Under this act, once a state develops a federally approved coastal management program, "federal consistency" requires that any federal actions affecting coastal land or water resources must be consistent with the state's program. In Louisiana, the LDNR Office of Coastal Resources oversees the state's Coastal Zone Management Program (CZM Program). The marine mammal and oyster alternatives are located within the Louisiana Coastal Zone established by the state and Local Coastal Resources Management Act of 1978 and modified in 2012 (LDNR, 2019), and will all require federal consistency determinations.

4.3.3.2. Fisheries and Aquaculture

In 2017, commercially important species within Louisiana included Gulf menhaden (716 million pounds), white shrimp (69 million pounds), blue crab (44 million pounds), brown shrimp (25 million pounds), and eastern oysters (13 million pounds). Landings from these five species amounted to approximately $332 million in 2017. Other commercially important species include crayfish (*Procambarus clarkii)*, blue catfish, black drum, and red snapper, among others (NOAA, 2020). Louisiana is also an important state for aquaculture; in 2017, aquaculture sales and distribution amounted to approximately $133.5 million (USDA, 2020). LSU's Agricultural Center estimates that there are more than 2,000 diverse aquaculture operations throughout the state, largely producing crawfish, catfish, crabs, and oysters, among others (Romaire et al., 2012).

4.4. NEPA Analysis for Marine Mammal Restoration Type

This section provides an evaluation of the potential impacts of each marine mammal restoration alternative on the area's physical, biological, and socioeconomic resources. More specifically, this section evaluates the alternatives' impacts on:

- Physical resources: geology and substrates, hydrology and water quality;
- Biological resources: habitats, terrestrial wildlife, marine and estuarine fauna, protected species, EFH; and

- Socioeconomic resources: land and marine management, fisheries and aquaculture.

Section 4.6 evaluates cumulative impacts.

4.4.1. Physical Resources

4.4.1.1. Geology and Substrates

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts on geology and substrates during stranding responses due to use of temporary nets for capture, contamination (e.g., from euthanasia solution, sedatives, antibiotics), carcass burial on site, and sediment disturbance during motorized boat operation and foot traffic associated with the response team. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016). Additionally, this alternative involves potential enhancements of Audubon's marine mammal rehabilitation facility (i.e., the Coastal Wildlife Network). Enhancements could include installation of a permanent pool and shade structure, which could result in short-term disturbances to geology and substrates in the area during construction. Construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016).

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts on geology and substrates during in-water health assessment activities due to use of temporary nets for capture; contamination from sedatives, antibiotics, blood, tissue, and other biological samples; and activities that disturb sediments, such as motorized boat operation and foot traffic. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts on substrates or geology would occur. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

4.4.1.2. Hydrology and Water Quality

FIGURE 4-4 illustrates the HUC6 water basins that overlap with the marine mammal alternatives. Both of the marine mammal alternatives would occur along the Louisiana coastline.

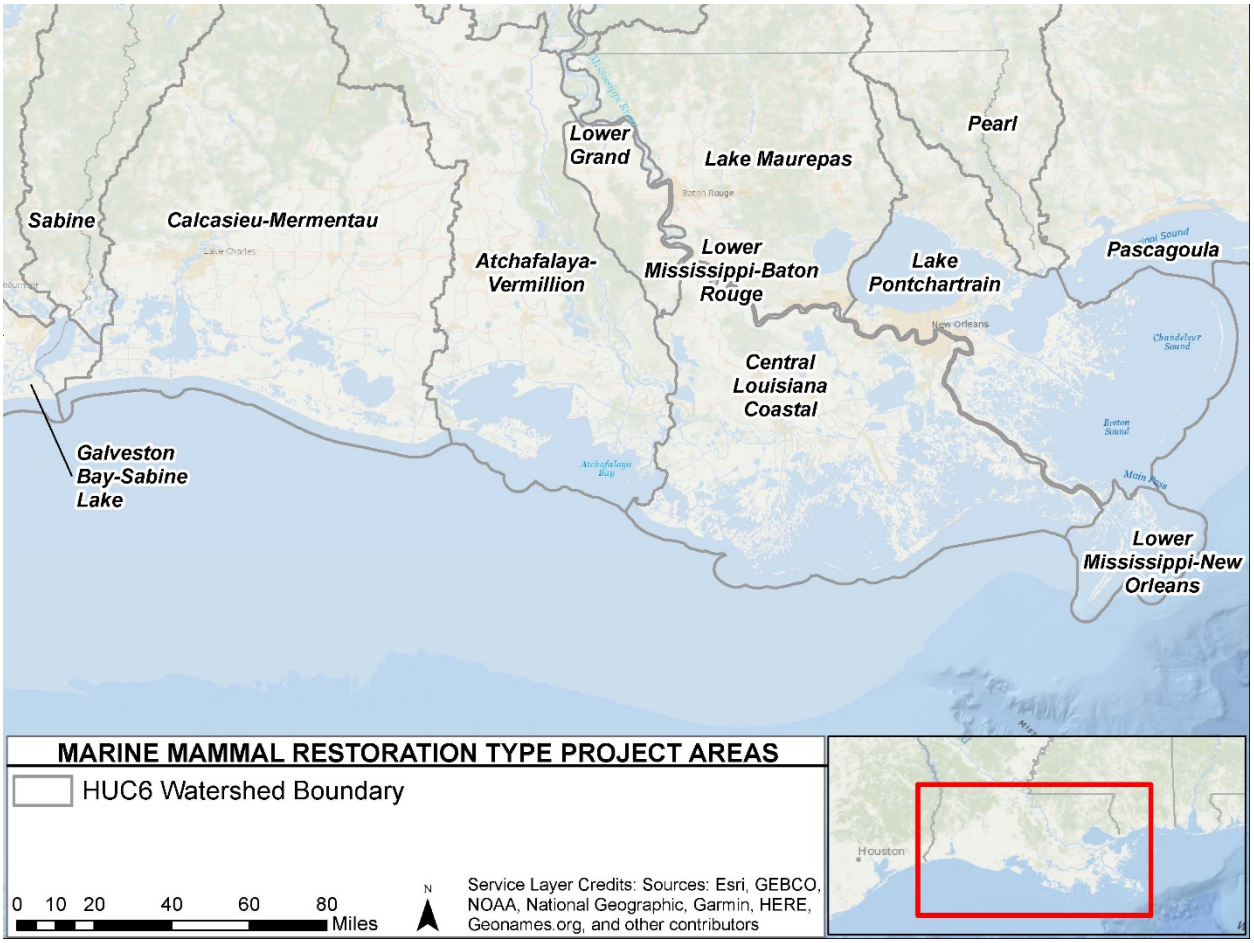

FIGURE 4-4. Louisiana water basins potentially affected by proposed marine mammal alternatives.

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts on water quality during stranding responses due to use of temporary nets, contamination (e.g., from euthanasia solution, sedatives, antibiotics), and carcass burial on site. Activities that require the use of a motorized boat could have some impacts on water quality due to wastes from motorized boats and leaks from equipment into surrounding waters. Boat operation and human presence in shallow water may result in short-term, minor increases in turbidity. However, all of these impacts are expected to be temporary, and conditions would return to baseline following completion of stranding response activities. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016). Audubon's marine mammal rehabilitation facility would maintain permits for wastewater discharges. All waste from the facility would be contained and disposed of properly and, therefore, would not materially adversely impact water quality.

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts on water quality during in-water health assessment activities due to spills of hazardous materials (e.g., sedatives, antibiotics, blood, tissue, and other biological samples). Protocols for appropriate handling of chemicals would be available, including all Material Safety Data Sheets (MSDS). Hazardous materials and toxic substances would be handled and stored according to Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910, subpart H and subpart Z).

Additionally, activities that require the use of motorized boats would have some impacts on water quality due to wastes from motorized boats and leaks from equipment into surrounding waters. Boat operation and human presence in shallow water may result in short-term, minor increases in turbidity. However, all of these impacts are expected to be temporary and conditions would return to baseline following completion of the health program activities. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts on hydrology or water quality would occur.

4.4.2. Biological Resources

4.4.2.1. Habitats

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts on beaches, dunes, marshes, or other coastal habitats where marine mammal strandings and associated response activities occur. Any potential impacts are expected to be temporary, resulting from operation of boats and foot traffic associated with the response team, potential spills of hazardous materials (e.g., euthanasia solution, sedatives, antibiotics), leaks from equipment into surrounding sand or waters, and human activity. Impacts could include disturbance of terrestrial and aquatic vegetation, damage to sand dunes, beach compaction, in-water turbidity, water contamination, and underwater noise during response activities. To avoid potential impacts on SAV, MMSN personnel would avoid working in areas with SAV, and if necessary, boat propellers would be elevated to avoid scarring the water bottom, or otherwise damaging seagrass or algae. Similarly, MMSN personnel would avoid disturbing dune or beach vegetation when possible. Any potential impacts would be temporary, and conditions would return to baseline following completion of stranding response activities. Any disturbance to dune or beach vegetation would recover naturally over time. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts on nearshore coastal habitats where health program activities may occur. Any potential impacts are expected to be temporary, resulting from operation of boats, potential spills of hazardous materials (e.g., sedatives, antibiotics, biological samples), leaks from equipment into surrounding sand or waters, and human activity. Impacts could include disturbance of aquatic vegetation, in-water turbidity, water contamination, and underwater noise during health program activities. To avoid potential impacts on SAV, health program personnel would avoid working in areas with SAV, and if necessary, boat propellers would be elevated to avoid scarring the water bottom, or otherwise damaging seagrass or algae. Any potential impacts would be temporary, and conditions would return to baseline following completion of health program activities. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts on habitats would occur.

4.4.2.2. Terrestrial Wildlife

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts to wildlife. Temporary disturbances to birds, including primarily shorebirds or wading birds, could occur during stranding response activities due to increases in boat traffic, foot traffic, noise, and human presence. Other passerines or beach-dwelling species could also be affected. Affected animals would likely avoid the area during response activities, but once completed, impacts are expected to be minor. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts to wildlife. Temporary disturbances to birds, including primarily shorebirds or wading birds, could occur during health program activities due to increases in boat traffic, noise, and human presence. Affected animals would likely avoid the area during health program activities, but once completed, impacts are expected to be minor. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no adverse impacts on terrestrial wildlife would occur.

4.4.2.3. Marine and Estuarine Fauna

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts to marine and estuarine fauna. These impacts could result from stranding response activities and the associated increases in boat traffic and human presence that could result in habitat disturbance or accidental injury to another animal (e.g., sea turtles, fish, birds). The presence of boats and personnel conducting stranding response activities could cause some mobile animals to temporarily move out of the area to find suitable habitat in adjacent areas, but individuals are likely to return to the area once activities are completed. Non-mobile benthic species could experience adverse impacts due to temporary increases in turbidity, and minor contamination from hazardous materials (e.g., euthanasia solution, sedatives, antibiotics), boat waste, or equipment leaks. Non-mobile organisms in intertidal and subtidal environments could be temporarily disturbed by response personnel stranding and working during response operations.

For marine mammals in particular, adverse impacts on individual animals could occur from close approach, tagging, marking, restraint, handling, capture, transport, sampling, and other activities that could increase stress and shock. However, stranding response and rehabilitation activities conducted by trained personnel would likely result in beneficial impacts by reducing animal pain and suffering and increasing the potential for recovery and release to the wild.

This alternative would likely result in long-term, beneficial impacts on marine and estuarine fauna because improved capacity for response and rehabilitation of stranded marine mammals would likely result in increased rescue, rehabilitation, and release of live marine mammals. Over time, stranding response methods would be refined to reduce stress on the animal during all stages of response and rehabilitation. Marine mammal stranding data would inform natural resource managers to better manage and protect marine mammals and their habitat. Tagging and post-release monitoring could provide valuable information on marine mammal health trends that could be used to understand stranding events, UMEs, and basic biological processes. Improved quality of necropsy samples would improve the ability to diagnose causes of illness and death, which would have long-term, beneficial impacts on restoring and supporting marine mammal populations. In particular, this alternative is anticipated to have long-term, beneficial impacts for coastal and estuarine stocks of bottlenose dolphins, as well as other offshore species that are subject to mass strandings or die-offs (e.g., short-finned pilot whales and rough-toothed dolphins). This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts to marine and estuarine fauna. These impacts could result from in-water health program activities and the associated increases in boat traffic and human presence that could result in habitat disturbance, or accidental injury to another animal (e.g., sea turtles, fish, birds). The presence of boats and personnel conducting these activities could cause some mobile animals to temporarily move out of the area to find suitable habitat in adjacent areas, but individuals are likely to return to the area once activities are completed. Non-mobile benthic species could experience adverse impacts due to temporary increases in turbidity, and minor contamination from hazardous materials (e.g., sedatives, antibiotics, biological samples), boat waste, or equipment leaks. Non-mobile organisms in intertidal and subtidal environments could be temporarily disturbed by health program personnel standing and working during health program operations.

For marine mammals in particular, adverse impacts to individual animals could occur from close approach, tagging, marking, restraint, handling, capture, sampling, and other health program activities that could increase stress and shock.

This alternative would likely result in long-term, beneficial impacts to marine and estuarine fauna because health program data and improved conservation medicine would better guide natural resource managers in managing marine mammals and their habitats. Tagging and post-release monitoring would provide valuable information on marine mammal health trends that could be used to improve

understanding of stranding events, UMEs, and basic biological processes. Health program data may also identify key stressors to target for future restoration efforts to restore and support marine mammal populations. This alternative may also benefit other marine and estuarine species that are dependent on marine mammal populations for maintaining ecosystem functions. This is consistent with the finding in the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

No Action Alternative

Under the no action alternative, no marine mammal restoration would occur, and there could be adverse impacts to marine and estuarine fauna. Stranding and health program data would not be collected, and restoration and rehabilitation techniques would not be improved, both of which could result in continued morbidity and death of marine mammals if natural and/or anthropogenic threats persist. This is consistent with the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

4.4.2.4. Essential Fish Habitat

The two marine mammal restoration alternatives' activities are expected to occur throughout coastal Louisiana in areas that overlap with designated EFH. EFH in these areas include emergent wetlands, mud substrate, and estuarine water columns. TABLE 4-6 lists the EFH that occur within the extent of each of the marine mammal alternatives' activities. Descriptions of the anticipated impacts on these species, by alternative, are discussed in the NEPA evaluations below.

TABLE 4-6. EFH within the proposed marine mammal restoration sites.

Alternative	Species With Designated Essential Fish Habitat
Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts (preferred alternative)	Brown shrimp, white shrimp, pink shrimp, red drum, gray snapper, lane snapper, red snapper, vermilion snapper, gray triggerfish, Spanish mackerel, king mackerel, almaco jack, greater amberjack, cobia, hammerhead shark, scalloped hammerhead shark, blacktip shark, bull shark, spinner shark, Atlantic sharpnose shark, blacknose shark, and finetooth shark.
Region-wide Marine Mammal Conservation Medicine and Health Program (non-preferred alternative)	Same as above.

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts on EFH. The proposed alternative would be implemented along the Louisiana coastline and throughout nearshore waters. Boat traffic, underwater noise, and human presence in shallow waters during stranding response could result in temporary disturbance or displacement of EFH species that are present near

the marine mammal stranding locations. The presence of boats and personnel conducting stranding response activities could cause some mobile animals to temporarily move out of the area to find suitable habitat in adjacent areas, but individuals are likely to return to the area once activities are completed. To avoid potential impacts, MMSN personnel would avoid operating in areas with sensitive habitat (e.g., SAV) and take all necessary precautions to minimize any potential disturbance. In situations where EFH may be impacted by response activities, the appropriate NMFS EFH Coordinator would be contacted. This is consistent with the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009).

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts to EFH. The proposed alternative would be implemented along the Louisiana coastline and throughout nearshore waters. Boat traffic, noise, and human presence in shallow waters during health program activities could result in temporary disturbance or displacement of EFH species that are present near the marine mammal health assessment locations. The presence of boats and personnel conducting health assessment activities could cause some mobile animals to temporarily move out of the area to find suitable habitat in adjacent areas, but individuals are likely to return to the area once activities are completed. To avoid potential impacts, health program personnel would avoid operating in areas with sensitive habitat (e.g., SAV) and take all necessary precautions to minimize any potential disturbance. In situations where EFH may be impacted by health program activities, the appropriate NMFS EFH Coordinator would be contacted. This is consistent with the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009).

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts to EFH would occur.

4.4.2.5. Protected Species

As shown in TABLE 4-5, nine species are currently listed as threatened or endangered under the ESA in the marine mammal alternatives' action area. Two ESA-listed bird species, piping plover and red knot have the potential to occur in the area during project activities; however, these are overwintering or migrating species and do not nest along the Gulf Coast. Although sea turtles are known to nest in the Louisiana restoration area, the likelihood of a nesting sea turtle or its nest being impacted by project activities is very low. As of 2018, two species in the marine mammal alternatives' action area have designated critical habitat: Atlantic sturgeon (Gulf subspecies) and piping plover (USFWS, 2018). The proposed marine mammal alternatives could occur within or in close proximity to designated critical habitat for both of these species. Federally protected marine mammals that could occur within or in close proximity to the marine mammal alternatives include the West Indian manatee and bottlenose dolphin.

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts on protected species and critical habitat. The proposed alternative would be implemented along the Louisiana coastline and throughout nearshore waters. Vehicle, boat, and foot traffic, noise, and human presence during stranding response could result in temporary disturbance or displacement of some protected species if individuals are present near the marine mammal stranding locations. The presence of boats and personnel conducting stranding response activities could cause some mobile animals to temporarily move out of the area to find suitable habitat in adjacent areas, but individuals are likely to return to the area once activities are completed. To avoid potential impacts on sea turtles, West Indian manatees, and critical habitat in the project area, MMSN personnel would avoid operating in areas with sensitive habitat (e.g., SAV) and take all necessary precautions to minimize any potential disturbance. There is no critical habitat in close proximity to the Audubon rehabilitation facility.

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts on protected species and critical habitat. The proposed alternative would be implemented along the Louisiana coastline and throughout nearshore waters. Boat traffic, noise, and human presence during health program activities could result in temporary disturbance or displacement of some protected species if individuals are present near the marine mammal health assessment locations. The presence of boats and personnel conducting health program activities could cause some mobile animals to temporarily move out of the area to find suitable habitat in adjacent areas, but individuals are likely to return to the area once activities are completed. To avoid potential impacts on sea turtles, West Indian manatees, and critical habitat in the project area, health program personnel would avoid operating in areas with sensitive habitat (e.g., SAV) and take all necessary precautions to minimize any potential disturbance.

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts on protected species would occur. This is consistent with the EIS on the Marine Mammals Health and Stranding Response Program (NOAA, 2009) and Section 6.4.9.3.1 of the Final PDARP/PEIS (DWH Trustees, 2016).

4.4.3. Socioeconomic Resources

4.4.3.1. Land and Marine Management

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts on land and marine management. The alternative involves establishing a base of operations for the Louisiana MMSN

coordinator, conducting multiple trainings, and potentially enhancing Audubon's marine mammal rehabilitation facility through installation of a permanent pool and shade structure. These activities would occur on land but would utilize existing structures and thus are not expected to conflict with current land uses or introduce a new land use. Appropriate permits would be obtained, and construction BMPs would be implemented for pool and shade structure construction to mitigate any adverse impacts (DWH Trustees, 2016).

Vehicle use on beaches during stranding response may impact recreational land use (i.e., beachgoers), but these potential impacts are expected to be minor and temporary, and conditions would return to baseline after the stranding response was complete. The alternative also involves in-water work for stranding response, assessment, and enforcement, which may interfere with existing marine uses such as recreational boating. However, impacts on these activities would be minor and temporary, and no long-term impacts on marine management are expected.

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts on land and marine management. The alternative involves convening an expert working group and conducting multiple trainings, both of which would occur on land. However, these activities would utilize existing structures and thus are not expected to conflict with current land uses or to introduce a new land use. The alternative also involves in-water work for health program activities, which may interfere with existing marine uses such as recreational boating. However, impacts on these activities would be minor and temporary, and no long-term impacts on land and marine management are expected.

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts on land and marine management would occur.

4.4.3.2. Fisheries and Aquaculture

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Inform Future Restoration Efforts

The Louisiana MMSN alternative could result in short-term, minor adverse impacts to fisheries and aquaculture. The alternative involves in-water stranding response activities which could interfere with fishery and aquaculture operations along the Louisiana coastline. To the extent possible, stranding response personnel would avoid disturbing areas of active aquaculture. Response activities would be temporary, and no long-term impacts on fisheries or aquaculture are anticipated.

Region-wide Marine Mammal Conservation Medicine and Health Program

The conservation medicine and health program alternative could result in short-term, minor adverse impacts on fisheries and aquaculture. The alternative involves in-water health program activities that could interfere with fishery and aquaculture operations along the Louisiana coastline. To the extent

possible, health program personnel would avoid disturbing areas of active aquaculture. Health program activities would be temporary, and no long-term impacts on fisheries or aquaculture are anticipated.

No Action Alternative

Under the no action alternative, no marine mammal restoration would take place, and no beneficial or adverse impacts on fisheries or aquaculture would occur.

4.5. NEPA Analysis for Oyster Restoration Type

This section provides an evaluation of the potential impacts of each oyster restoration alternative on the area's physical, biological, and socioeconomic resources. The direct and indirect impacts of implementation and construction on the resources analyzed in detail (described in Section 4.3) are presented. Two of the alternatives (Enhancing Oyster Recovery Using Brood Reefs; Cultch Plant Oyster Restoration) include both planned and programmatic components. Affirmation of environmental consequences for additional sites as identified in the future will be documented according to the process as described below.

More specifically, this section evaluates the alternatives' impacts on:

- Physical resources: geology and substrates, hydrology and water quality;
- Biological resources: habitats, terrestrial wildlife, marine and estuarine fauna, protected species, EFH; and
- Socioeconomic resources: land and marine management, fisheries and aquaculture.

Three of the oyster alternatives (Enhancing Oyster Recovery Using Brood Reefs, Caillou Lake Artificial Oyster Reef, and Cultch Plant Oyster Restoration) share common restoration approaches and construction methodologies, and thus the anticipated impacts on resources are similar. Section 4.5 highlights any notable exceptions to this general statement, and Section 4.6 evaluates cumulative impacts.

Affirming Programmatic Environmental Review for Future Site Implementation

Two alternatives (Enhancing Oyster Recovery Using Brood Reefs and Cultch Plant Oyster Restoration) include additional sites for programmatic inclusion for future implementation. Once these additional locations for brood reefs or cultch plants are identified, the Trustees would evaluate environmental conditions at additional sites to affirm the expected impacts are otherwise consistent with or below the maximum impacts described in this RP/EA.

If the additional site-specific actions (i.e., brood reef or cultch plant construction at additional sites) is consistent with or below the maximum impacts described in this RP/EA, the analysis of the impacts would be documented by the TIG, included in the administrative record, and the action may proceed. If the evaluation of the planned site-specific action indicates the impacts are likely to exceed the maximum impacts described in this RP/EA, the Louisiana TIG would undertake additional site-specific environmental review, consistent with NEPA and other environmental compliance requirements.

4.5.1. Physical Resources

4.5.1.1. Geology and Substrates

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction could result in short- or long-term, minor adverse impacts on geology and substrates from activities that disturb sediments and/or convert soft bottom substrate to hard bottom. In the short term, use of large equipment and in-water construction activities could temporarily disturb sediments; however, construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). In the long-term, this alternative would replace a limited amount of soft sedimentary substrates with hard substrates. To minimize substrate impacts, brood reef construction sites were intentionally selected based on the existing availability of hard substrate; however, across the total area of brood reefs constructed (i.e., 40 acres), numerous, small, patchy areas of soft sediment may result in several acres of sediment substrate being permanently converted to hard bottom. Potential programmatic sites would also be selected based on the availability of hard substrate.

Cultch Plant Oyster Restoration

Cultch plant construction could result in short- or long-term, minor adverse impacts from activities that disturb sediments and/or convert soft bottom substrate to hard bottom. In the short term, the use of large equipment and in-water construction activities could temporarily disturb sediments; however, construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). In the long-term, this alternative would replace a limited amount of soft sedimentary substrates with hard substrates. To minimize substrate impacts, cultch plant construction sites were intentionally selected based on the existing availability of hard substrate; however, across the total area of cultch plants constructed (i.e., 1600-2000 acres), numerous small, patchy areas of soft sediment may result in several acres of sediment substrate being permanently converted to hard bottom. Potential programmatic sites would also be selected based on the availability of hard substrate.

Hatchery-based Oyster Restoration

The oyster hatchery alternative would utilize the existing hatchery facility in Grand Isle, Louisiana; thus, hatchery operations are not anticipated to result in any impacts on geology or substrates. No additional construction on the site is proposed.

This alternative would also place spat-on-shell onto either existing reefs or reefs in construction. Because these activities would occur on top of the existing hard substrates, they are not expected to result in any impacts on geology or substrates. This action could potentially replace a limited amount of soft sediment with hard substrates. BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

Caillou Lake Artificial Oyster Reef

Artificial reef construction in Caillou Lake could result in short- or long-term, minor adverse impacts from activities that disturb sediments and/or convert soft bottom substrate to hard bottom. In the short term, the use of large equipment and in-water construction activities could temporarily disturb sediments; however, construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). In addition, this action would replace soft sedimentary substrates with hard substrates.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and no impacts on substrates or geology would occur.

4.5.1.2. Hydrology and Water Quality

FIGURE 4-5 illustrates the water basins that have geographical overlap with the oyster alternatives. All proposed project sites (depicted by triangles) fall within the HUC6 watershed boundary, and for example the Grand Banks Cultch Plant site (depicted by the yellow triangle) falls within the Pascagoula watershed basin.

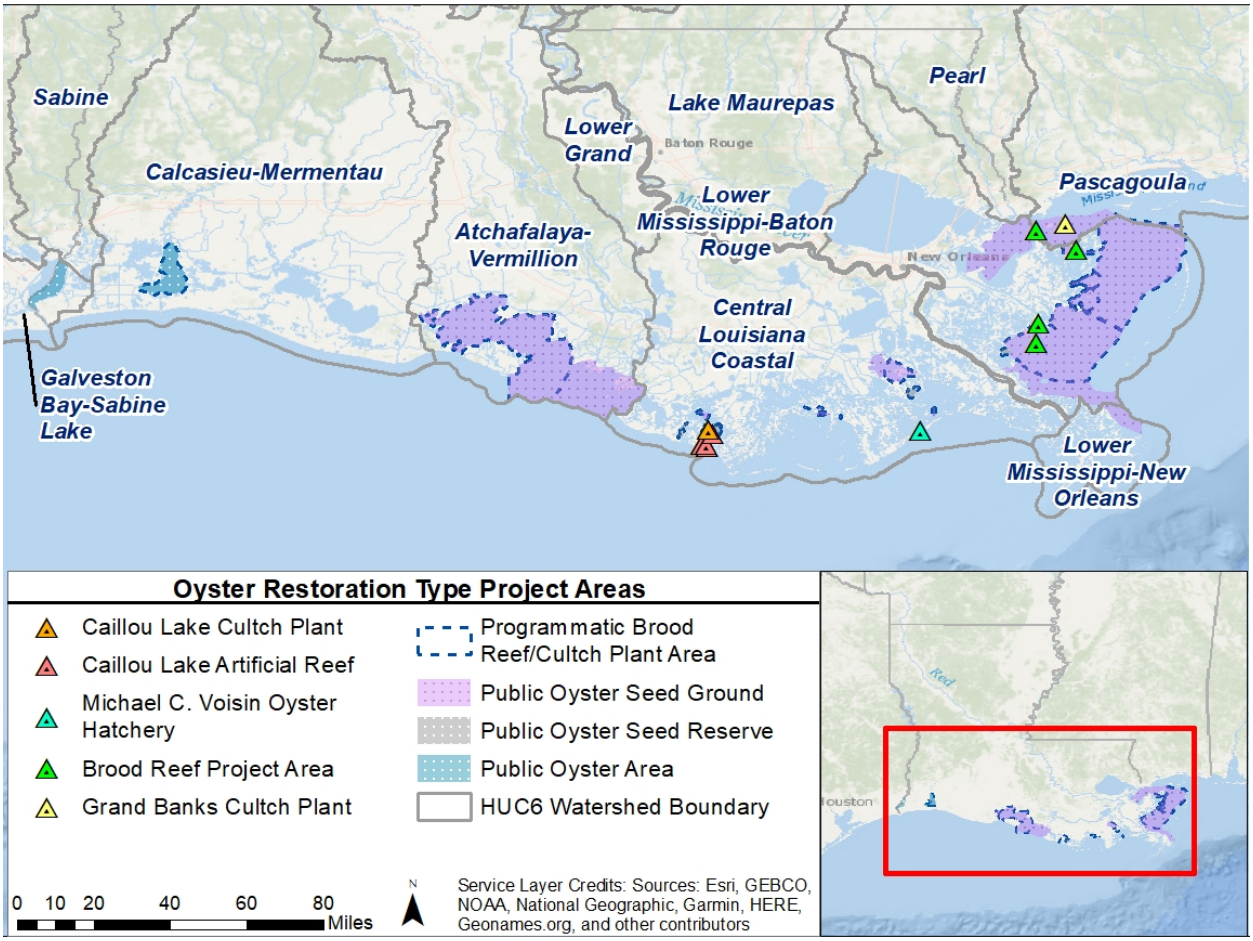

FIGURE 4-5. Louisiana water basins potentially affected by proposed oyster alternatives.

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction could result in short-term, minor adverse impacts on water quality at the restoration site and at potential programmatic sites due to the increased suspended sediment from bed-disturbing activities. In-water construction BMPs would be implemented to localize and ameliorate these impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

Over the long term, the constructed brood reef could result in long-term, beneficial impacts on water quality because the increased abundance of oysters would increase filter feeding to remove sediment and nutrients from the water column and improve water quality.

In addition, brood reef construction would benefit adjacent floodplains and wetlands by reducing wave energy and increasing sediment accretion.

Cultch Plant Oyster Restoration Project

Cultch plant construction could result in short-term, minor adverse impacts on water quality at the restoration site and at potential programmatic sites due to the increased suspended sediment from bed-disturbing activities. In-water construction BMPs would be implemented to localize and ameliorate these impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011).

Over the long term, the cultch plants constructed could result in long-term, beneficial impacts on water quality because increased abundance of oysters would increase filter feeding, which removes sediment and nutrients from the water column and improves water quality. In addition, cultch plants could benefit adjacent floodplains and wetlands by reducing wave energy and increasing sediment accretion.

Hatchery-based Oyster Restoration

The oyster hatchery alternative would use the existing hatchery facility and thus is not anticipated to result in any impacts on hydrology. The hatchery's wastewater discharge is transported to a sewer treatment plant and hazardous waste chemicals used in the lab and hatchery are collected and disposed of following DEQ protocols. Nutrients are not expected to be released into nearby waters adjacent to the facility, and no impacts on water quality are anticipated.

This alternative includes placing hatchery-raised spat-on-shell onto either existing reefs or reefs in construction. In the long term, this component of the alternative is expected to result in long-term, beneficial impacts to water quality. Increased oyster abundance would increase filter feeding, which removes sediments and nutrients from the water column and improves water quality.

Neither hatchery operations nor activities associated with deployment of hatchery-raised oysters are expected to impact floodplains or wetlands; however, oyster reef restoration would benefit adjacent floodplains and wetlands by reducing wave energy and increasing sediment accretion.

Caillou Lake Artificial Oyster Reef

Construction of the artificial reef could result in short-term, minor adverse impacts on water quality from the increased suspended sediment from bed-disturbing activities; however, in-water construction BMPs would be implemented to localize and ameliorate these impacts (DWH Trustees, 2016; Leonard &

Macfarlane, 2011). Over the long term, the establishment of new oyster reefs could result in long-term, beneficial impacts on water quality because the artificial reef would create a less active water column between the reef and shoreline, allowing sediment to fall out of suspension, and fostering sediment accretion. Additionally, the increased abundance of oysters would increase filter feeding, removing sediment and nutrients from the water column and improving water quality.

Artificial reef construction could benefit adjacent floodplains and wetlands by reducing wave energy and increasing sediment accretion.

No Action Alternative

Under the no action alternative, no oyster restoration would take place and no impacts on hydrology, water quality, floodplains, or wetlands would occur.

4.5.2. Biological Resources

4.5.2.1. Habitats

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction could result in short-term, minor adverse impacts on submerged soft bottom estuarine habitat from a temporary increase in turbidity and underwater noise and activity during construction. Use of large equipment and in-water construction activities could temporarily increase underwater noise, disturb sediments, and increase turbidity; however, in-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Turbidity is expected to return to baseline levels following construction.

In the long-term, this action would replace a limited amount of soft sedimentary substrates with hard substrates. To minimize substrate impacts, brood reef construction sites were intentionally selected based on the existing availability of hard substrate; however, across the total area of brood reefs constructed (i.e., 40 acres), numerous, small, patchy areas of soft sediment may result in several acres of sediment substrate being permanently converted to hard bottom. Potential programmatic sites would also be selected based on the availability of hard substrate.

This alternative could result in long-term, beneficial impacts on estuarine habitats due to the increase in oyster production and improvement of ecosystem services that may result from high oyster abundance such as reduced shoreline erosion, improved water quality, enhanced nutrient recycling, and increased habitat availability for commercially and recreationally important fish.

Cultch Plant Oyster Restoration

Cultch plant construction could result in short-term, minor adverse impacts on submerged soft bottom estuarine habitat from a temporary increase in turbidity and underwater noise and activity during construction. Use of large equipment and in-water construction activities could temporarily increase underwater noise, disturb sediments, and increase turbidity; however, in-water construction BMPs

would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Turbidity is expected to return to baseline levels following construction.

In the long-term, this action would replace a limited amount of soft sedimentary substrates with hard substrates. To minimize substrate impacts, cultch plant construction sites were intentionally selected based on the existing availability of hard substrate; however, across the total area of cultch plants constructed (i.e., 1600-2000 acres), numerous small, patchy areas of soft sediment may result in several acres of sediment substrate being permanently converted to hard bottom. Potential programmatic sites would also be selected based on availability of hard substrate.

This alternative could result in long-term, beneficial impacts to estuarine habitats due to the increase in oyster production and improvement of ecosystem services that may result from high oyster abundance such as reducing shoreline erosion and improving water quality, enhancing nutrient recycling, and increasing habitat availability for commercially and recreationally important fish.

Hatchery-based Oyster Restoration

The oyster hatchery alternative would use the existing, hatchery facility structure and thus is not expected to result in any impacts on habitats.

This alternative would also place hatchery-raised spat-on-shell onto either existing reefs or reefs in construction. These activities could result in short-term, minor adverse impacts on submerged soft bottom estuarine habitat from a temporary increase in turbidity and underwater noise and activity during construction. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Turbidity is expected to return to baseline levels following deployment. Deployment sites were intentionally selected based on the availability of existing hard substrate; however, small areas of soft bottom habitat may be permanently converted to hard bottom habitat.

This alternative could result in long-term, beneficial impacts on estuarine habitats due to the increase in oyster production and improvement of ecosystem services that may result from high oyster abundance such as reducing shoreline erosion, improving water quality, enhancing nutrient recycling, and increasing habitat availability for commercially and recreationally important fish.

Caillou Lake Artificial Oyster Reef

Artificial reef construction could result in short- or long-term, minor adverse impacts on submerged soft bottom estuarine habitat. Use of large equipment and in-water construction activities could temporarily increase underwater noise, disturb sediments, and increase turbidity; however, in-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Turbidity is expected to return to baseline levels following construction.

This alternative could result in long-term, beneficial impacts to estuarine habitats due to the preservation of marsh habitat and the land bridge protecting Caillou Lake. In addition, the alternative could increase oyster production and improve ecosystem services that may result from high oyster

abundance such as reducing shoreline erosion, improving water quality, enhancing nutrient recycling, and increasing habitat availability for commercially and recreationally important fish.

No Action Alternative

Under the no action alternative, no oyster restoration would occur. There would be long-term, minor to moderate, adverse impacts on estuarine habitats resulting from erosive forces, subsidence, and sea-level rise compared to the other alternatives.

4.5.2.2. Terrestrial Wildlife

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction could result in short-term, minor adverse impacts on some terrestrial wildlife near the restoration sites and potential programmatic sites. Temporary disturbance of birds, primarily shorebirds or wading birds, could occur during construction, which could decrease bird foraging or cause them stress because of displacement. Affected birds would likely avoid the area during construction; however, once completed, impacts are expected to be minimal.

The alternative could result in long-term, beneficial impacts to terrestrial wildlife such as ducks because oyster reefs provide habitat for these species and their prey.

Cultch Plant Oyster Restoration

Cultch plant construction could result in short-term, minor adverse impacts on wildlife near the restoration site and potential programmatic sites. Temporary increases in water traffic and the use of large equipment could temporarily disturb and displace nearby wildlife, primarily birds. Affected animals would likely avoid the area during construction; however, once completed, impacts are expected to be minimal.

The alternative could result in long-term, beneficial impacts to terrestrial wildlife such as ducks because oyster reefs provide habitat for these species and their prey.

Hatchery-based Oyster Restoration

The oyster hatchery alternative would use the existing hatchery facility structure; thus, the alternative is not expected to result in any impacts on terrestrial wildlife.

This alternative would place hatchery-raised spat-on-shell onto either existing reefs or reefs in construction, an activity that could result in short-term, minor adverse impacts on terrestrial wildlife. During the oyster deployment, temporary disturbance to birds, primarily shorebirds and wading birds, could occur, potentially decreasing bird foraging or causing stress during displacement. Affected animals would likely avoid the area during deployment; however, once completed, impacts are expected to be minimal.

The alternative could result in long-term, beneficial impacts to terrestrial wildlife such as ducks because oyster reefs provide habitat for these species and their prey.

Caillou Lake Artificial Oyster Reef

Artificial reef construction in Caillou Lake could result in short-term, minor adverse impacts on wildlife. During construction, temporary disturbance to birds, primarily shorebirds and wading birds, could occur, decreasing bird foraging or causing stress during displacement. Affected animals would likely avoid the area during construction; however, once completed, impacts are expected to be minimal.

The alternative could result in long-term, beneficial impacts for terrestrial wildlife such as ducks because oyster reefs provide habitat for these species and their prey.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and no adverse impact on terrestrial wildlife would occur (DWH Trustees, 2017b). If the alternatives were not implemented, there could be long-term, moderate, adverse impacts on oyster reefs in coastal Louisiana from continued erosion and sedimentation, which could affect habitat availability for terrestrial wildlife.

4.5.2.3. Marine and Estuarine Fauna

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction could result in short-term, minor adverse impacts on marine and estuarine fauna within the planned and potential programmatic sites. Potential impacts could include noise, vibration, temporary increases in turbidity, and visual disturbances associated with the construction of brood reefs, boat traffic, and human presence. The nature of these impacts would depend on the organism. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Construction could result in injury or mortality of sessile benthic species in the immediate project area. However, such species are likely not habitat-limited, and would be expected to assimilate elsewhere. Mobile species would likely avoid the area for the duration of in-water work, avoiding injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation).

The alternative could result in long-term, beneficial impacts on marine and estuarine fauna because the brood reefs would enhance oyster spat production, potentially increasing oyster abundance and recruitment in Louisiana waters. The brood reefs could also benefit other reef-associated marine and estuarine species including fish, invertebrates, and other shellfish.

Cultch Plant Oyster Restoration

Construction of cultch plants could result in short-term, minor adverse impacts on marine and estuarine fauna within the planned and potential programmatic sites. Potential impacts could include noise, vibration, temporary increases in turbidity, and visual disturbances associated with the construction of the cultch plants, boat traffic, and human presence. The nature of these impacts would depend on the organism. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Construction could result in injury or

mortality of sessile benthic species in the immediate project area. However, such species are likely not habitat-limited, and would be expected to assimilate elsewhere. Mobile species would likely avoid the area for the duration of in-water work, avoiding injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation).

The alternative could result in long-term, beneficial impacts on marine and estuarine fauna because it would create oyster reef habitat, which not only benefits oysters, but also provides important habitat for other reef-associated marine and estuarine species, including fish, invertebrates, and other shellfish.

Hatchery-based Oyster Restoration

The oyster hatchery alternative would use the existing hatchery facility and thus is not expected to result in any short- or long-term impacts on marine and estuarine fauna.

This alternative also involves spat-on-shell deployment of hatchery-raised oysters which could result in short-term, minor adverse impacts on marine and estuarine fauna. Potential impacts could include noise, vibration, temporary increases in turbidity, and visual disturbances associated with the deployment of oysters, boat traffic, and human presence. The nature of these impacts would depend on the organism. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Deployment could result in injury or mortality of sessile benthic species in the immediate project area. However, such species are likely not habitat-limited, and would be expected to assimilate elsewhere. Mobile species would likely avoid the area for the duration of in-water work, avoiding injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation).

The alternative could result in long-term, beneficial impacts on marine and estuarine fauna because it would support oyster reef habitat, which not only benefits oysters, but also provides important habitat for other reef-associated marine and estuarine species, including fish, invertebrates, and other shellfish.

Caillou Lake Artificial Oyster Reef

Artificial reef construction could result in short-term, minor adverse impacts on marine and estuarine fauna within the site. Potential impacts could include noise, vibration, temporary increases in turbidity, and visual disturbances associated with the construction of the artificial reef, boat traffic, and human presence. The nature of these impacts would depend on the organism. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Construction could result in injury or mortality of sessile benthic species in the immediate project area. However, such species are likely not habitat-limited, and would be expected to assimilate elsewhere. Mobile species would likely avoid the area for the duration of in-water work, avoiding injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation).

The alternative could result in long-term, beneficial impacts on marine and estuarine fauna because the artificial reef would provide a substrate to which oysters can attach, grow, and reproduce, and also a vertical structure that could attenuate wave energy and protect the shoreline from erosion. The artificial reef could create a less active water column between the reef and shoreline, allowing sediment to fall out of suspension, thereby fostering sediment accretion. In turn, this could benefit marine and estuarine species associated with oyster reef habitat such as fish, invertebrates, and other shellfish.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and no beneficial impacts to marine or estuarine fauna associated with oyster reef habitats would occur. There would be long-term, minor to moderate, adverse impacts to marine and estuarine aquatic fauna resulting from erosive forces, subsidence, and sea-level rise compared to the other alternatives.

4.5.2.4. Essential Fish Habitat

All four oyster restoration alternatives contain EFH, such as emergent wetlands, mud substrate, and estuarine water columns. TABLE 4-7 describes EFH that may be affected by the oyster alternatives, and the remainder of this section describes the anticipated impacts on EFH from each of the alternatives.

TABLE 4-7. EFH within the preferred oyster alternative project areas.

Action Alternative	Species With Designated Essential Fish Habitat
Enhancing Oyster Recovery Using Brood Reefs	Brown shrimp, white shrimp, pink shrimp, red drum, gray snapper, lane snapper, red snapper, vermilion snapper, gray triggerfish, Spanish mackerel, king mackerel, almaco jack, greater amberjack, cobia, hammerhead shark, scalloped hammerhead shark, blacktip shark, bull shark, spinner shark, Atlantic sharpnose shark, blacknose shark, and finetooth shark.
Cultch-based Oyster Restoration	Same as above.
Hatchery-Based Oyster Restoration	Same as above.
Caillou Lake Artificial Reef	brown shrimp, white shrimp, red drum, gray snapper, lane snapper, red snapper, vermilion snapper, gray triggerfish, king mackerel, almaco jack, greater amberjack, cobia, scalloped hammerhead shark, blacktip shark, bull shark, spinner shark, Atlantic sharpnose shark, blacknose shark, and finetooth shark.

Enhancing Oyster Recovery Using Brood Reefs

Brood reefs could result in short-term, minor adverse impacts on EFH. Temporary disturbances could result from an increase in turbidity, underwater noise, and human activity during brood reef construction and monitoring, which could contribute to temporary disturbance or displacement of EFH species. The nature of the impact would depend on the organism. Mobile species would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation). Although less mobile benthic species could be buried during

brood reef construction, construction in areas where hard bottom exists would minimize the potential adverse impacts to soft bottom benthic fauna. Following brood reef placement, turbidity and noise would return to baseline levels.

The alternative could result in long-term, beneficial impacts to EFH because oyster reefs provide habitat for protected species and their sources of prey.

Cultch Plant Oyster Restoration

The construction of the oyster cultch plants could result in short-term, minor adverse impacts on EFH. Temporary disturbances could result from an increase in turbidity, underwater noise, and human activity during oyster cultch construction and monitoring, which could contribute to temporary disturbance or displacement of EFH species. The nature of the impact would depend on the organism. Mobile species would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation). Although less mobile benthic species could be buried during cultch plant construction, construction in areas where hard bottom exists would minimize the potential adverse impacts to soft bottom benthic fauna. Following cultch placement, turbidity and noise would return to baseline levels.

The alternative could result in long-term, beneficial impacts for EFH because oyster reefs provide habitat for protected species and their sources of prey.

Hatchery-based Oyster Restoration

The hatchery-based oyster restoration alternative may result in short-term, minor adverse impacts on EFH. Any in-water oyster spat-on-shell deployment of hatchery-raised oysters may result in temporary disturbances, including increased turbidity, underwater noise, and human activity, which could contribute to temporary disturbance or displacement of EFH species. The nature of the impact would depend on the organism. Mobile species would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation). Although less mobile benthic species could be buried during deployment of hatchery-raised oysters, deployment primarily in areas where hard bottom exists would minimize the potential adverse impacts to soft bottom benthic fauna. Turbidity and noise would return to baseline levels immediately following in-water work.

The alternative could result in long-term, beneficial impacts for EFH because oyster reefs provide habitat for protected species and their sources of prey.

Caillou Lake Artificial Oyster Reef

Artificial reef construction could result in short-term, minor adverse impacts on EFH. Temporary disturbances could result from an increase in turbidity, underwater noise, and human activity during artificial oyster reef construction and monitoring, which could contribute to temporary disturbance or displacement of EFH species. The nature of the impact would depend on the organism. Mobile species

would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality; however, they may experience decreased foraging opportunities, displacement-related stress, or mortality (e.g., due to potential increased exposure to predation). Although less mobile benthic species could be buried during artificial reef construction, construction in areas where hard bottom exists would minimize the potential adverse impacts to soft bottom benthic fauna. Following artificial oyster reef construction, turbidity and noise would return to baseline levels.

The alternative could result in long-term, beneficial impacts for EFH because oyster reefs provide habitat for protected species and their sources of prey.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and no adverse impacts on EFH would occur. However, long-term, beneficial impacts associated with the restoration and enhancement of oyster reef habitat, which provides important habitat for many EFH species and their prey, would not be realized. There would also be long-term, minor to moderate, adverse impacts on estuarine habitats resulting from erosive forces, subsidence, and sea-level rise compared to the other alternatives.

4.5.2.5. Protected Species

As shown in TABLE 4-5, nine species are currently listed as threatened or endangered under the ESA in the oyster alternatives' action area. Two ESA-listed bird species, piping plover and red knot, have the potential to occur in the area during project activities; however, these are overwintering or migrating species and do not nest along the Gulf Coast. Although sea turtles are known to nest in the Louisiana restoration area, the likelihood of a nesting sea turtle or its nest being impacted by project activities is very low. As of 2018, two species in the potentially affected project areas have designated critical habitat: Atlantic sturgeon (Gulf subspecies) and piping plover (USFWS, 2018). Several of the proposed oyster alternatives would occur within or in close proximity to designated critical habitat for the Atlantic sturgeon (Gulf subspecies), and some alternative locations may be within close proximity to critical habitat for the piping plover (FIGURE 4-2). Federally protected marine mammals that could occur within or in close proximity to the alternatives include the West Indian manatee and bottlenose dolphin.

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction could result in short-term, minor adverse impacts on protected species. The proposed project sites are located in St. Bernard and Plaquemines Parishes; protected species in inshore waters in these parishes include the West Indian manatee, piping plover, red knot, Atlantic sturgeon (Gulf subspecies), pallid sturgeon, giant manta ray, green sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle. One site (Petit Pass) is within critical habitat for Atlantic sturgeon (Gulf subspecies). This reef would be constructed on existing

shell substrate to ameliorate any adverse impacts to Atlantic sturgeon (Gulf subspecies) critical habitat. West Indian manatees and sea turtles are primarily found in calm waters where seagrass is present, and brood reef sites were selected to avoid seagrass beds. Thus, these species are unlikely to be adversely affected by the alternative.

Temporary disturbances to or displacement of other protected species could result from an increase in turbidity, underwater noise, and human activity during brood reef construction and monitoring; however, in-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Although less mobile benthic species could be injured or killed during brood reef deployment, the affected protected species are mobile and would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality. Following brood reef placement, turbidity and noise would return to baseline levels.

The alternative could result in long-term, beneficial impacts for protected species because oyster reefs provide habitat for epibenthic fauna, mobile invertebrates, and fish that may be sources of prey for the protected species in this area, such as sturgeon and sea turtles.

Cultch Plant Oyster Restoration

Cultch plant construction could result in short-term, minor adverse impacts on protected species. The proposed project sites are located in St. Bernard and Terrebonne Parishes; protected species in inshore waters in these parishes include the West Indian manatee, piping plover, red knot, Atlantic sturgeon (Gulf subspecies), pallid sturgeon, giant manta ray, green sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle. One site (Grand Banks) is within critical habitat for Atlantic sturgeon (Gulf subspecies). This cultch plant would be constructed on existing shell substrate to ameliorate any adverse impacts to Atlantic sturgeon (Gulf subspecies) critical habitat. Additional programmatic cultch plant sites within critical habitat would also be constructed on existing hard bottom shell substrate. West Indian manatees and sea turtles are primarily found in calm waters where seagrass is present, and cultch plant sites were selected to avoid seagrass beds. Thus, these species are unlikely to be adversely affected by the alternative.

Temporary disturbances to or displacement of other protected species could result from an increase in turbidity, underwater noise, and human activity during oyster cultch construction and monitoring; however, in-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Although less mobile benthic species could be injured or killed during cultch deployment, the affected protected species are mobile and would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality. Following cultch placement, turbidity and noise would return to baseline levels.

The alternative could result in long-term, beneficial impacts for protected species because oyster reefs provide habitat for epibenthic fauna, mobile invertebrates, and fish that may be sources of prey for the protected species in this area, such as sturgeon and sea turtles.

Hatchery-based Oyster Restoration

The hatchery-based oyster restoration alternative may result in short-term, minor adverse impacts on protected species. The hatchery is located in Jefferson Parish; protected species in inshore waters in this parish include the West Indian manatee, piping plover, red knot, Atlantic sturgeon (Gulf subspecies), pallid sturgeon, giant manta ray, green sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle. Critical habitat for the Atlantic sturgeon (Gulf subspecies) is within or in close proximity to potential

oyster deployment locations. Deployment locations within critical habitat would occur on existing shell substrate to ameliorate any adverse impacts. West Indian manatees and sea turtles are primarily found in calm waters where seagrass is present, and deployment sites for hatchery-raised oysters would be selected to avoid seagrass beds. Thus, these species are unlikely to be adversely affected by the alternative.

Any in-water oyster spat-on-shell deployment of hatchery-raised oysters may result in temporary disturbances to other protected species, including increased turbidity, underwater noise, and human activity. In-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Although less mobile benthic species could be injured or killed during deployment, the affected protected species are mobile and would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality. Turbidity and noise would return to baseline levels immediately following in-water work.

The alternative could result in long-term, beneficial impacts for protected species because oyster reefs provide habitat for epibenthic fauna, mobile invertebrates, and fish that may be sources of prey for the protected species in this area, such as sturgeon and sea turtles.

Caillou Lake Artificial Oyster Reef

Artificial reef construction in Caillou Lake could result in short-term, minor adverse impacts on protected species. The proposed project site is located in Terrebonne Parish; protected species in inshore waters in this parish include the West Indian manatee, piping plover, red knot, Atlantic sturgeon (Gulf subspecies), pallid sturgeon, giant manta ray, green sea turtle, Kemp's ridley sea turtle, and loggerhead sea turtle. West Indian manatees and sea turtles are primarily found in calm waters where seagrass is present, and the artificial reef site was selected to avoid seagrass beds. Thus, these species are unlikely to be adversely affected by the alternative.

Temporary disturbances to or displacement of other protected species could result from an increase in turbidity, underwater noise, and human activity during artificial oyster reef construction and monitoring; however, in-water construction BMPs would be implemented to localize and ameliorate any adverse impacts (DWH Trustees, 2016; Leonard & Macfarlane, 2011). Although less mobile benthic species could be injured or killed during artificial reef construction, the affected protected species are mobile and would likely avoid the area for the duration of in-water work, avoiding direct injury or mortality. Following artificial oyster reef construction, turbidity and noise would return to baseline levels.

The alternative could result in long-term, beneficial impacts for protected species because oyster reefs provide habitat for epibenthic fauna, mobile invertebrates, and fish that may be sources of prey for the protected species in this area, such as sturgeon and sea turtles.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and protected species that depend on oyster reef habitat would not benefit. There would be long-term, minor to moderate,

adverse impacts on protected species and critical habitat resulting from erosive forces, subsidence, and sea-level rise compared to the other alternatives.

4.5.3. Socioeconomic Resources

4.5.3.1. Land and Marine Management

Enhancing Oyster Recovery Using Brood Reefs

Because brood reef restoration sites are or will be on state-owned water bottom and do not include any land, no impacts on land management are anticipated. Brood reef construction could, however, result in short-or long-term, minor adverse impacts on marine management. In particular, although the brood reefs would not be located in areas designated for marine transport, they may be located in areas used for commercial and recreational fishing. Signage would be installed around the brood reefs to mark their location, navigational warnings would be broadcast, and all activities would be conducted in accordance with applicable permits.

The alternative could result in long-term, beneficial impacts for marine management because oyster reefs provide habitat for commercially and recreationally important species, which may increase fishing opportunities for the lifespan of the brood reefs.

Cultch Plant Oyster Restoration

Because cultch plant restoration sites are or will be on state-owned water bottom and do not include any land, no impacts on land management are anticipated. Oyster cultch plant construction could, however, result in short- or long-term, minor adverse impacts on marine management. In particular, although restoration sites would not be located in areas designated for marine transport, they may be located in areas used for commercial and recreational fishing. Signage would be installed around the cultch plants to mark the location, navigational warnings would be broadcast, and all activities would be conducted in accordance with applicable permits.

The alternative could result in long-term, beneficial impacts for marine management because oyster reefs provide habitat for commercially and recreationally important species, which may increase fishing opportunities for the lifespan of the cultch plant.

Hatchery-based Oyster Restoration

The hatchery-based oyster restoration alternative is not anticipated to result in any adverse impacts to land and marine management. Because the oyster hatchery alternative would utilize the existing hatchery facility in Grand Isle, Louisiana, land management would be unaffected. Hatchery-raised spat-on-shell would be deployed on water bottom that is currently state-owned and managed by LDWF; therefore, this alternative is also not expected to result in any adverse impacts to land or marine management.

Caillou Lake Artificial Oyster Reef

Because the artificial reef restoration site would be on state-owned water bottom and does not include any land, no impacts on land management are anticipated. Artificial reef construction could, however, result in short-term, minor adverse impacts to land and marine management. Although the artificial reefs would not be located in an area designated for marine transport, they may be in located in an area used for commercial and recreational fishing. Signage would be installed around the artificial reef to mark the location, navigational warnings would be broadcast, and all activities would be conducted in accordance with applicable permits.

The alternative could result in long-term, beneficial impacts for marine management because oyster reefs provide habitat for commercially and recreationally important species, which may increase fishing opportunities for the lifespan of the artificial reef in Caillou Lake.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and no impacts on land or marine management would occur.

4.5.3.2. Fisheries and Aquaculture

Enhancing Oyster Recovery Using Brood Reefs

Brood reef construction is not anticipated to result in any short-term adverse impacts to fisheries and aquaculture at the restoration sites or potential programmatic sites. The alternative could result in long-term, beneficial impacts to fisheries and aquaculture. Brood reefs would be constructed with the goal of increasing oyster spawning stock and connecting existing oyster reefs. This, in turn, could enhance the quality of the area's reef habitat for associated fish, which could benefit commercial and recreational activities.

Cultch Plant Oyster Restoration

Cultch plant construction is not anticipated to result in any short-term adverse impacts to fisheries and aquaculture at the restoration site or potential programmatic sites. The alternative could result in long-term, beneficial impacts to fisheries and aquaculture. If performance criteria are met, cultch plants would be open to harvest after as early as two years post-construction, increasing recreational and commercial oyster harvest opportunities. Cultch plants would also increase natural productivity in the area by increasing oyster recruitment and thereby the quality of habitat for associated fish, which could benefit commercial and recreational activities.

Hatchery-based Oyster Restoration

The hatchery-based oyster restoration alternative is not anticipated to result in any short-term adverse impacts to fisheries and aquaculture. The alternative could result in long-term, beneficial impacts to fisheries and aquaculture. Up to 75 percent of hatchery-raised oysters would be allocated to restoration on lands that are open to harvest, increasing recreational and commercial oyster harvest opportunities.

Caillou Lake Artificial Oyster Reef

Artificial reef construction is not anticipated to result in any short-term adverse impacts to fisheries and aquaculture. The alternative could result in long-term, beneficial impacts to fisheries and aquaculture. The artificial reef would provide a substrate on which oysters can attach, grow, and reproduce, thereby increasing natural productivity and enhancing habitat for reef-associated fish, which could benefit commercial and recreational activities.

No Action Alternative

Under the no action alternative, no oyster restoration would take place, and no benefit to fisheries or aquaculture would occur.

4.6. Cumulative Impacts

The CEQ defines cumulative impacts as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR §1508.7). As stated in the CEQ handbook, *Considering Cumulative Effects* (CEQ, 1997), cumulative impacts need to be analyzed in terms of the specific resource, ecosystem, and human community being affected and should focus on impacts that are truly meaningful. Cumulative impacts should be considered for all alternatives, including the no action alternative.

The Final PDARP/PEIS (Section 6.17.2) states that consideration of cumulative impacts of proposed alternatives in RP/EAs should build on the programmatic analyses and focus on site-specific issues (DWH Trustees, 2016). This is consistent with the 2014 CEQ guidance regarding effective use of programmatic NEPA analysis:

> An analysis of the cumulative impacts for each resource would be provided in each level of review, either by relying upon the analysis in the programmatic NEPA review or adding to that analysis in the tiered NEPA review, either approach facilitated by incorporating by reference the cumulative impact analysis provided in the programmatic NEPA review (CEQ, 2014).

The Louisiana TIG determined that the conditions and environmental impacts described in the Final PDARP/PEIS are valid and relied upon the cumulative impacts analysis for the alternatives analyzed in this RP/EA, where applicable. Considering context and intensity, the Louisiana TIG considers negligible to minor direct and indirect impacts described in this RP/EA as sufficiently analyzed cumulatively in the Final PDARP/PEIS (DWH Trustees, 2016). No moderate or major impacts were identified.

Section 6.6.2 of the Final PDARP/PEIS outlines the following steps involved in a cumulative impact analysis: (1) identify the resources affected, (2) establish the boundaries of analysis, (3) identify the cumulative impacts scenario, and (4) conduct a cumulative impacts analysis. Additional details for each of these steps are provided below.

Step 1: Identify the resources affected. The CEQ handbook states that the analyst must first determine the realistic potential for the resource to sustain itself in the future and whether the proposed action would affect this potential; therefore, the baseline condition of the resource should include a

description of how conditions have changed over time and how they are likely to change in the future if the proposed action is not implemented. The baseline condition should also include other ongoing actions, as discussed in Section 6.6.4 of the Final PDARP/PEIS (DWH Trustees, 2016).

Step 2: Establish the boundaries of analysis. In order to properly bound the cumulative impacts analysis, the CEQ handbook recommends determining appropriate spatial and temporal impact boundaries. The alternatives analyzed in this RP/EA would have local and minor adverse impacts, most of which would be short term in duration (i.e., during implementation). Therefore, the Louisiana TIG considered these short-term adverse impacts in concert with other present actions (i.e., restoration actions with impacts that would overlap with the implementation stage of the alternatives), thus limiting the temporal boundary of the analysis to the construction/implementation phases. In determining the spatial boundary, the Louisiana TIG considered the programmatic analysis of cumulative impacts in the Final PDARP/PEIS, which analyzed impacts on a regional, ecosystem scale (DWH Trustees, 2016). The spatial boundary of the cumulative impacts analysis in this RP/EA is a local scale. In summary, the analysis boundaries for this plan include:

- Affected resource-specific spatial boundaries:
    - Coastal Louisiana
- Affected resource-specific temporal boundaries:
    - One to 10-year implementation of the alternatives

Step 3: Identify the cumulative impacts scenario. The Final PDARP/PEIS describes the affected environment and evaluates the impacts of restoration as well as programmatic development activities by considering cumulative impacts from implementation of DWH early restoration (DWH Trustees, 2012). The Final PDARP/PEIS analysis is incorporated by reference, where applicable (DWH Trustees, 2016). No significant cumulative impacts were concluded in this analysis. Where applicable, each RP/EA's cumulative impacts analysis should build on previous plans, incorporating only impacts not considered in previous analyses. The scenario includes:

Past, Present, and Reasonably Foreseeable Future Actions - Past activities that have contributed to the current condition of resources are described and analyzed in Chapter 6 of the Final PDARP/PEIS and are not repeated in this analysis. The Louisiana TIG identified relevant present and reasonably foreseeable future actions not analyzed in the previous documents and considered their potential impacts in the analysis (TABLE 4-8). Applicable to the marine mammal and oyster restoration types, these include restoration related to the DWH oil spill (barrier island/headland restoration, freshwater diversions, hydrologic restoration, marsh creation, oyster restoration, recreational use, and sediment diversions), military operations, marine transportation, energy activities, dredged material disposal, marine mineral mining, fisheries and aquaculture, tourism and recreation, and coastal development and land use activities. Where these actions are planned and/or ongoing, they may apply as present and reasonably foreseeable future actions.

Step 4: Cumulative impacts analysis. The Louisiana TIG analyzed whether the adverse impacts from implementation of the marine mammal and oyster alternatives would contribute substantially to adverse cumulative impacts when added to past, present, or reasonably foreseeable future actions.

There were no direct or indirect moderate, long-term adverse impacts for the marine mammal or oyster alternatives, nor the no action alternative.

Restoration Type: Marine Mammals

Cumulative Impacts Determination for Marine Mammal Alternatives in this RP/EA

There are no long-term, moderate or major adverse impacts considered for implementation of the preferred marine mammal alternative. Therefore, there would be no cumulative impacts resulting from the implementation of the marine mammal alternative. The contribution of adverse impacts from the proposed implementation of the marine mammal alternative falls within the range of cumulative impacts described in the Final PDARP/PEIS (Section 6.6; DWH Trustees, 2016). Upon further review, the alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to physical, biological, or socioeconomic resources.

TABLE 4-8. Present and reasonably foreseeable future actions considered in the cumulative impact analysis.

Action Description	Key Resource Areas with Potential for Adverse Cumulative Impacts
Restoration Related to DWH Oil Spill (funded by RESTORE, NRDA, and NFWF GEBF)	
Project types funded by DWH include barrier island/headland restoration, freshwater diversion, hydrologic restoration, marsh creation, oyster barrier reef creation, recreational use, and sediment diversion. These programs would restore coastal habitats, water quality, and marine and estuarine fauna. Projects that are recently completed, planned, or are in process are listed here: **Barrier Island/Headland Restoration:** West Grand Terre Beach Nourishment and Stabilization; Shell Island West; Caillou Lake Headlands; Queen Bess Island Restoration; Rabbit Island Restoration; Caminada Headland Beach and Dune Restoration; Terrebonne Basin Barrier Island and Beach Nourishment **Freshwater Diversion:** River reintroduction into Maurepas Swamp **Hydrologic Restoration:** Calcasieu Ship Channel Salinity Control Measures; Houma Navigation Canal Lock Complex **Marsh Creation:** Golden Triangle Marsh Creation; Lake Hermitage Mash Creation; Barataria Basin Ridge and Marsh Creation – Spanish Pass Increment; Lake Borgne Marsh Creation – Increment 1; Terrebonne Basin Ridge and Marsh Creation – Bayou Terrebonne Increment; Large-Scale Barataria Marsh Creation; Grande Cheniere Ridge Marsh Creation **Other:** Lowermost Mississippi River Management Plan **Oyster Restoration:** Biloxi Marsh Living Shoreline **Recreational Use:** Island Road Fishing Piers; Atchafalaya Delta WMA Boat Access; Atchafalaya Delta WMA Campground Improvements; Bayou Segnette State Park Improvements; Grand Isle State Park Improvements; Rockefeller Piers and Signage; Pass a Loutre Crevasses; Pass a Loutre Campgrounds; Middle Pear River WMA Boat Launch; Pointe-Aux-Chene WMA Enhancement; Cypremort Point State Park Improvements **Sediment Diversion:** Mid-Barataria Sediment Diversion; Mid Breton Sediment Diversion; Increase Atchafalaya Flow to Terrebonne; Sediment Diversion Implementation and Program Management	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; Terrestrial wildlife; Protected species; EFH; Land and marine management; Fisheries and aquaculture.

Action Description	Key Resource Areas with Potential for Adverse Cumulative Impacts
Military Operations	
The US Air Force and US Navy conduct military operations within federally designated areas of Louisiana for the purposes of personnel training, research, design, testing, and evaluation. The US Navy conducts surface and subsurface training and operations at an offshore operating area near New Orleans, Louisiana.	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; EFH; Land and marine management; Fisheries and aquaculture.
Marine Transportation	
Marine Highway Corridors M-49 and M-55 are located in Morgan City and New Orleans, respectively. The corridors are used for port development; shipping and maritime services; and associated navigation, channel construction, and maintenance. Future actions are likely to occur along corridors or at ports in Louisiana as maritime traffic is expected to increase.	Hydrology and water quality; Habitats; Marine and estuarine fauna; EFH; Land and marine management; Fisheries and aquaculture
Energy Activities	
Louisiana has one of the highest levels of oil and gas activity in the Gulf of Mexico region. Production of oil in Louisiana decreased by nearly eight percent between 2016 and 2017, but gas production increased by 11 percent between 2016 and 2017. Daily crude oil average runs to stills in 2017 were just over three million barrels per day, an increase of 2.3 percent from 2016 (LDNR, 2017). Oil and gas activities will continue in the foreseeable future.	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; Protected species; EFH; Land and marine management; Fisheries and aquaculture
Dredged Material Disposal	
The USACE's New Orleans District office oversees seven ocean dredged-material sites in the Gulf of Mexico. Estimates suggest that an annual average of about 17 million cubic yards of dredged materials is used beneficially. EPA and USACE are jointly responsible for the management and monitoring of ocean disposal sites.	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; Protected species; EFH; Land and marine management; Fisheries and aquaculture
Marine Mineral Mining, Including Sand and Gravel Mining	
The Louisiana Coastal Area Ecosystem Restoration Plan permits the use of up to 60 million cubic yards of OCS sand offshore of Louisiana. However, there has been a recent increase in state funded projects requesting OCS sand resources, so it is expected that this number may increase.	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; Protected species; EFH; Land and marine management; Fisheries and aquaculture
Fisheries and Aquaculture	
LDWF is responsible for regulating recreational and commercial fishing as well as aquaculture activities within Louisiana state waters. The agency provides licenses and permits; leases coastal submerged land for aquaculture; sets catch limits, quotas, and seasons; regulates harvest and processing; and provides technical assistance. Examples include the Caernarvon bass rearing ponds and crawfish ponds.	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; Protected species; EFH; Land and marine management; Fisheries and aquaculture

Action Description	Key Resource Areas with Potential for Adverse Cumulative Impacts
Tourism and Recreation	
The Louisiana Office of Tourism provides grants and opportunities for tourism promotion within the state in an effort to increase marketing opportunities. Examples include park upgrades to walking and biking paths.	Geology and substrates; Habitats; Terrestrial wildlife; Protected species; EFH; Land and marine management
Coastal Development and Land Use	
Examples of coastal development activities include commercial, residential, and other development; roadway maintenance and improvement; structural and nonstructural risk reduction projects; marsh creation; sediment diversions; and hydrologic and ridge restoration.	Geology and substrates; Hydrology and water quality; Habitats; Marine and estuarine fauna; Terrestrial wildlife; Protected species; EFH; Land and marine management; Fisheries and aquaculture

Restoration Type: Oysters

Cumulative Impacts Determination for Oyster Alternatives in this RP/EA

There are no long-term, moderate or major adverse impacts considered for implementation of the preferred oyster alternatives. Therefore, there would be no cumulative impacts resulting from the implementation of the oyster alternatives. The spatial extent of the area of impacts is small (1,640 to 2,040 acres) in comparison to resource availability (nearly 1.7 million acres of POA in Louisiana; LDWF, 2017), even in combination with other present and reasonably foreseeable future actions.

In summary, the contribution of adverse impacts from the proposed implementation of the oyster alternatives falls within the range of cumulative impacts described in the Final PDARP/PEIS (Section 6.6; DWH Trustees, 2016). Upon further review, the alternatives are not expected to contribute substantially to short-term or long-term cumulative adverse impacts to physical, biological, or socioeconomic resources.

No Action Alternative (summarized from the Final PDARP/PEIS, Section 6.6)

Under the no action alternative, restoration alternatives considered in this RP/EA would not occur. Short- and long-term adverse impacts would result due to continued degradation of Louisiana's coastal environment and from the lack of benefits provided by the implementation of the preferred alternatives. This alternative would not contribute to the impacts of past, present, and reasonably foreseeable future actions.

Habitat restoration, conservation, and recovery efforts associated with other environmental stewardship and restoration activities in the Gulf of Mexico would continue to provide benefits. These actions would likely create restored habitats, protect habitats from fragmentation, and preserve unaffected quality habitats, especially sensitive habitats (e.g., SAV). Under the no action alternative, however, the alternatives considered in this RP/EA would not contribute to the benefits provided by other restoration efforts.

5. COMPLIANCE WITH OTHER LAWS AND REGULATIONS

5.1. Compliance with Additional Federal Laws

Additional federal laws, regulations, and EOs that may be applicable to the proposed action and alternatives in this RP/EA include the following:

- Endangered Species Act (16 U.S.C. §§ 1531 *et seq*.)
- Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801 *et seq*.)
- Marine Mammal Protection Act (16 U.S.C. §§ 1361 *et seq*.)
- Coastal Zone Management Act (16 U.S.C. §§ 1451 *et seq*.)
- National Historic Preservation Act (16 U.S.C. §§ 470 *et seq*.)
- Coastal Barrier Resources Act (16 U.S.C. §§ 3501 *et seq*.)
- Clean Air Act (42 U.S.C. §§ 7401 *et seq*.)
- Federal Water Pollution Control Act (CWA) (33 U.S.C. §§ 1251 *et seq*.) and/or Rivers and Harbors Act (33 U.S.C. §§ 401 *et seq*.)
- Marine Protection, Research and Sanctuaries Act (16 U.S.C. §§ 1431 *et seq*. and 33 U.S.C. §§ 1401 *et seq*.)
- Estuary Protection Act (16 U.S.C. §§ 1221-1226)
- Archaeological Resource Protection Act (16 U.S.C. §§ 470aa-470mm)
- National Marine Sanctuaries Act (16 U.S.C. §§ 1431 *et seq*.)
- Farmland Protection Policy Act (7 U.S.C. §§ 4201 – 4209)
- EO 11988: Floodplain Management (augmented by EO 13690, January 30, 2015), as amended.
- EO 11990: Protection of Wetlands, as amended.
- EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, as amended.
- EO 12962: Recreational Fisheries, as amended.
- EO 13112: Safeguarding the Nation from the Impacts of Invasive Species, as amended.
- EO 13175: Consultation and Coordination with Indian Tribal Governments, as amended.
- EO 13186: Responsibilities of Federal Agencies to Protect Migratory Birds, as amended.
- EO 13693: Planning for Federal Sustainability in the Next Decade, as amended.

Federal environmental compliance responsibilities and procedures in Section 9.4.6 of the Trustee Council SOPs would be followed (Trustee Council, 2016). The implementing Trustee for each alternative would ensure that the status of environmental compliance (e.g., completed versus in progress) is tracked through the Restoration Portal. Implementing Trustees would keep a record of compliance documents (e.g., ESA biological opinions and USACE permits) and ensure that they are submitted for inclusion to the administrative record.

5.2. Compliance with State and Local Laws

The Louisiana TIG would ensure compliance with all applicable state and local laws and other applicable federal laws and regulations relevant to the state of Louisiana. Additional laws and regulations are listed as follows:

- Archeological Finds on State Lands (La. Rev. Stat. 41:1605)
- Coastal Wetlands Conservation and Restoration Authority (La. Rev. Stat. 49:213.1)
- Coastal Wetlands Conservation and Restoration Plan (La. Rev. Stat. 49:213.6)
- Louisiana State and Local Coastal Resources Management Act (La. Rev. Stat. 49:214.21 –214.42)
- Louisiana Oil Spill Prevention and Response Act (La. Rev. Stat. 30:2451 *et seq*.)
- Management of State Lands (La. Rev. Stat. 41:1701.1 *et seq*.)
- Louisiana Coastal Resources Program (La. Admin. Code 43:700 *et seq*.)
- Louisiana Surface Water Quality Standards (La. Admin. Code 33.IX, Chapter 11)
- Management of Archaeological and Historic Sites (La. Rev. Stat. 41:1605)
- Oyster Lease Relocation Program (La. Admin. Code 43:I, 850-859, Subchapter B)
- Louisiana Scenic Rivers Program (La. Rev. Stat. 56:1856)

5.3. Summary of Environmental Compliance and Next Steps for Louisiana TIG

The Louisiana TIG has begun technical assistance with regulatory agencies for protected species and their habitats under the ESA, EFH protected under the MSA, marine mammals under the MMPA, cultural resources under the NHPA, permits under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act, and other federal statutes, where appropriate. *Supra.*

Pursuant to the CZMA, federal activities must be consistent to the maximum extent practicable with the federally approved coastal management programs for states where the activities would affect a coastal use or resource. The federal Trustees are submitting consistency determinations for state review coincident with public review of this document. Additional reviews may occur during the permitting processes required for implementation. Implementing Trustees are required to implement alternative-specific mitigation measures (including BMPs) identified in this RP/EA and completed consultations/permits. Implementing Trustees would provide oversight with regard to ensuring no unanticipated impacts on listed species and habitats, including ensuring that BMPs are implemented and continue to function as intended (DWH Trustees, 2016).

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APPENDICES

Appendix A – List of Repositories

State	Repository	Address	City	Zip Code
Louisiana	St. Tammany Parish Library	310 W. 21st Avenue	Covington	70433
Louisiana	Terrebonne Parish Library	151 Library Drive	Houma	70360
Louisiana	New Orleans Public Library, Louisiana Division	219 Loyola Avenue	New Orleans	70112
Louisiana	East Baton Rouge Parish Library	7711 Goodwood Boulevard	Baton Rouge	70806
Louisiana	Jefferson Parish Library East Bank Regional Library	4747 W. Napoleon Avenue	Metairie	70001
Louisiana	Jefferson Parish Library West Bank Regional Library	2751 Manhattan Boulevard	Harvey	70058
Louisiana	Plaquemines Parish Library	8442 Highway 23	Belle Chase	70037
Louisiana	St. Bernard Parish Library	1125 E. St. Bernard Highway	Chalmette	70043
Louisiana	St. Martin Parish Library	201 Porter Street	Martinville	70582
Louisiana	Alex P. Allain Library	206 Iberia Street	Franklin	70538
Louisiana	Vermillion Parish Library	405 E. St. Victor Street	Abbeville	70510
Louisiana	Martha Sowell Utley Memorial Library	314 St. Mary Street	Thibodaux	70301
Louisiana	South Lafourche Public Library	16241 E. Main Street	Cut Off	70345
Louisiana	Calcasieu Parish Public Library Central Branch	301 W. Claude Street	Lake Charles	70605
Louisiana	Iberia Parish Library	445 E. Main Street	New Iberia	70560
Louisiana	Mark Shirley, Louisiana State University Ag Center	1105 West Port Street	Abbeville	70510

Appendix B – List of Preparers, Reviewers, Agencies, and Persons Consulted

Agency/Firm	Name	Title/Role
National Oceanic and Atmospheric Administration		
NOAA National Marine Fisheries Service	Laura Engleby	Chief, Marine Mammal Branch
NOAA Restoration Center	Christina Fellas	DWH Environmental Compliance Coordinator/Biologist
NOAA Restoration Center	Erin Fougeres	Stranding Program Administrator
NOAA Restoration Center	Mel Landry	Marine Habitat Resource Specialist
NOAA Office of the General Counsel, Natural Resources Section	Jared Piaggione	Attorney Advisor
NOAA Restoration Center/ Earth Resources Technology, Inc.	Barrett Ristroph	Marine Habitat Restoration Specialist
NOAA Restoration Center	Ramona Schreiber	DWH NEPA Coordinator
NOAA Restoration Center/ Earth Resources Technology, Inc.	Courtney Schupp	Marine Habitat Resource Specialist
NOAA Office of Habitat Conservation	Jeff Shenot	NEPA Coordinator
NOAA Office of Habitat Conservation; NOAA Restoration Center	Eric Weissberger	Marine Habitat Resource Specialist
State of Louisiana		
Louisiana Department of Wildlife and Fisheries	Todd Baker	Coastal Resources Scientist Manager
Coastal Protection and Restoration Authority	Chris Barnes	Attorney
Louisiana Department of Wildlife and Fisheries	Carolina Bourque	Marine Fisheries Biologist
Louisiana Department of Wildlife and Fisheries	Brady Carter	Coastal Resources Scientist Manager
Louisiana Department of Environmental Quality	Adrienne Gossman	Environmental Scientist
Louisiana Department of Wildlife and Fisheries	Annie Howard	Coastal Resources Scientist Manager
U.S. Department of Agriculture		
USDA, Natural Resources Conservation Service	Mark Defley	Biologist
U.S. Department of the Interior		
DOI	Robin Renn	DWH NEPA Coordinator
U.S. Environmental Protection Agency		
EPA Office of General Counsel	James Bove	Attorney Advisor
EPA Region 6	Raul Gutierrez, PhD	Environmental Scientist
EPA Region 6	J. Douglas Jacobson	Environmental Protection Specialist, Louisiana Team Leader
Contractor Team		
Industrial Economics, Inc.	Gail Fricano	Principal
Industrial Economics, Inc.	Alexandra van Geel	Senior Technical Consultant
Industrial Economics, Inc.	Jennifer Hart	Senior Technical Consultant
Industrial Economics, Inc.	Niamh Micklewhite	Research Analyst
Industrial Economics, Inc.	Michaela Murray	Research Analyst

Industrial Economics, Inc.	Eric Ruder	Principal
Industrial Economics, Inc.	Sophie Swetz	Research Analyst

Appendix C – NEPA Impact Thresholds

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
Physical Resources				
Geology and Substrates	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impact on geologic features and soils would be detectable but small and localized. Localized erosion and/or compaction could occur.	The impact on geologic features and soils would be readily apparent and occur over local and immediately adjacent areas. Erosion and/or compaction impacts could occur...	The impact on geologic features and soils would be readily apparent and occur over a widespread area. Erosion, compaction, and other disruptions of soils and substrates could occur and may be permanent.
Hydrology and Water Quality	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	*Hydrology*: The impact on hydrology would be detectable but small and localized. The impact would only temporarily alter the area's surface and ground water flows. *Water quality*: The impact on water quality would be detectable but small, localized, and return to baseline quickly. State water quality standards as required by the CWA would not be exceeded. *Floodplains*: The impact on floodplains would be detectable but small and localized. There would be no appreciable increased risk of flooding and risks to human safety, health, and welfare. *Wetlands*: The impact on wetlands would be detectable but small and localized. Wetland function would return to normal if left alone.	*Hydrology*: The impact on hydrology would be readily apparent and occur over local and immediately adjacent areas. Permanent impacts to surface and ground water flows may occur. *Water quality*: The impact on water quality would be readily apparent over local and immediately adjacent areas. Change in water quality could persist; however, it would not exceed state water quality standards as required by the CWA. *Floodplains*: The impact on floodplains would be readily apparent over local and immediately adjacent areas. Impacts would result in a change to natural and beneficial floodplain values. Location of operations could increase risk of flood loss and risks to human safety, health, and welfare. *Wetlands*: The impact on wetlands would cause a measurable impact on wetlands indicators (size, integrity, or connectivity) or would	*Hydrology*: The impact on hydrology would be readily apparent over a widespread area. The impact could permanently alter surface and ground water flows. *Water quality*: The impact on water quality would be readily apparent over a widespread area. State water quality standards as required by the CWA would likely be exceeded and/or designated uses of a water body would be impaired. *Floodplains*: The impact on floodplains would be readily apparent over a widespread area. Impacts would result in a change to natural and beneficial floodplain values which could have substantial consequences. Location of operations could increase risk of flood loss and risks to human safety, health, and welfare. *Wetlands*: The impact on wetlands would be a permanent loss of wetlands across a widespread area. The character of the wetlands could be changed so that the functions

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
			result in a permanent loss of wetland acreage across local and adjacent areas.	typically provided by the wetland would be permanently lost.
Air Quality	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impact on air quality would be detectable but localized and temporary, such that the emissions do not exceed the EPA's de minimis criteria for a general conformity determination under the CAA.	The impact on air quality would be readily apparent over local and immediately adjacent areas. Emissions of criteria pollutants would be at EPA's de minimis criteria levels for general conformity determination under the CAA.	The impact on air quality would be readily apparent over a widespread area. Emissions of criteria pollutants would be high, such that they exceed EPA's de minimis criteria for a general conformity determination under the CAA.
Noise	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	Noise impacts would be detectable but localized and temporary. Noise levels would quickly return to baseline after project construction/implementation.	Noise impacts would be readily apparent over local and immediately adjacent areas. Impacts would compromise other land uses in the area (e.g., recreation).	Noise impacts would be readily apparent over widespread areas. Impacts would compromise other land uses in the area (e.g., recreation).
Biological Resources				
Habitats	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impact on habitats would be detectable but would not dramatically alter natural conditions and would be limited to localized areas. Infrequent or insignificant disturbance to local habitat would occur, but sufficient additional habitat would remain functional at both the local and regional scales.	The impact on habitats would be readily apparent over local and immediately adjacent areas. Occasional disturbance to local habitat would occur but would not affect regional stability.	The impact on habitats would be readily apparent over a widespread area. Frequent disturbance to habitat would occur with adverse impacts at both local and regional levels.
Terrestrial Wildlife	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer. breeding seasons.	The impact on terrestrial wildlife would be detectable but small and localized. Infrequent disturbance to some individuals would be expected, but without interference to feeding, reproduction, resting, migrating, or other factors affecting population levels. Small changes to local population numbers, population structure, and other	The impact on terrestrial wildlife would be readily apparent over local and immediately adjacent areas. Occasional disturbance to some individuals would be expected, with some adverse impacts to feeding, reproduction, resting, migrating, or other factors affecting local population levels. Some impacts might occur in key	The impact on terrestrial wildlife would be readily apparent over a widespread area. Frequent disturbance to some individuals would be expected, with adverse impacts to feeding, reproduction, migrating, or other factors resulting in a decrease in both local and range-wide population levels and habitat type. Impacts would occur

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
		demographic factors could occur. Sufficient habitat would remain functional at both the local and range-wide scales to maintain the viability of the species.	habitats. However, sufficient population numbers or habitat would retain function to maintain the viability of the species both locally and throughout its range.	during critical periods of reproduction or in key habitats and would result in direct mortality or loss of habitat that might affect the viability of a species. Local population numbers, population structure, and other demographic factors might experience large changes or declines.
Marine and Estuarine Fauna	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impact on marine and estuarine fauna would be detectable but small and localized. Disturbance to individual species would occur; however, there would be no change in local populations of marine and estuarine species. Infrequent disturbances would not interfere with key behaviors such as feeding and spawning. There would be no restriction of movements daily or seasonally.	The impact on marine and estuarine fauna would be readily apparent over local and immediately adjacent areas. Disturbances would result in a small change in species diversity; however, overall populations would not be altered. Some key behaviors would be affected but not to the extent that species viability is affected. Some movements would be restricted seasonally.	The impact on marine and estuarine fauna would be readily apparent over widespread areas. Disturbances would result in substantial changes to marine and estuarine species populations. The viability of some species would be affected. Species movements would be seasonally constrained or eliminated.
Protected Species	Short-term: During construction/implementation period Long-term: Over the life of the project or longer.	The impacts on protected species would be detectable but small and localized. Infrequent disturbances would not measurably alter natural conditions. Impacts would likely result in a "may affect, not likely to adversely affect" determination for at least one listed species.	The impacts on protected species would be readily apparent over local and immediately adjacent areas. Occasional disturbances would result in some adverse impacts to feeding, reproduction, resting, migrating, or other factors affecting local and adjacent population levels. Impacts could occur in key habitats, but sufficient population numbers or habitat would remain functional to maintain the viability of the species both locally and throughout their range. Impacts would likely result	The impacts on protected species would be readily apparent over a widespread area. Frequent disturbances would result in substantial impacts to the population numbers of protected species, or interference with their survival, growth, or reproduction. There would be impacts to key habitat, resulting in substantial reductions in species numbers. Impacts would likely result in an "is likely to jeopardize proposed or listed species/adversely modify proposed or designated critical

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
			in a "may affect, likely to adversely affect" determination for at least one listed species. No adverse modification of critical habitat could be expected.	habitat (impairment)" determination for at least one listed species.
Socioeconomic Resources				
Socioeconomics and Environmental Justice	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impacts to socioeconomics and environmental justice would be detectable but small and localized. A few individuals, groups, businesses, properties, or institutions would be affected, but these impacts are not expected to substantively alter social and/or economic conditions. Actions would not disproportionately affect minority and low-income populations.	The impacts to socioeconomics and environmental justice would be readily apparent over the local and immediately adjacent area. Many individuals, groups, businesses, properties, or institutions would be affected and would have an impact on social and/or economic conditions. Actions could disproportionately affect minority and low-income populations. However, all impacts would be temporary.	The impacts to socioeconomics and environmental justice would be readily apparent over a widespread area. A large number of individuals, groups, businesses, properties, or institutions would be affected and would have a substantial influence on social and/or economic conditions. Actions could disproportionately affect minority and low-income populations. Impacts would be permanent.
Cultural Resources	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impacts to cultural resources would be detectable, but small and localized. The disturbance of a site, building, structure, or object would result in little, if any, loss of important cultural information potential.	The impacts to cultural resources would be readily apparent over the local and immediately adjacent area. Disturbance of a site, building, structure, or object would not result in a substantial loss of important cultural information.	The impacts to cultural resources would be readily apparent over a widespread area. Disturbance of a site, building, structure, or object would be substantial and may result in the loss of most or all its potential to yield important cultural information.
Infrastructure	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impacts to infrastructure would be detectable but small and localized. The action would affect public services or utilities, but impacts are not expected to result in any inconvenience.	The impacts to infrastructure would be readily apparent over the local and immediately adjacent area. The action would affect public services or utilities and would result in increases in daily traffic volumes (with slightly reduced speed of travel), resulting in slowed traffic and delays, but no change in level of service (LOS). Short service	The impacts to infrastructure would be readily apparent over a widespread area. The action would affect public services or utilities and would result in the loss of certain services or necessary utilities. Extensive increase in daily traffic volumes (with reduced speed of travel) would result in an adverse change in LOS to worsened

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
			interruptions (temporary closure for a few hours) to roadway and railroad traffic would occur.	conditions. Extensive service disruptions (temporary closure of one day or more) to roadways or railroad traffic would occur.
Land and Marine Management	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impact to land and marine management would be detectable but small and localized. The action may require a variance or zoning change or an amendment to a land use, area comprehensive, or management plan, but would not affect overall use and management beyond the local area.	The impact to land and marine management would be readily apparent over the local and immediately adjacent area. The action would require a variance or zoning change or an amendment to a land use, area comprehensive, or management plan, and would affect overall land use and management in local and adjacent areas.	The impact to land and marine management would be readily apparent over a widespread area. The action would cause permanent changes to and conflict with land uses or management plans over a widespread area.
Tourism and Recreation	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impact to tourism and recreation would be detectable but small and localized. There would be slight changes in visitor use and/or partial site closures to protect public safety, but the same site capacity and visitor experience would remain after construction.	The impact to tourism and recreation would be readily apparent over the local and immediately adjacent area. There would be changes in visitor use and/or complete site closures to protect public safety. Sites would be reopened after activities occur; however, there could be slightly reduced site capacity. Some users would choose to pursue activities in other available local or regional areas.	The impact to tourism and recreation would be readily apparent over a widespread area. All developed site capacity would be eliminated because developed facilities would be closed and removed. Visitors would be displaced, and visitor experiences could no longer be available in many locations. Users would choose to pursue activities in other available regional areas.
Fisheries and Aquaculture	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impacts to fisheries and aquaculture would be detectable, but small and localized. Infrequent disturbances would not measurably alter natural, social, and/or economic conditions.	The impacts to fisheries and aquaculture would be readily apparent over the local and immediately adjacent areas. Occasional disturbances would result in some adverse impacts to natural, social, and/or economic conditions. Enough resources would remain to maintain the	The impacts to fisheries and aquaculture would be readily apparent over a widespread area. Frequent disturbances would result in adverse impacts to natural, social, and/or economic conditions. The viability of the fishery or aquaculture site would be compromised.

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
			viability of the fishery or aquaculture site.	
Aesthetics and Visual Resources	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impacts to aesthetics and visual resources would be detectable, but small and localized. There would be a change in the view shed but it would not attract attention, dominate the view, or detract from current user activities or experiences.	The impacts to aesthetics and visual resources would be readily apparent over the local and immediately adjacent area. There would be a change in the view shed that was attracts attention. Changes would not dominate the viewscape, although they could detract from the current user activities or experiences.	The impacts to aesthetics and visual resources would be readily apparent over a widespread area. There would be changes in the view shed that that would dominate and detract from current user activities or experiences.
Public Health and Safety	Short-term: During construction/implementation period. Long-term: Over the life of the project or longer.	The impacts to public health and safety would be temporary and localized. Actions would not result in (1) soil, ground water, and/or surface water contamination; (2) exposure of contaminated media to construction workers or transmission line operations personnel; and/or (3) mobilization and migration of contaminants currently in the soil, ground water, or surface water at levels that could harm the workers or general public. Increased risk of potential hazards (e.g., increased likelihood of storm surge) to visitors, residents, and workers from decreased shoreline integrity would be minimal.	The impacts to public health and safety would be readily apparent over local and immediately adjacent areas. Actions would result in (1) exposure, mobilization and/or migration of existing contaminated soil, ground water, or surface water to an extent that requires mitigation; and/or (2) would introduce detectable levels of contaminants to soil, ground water, and/or surface water in localized areas within the project boundaries such that mitigation/remediation is required to restore the affected area to the preconstruction conditions. Increased risk of potential hazards to visitors, residents, and workers from decreased shoreline integrity would be enough to cause a permanent change in use patterns and area avoidance.	The impacts to public health and safety would be readily apparent over a widespread area. Actions would result in (1) soil, ground water, and/or surface water contamination at levels exceeding federal, state, or local hazardous waste criteria, including those established by 40 CFR § 261; (2) mobilization of contaminants currently in the soil, ground water, or surface water, resulting in exposure of humans or other sensitive receptors such as plants and wildlife to contaminant levels that would result in health impacts; and (3) the presence of contaminated soil, ground water, or surface water within the project area, exposing workers and/or the public to contaminated or hazardous materials at levels exceeding those permitted by the federal Occupational Safety and Health Administration (OSHA) in 29 CFR § 1910. Increased risk of potential hazards to visitors,

Resource	Impact Duration	Minor Intensity	Moderate Intensity	Major Intensity
				residents, and workers from decreased shoreline integrity would be substantial and cause permanent changes in use patterns and area avoidance.

Appendix D – MAM Plans

Monitoring and Adaptive Management Plan for *Deepwater Horizon* NRDA Project:

Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Increase Survival of Stranded Cetaceans and Inform Future Restoration Efforts

Prepared by: Louisiana Natural Resource Trustees

Draft Version Date: 3/6/2020

Table of Contents

1 Introduction

The Louisiana Natural Resource Trustees (Trustees) developed this monitoring plan (plan) for the Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Increase Survival of Stranded Cetaceans and Inform Future Restoration Efforts Project (project). This project is included as a preferred alternative for the marine mammal restoration type in the *Louisiana Draft Restoration Plan/Environmental Assessment (RP/EA) #5, Living Coastal and Marine Resources (LCMR): Marine Mammals and Oysters*. The goal of this project is to increase the capabilities of Louisiana's Marine Mammal Stranding Network (MMSN) organizations, especially their ability to diagnose causes of illness and death in stranded marine mammals. MMSN organizations will use that information to better understand population health in order to offset impacts resulting from exposure to Deepwater Horizon (DWH) oil, dispersant, and response activities.

The purpose of this plan is to describe monitoring activities that will be conducted to evaluate and document restoration effectiveness, including performance criteria for determining the success of restoration or need for interim corrective action (15 CFR 990.55(b)(1)(vii)). This plan will be implemented by the National Oceanic and Atmospheric Administration (NOAA) in partnership with the Audubon Nature Institute Coastal Wildlife Network (Audubon) and the Louisiana Department of Wildlife and Fisheries (LDWF) and may be modified over time based on the management needs for the project.

1.1 Project Overview

This project would implement a series of actions to address personnel and data gaps and enhance capacity in the current capabilities of the MMSN in Louisiana in order to improve timeliness of response, enhance survival, and improve diagnosis of illness and cause of death in cetaceans to better understand natural and anthropogenic threats, which will inform restoration planning, monitoring, and adaptive management.

The specific project objectives are to (1) enhance capacity for marine mammal stranding response in Louisiana, (2) improve capabilities to collect, store, and analyze samples from stranded cetaceans, (3) enhance capabilities to care for live, stranded marine mammals to increase the likelihood of survival, and (4) increase reporting of stranded marine mammals. This project would hire a Stranding Coordinator to focus on partnership building and outreach tasks, increase the network of trained stranding network personnel in Louisiana, and fill in gaps in the spatial coverage of MMSN personnel and equipment along the coast. The project would provide support to the Stranding Coordinator and authorized partners for the necessary trainings and resources (e.g., personnel, equipment, supplies) to enhance capabilities to collect, store, and analyze samples collected from stranded cetaceans, and to improve diagnosis of illness and cause of death for marine mammals in Louisiana.

In addition to hiring and training personnel, this project would provide the infrastructure, equipment, and supplies needed to facilitate stranding response and improve rehabilitation capabilities. A base of operations in Louisiana would be established for the Stranding Coordinator to operate out of with all appropriate equipment (e.g., computer, desk, phone, copier). Trucks, boats, and boat trailers would be provided to facilitate stranding response on remote beaches, marshes, and islands. Freezers and other

sample collection and storage supplies would also be provided to enhance the MMSN's capabilities to store and analyze samples collected from stranded cetaceans. Resources and equipment to enhance marine mammal rehabilitation at Audubon would also improve care for live stranded marine mammals, thus enhancing their chances of survival.

Enhancing capacity for stranding response in Louisiana would improve the timeliness of response throughout the state (i.e., how quickly trained MMSN personnel respond to a stranded animal). Enabling a more rapid response to a live stranded cetacean will increase that animal's chance of survival by reducing stranding time, reducing stress on the animal, providing rapid treatment, and, if appropriate, transport to an authorized rehabilitation facility for additional treatment and care. This project would ensure that there are trained and authorized MMSN partners in Louisiana with the necessary equipment and supplies to enable rapid response to reports of live, entangled, injured, and out-of-habitat cetaceans in the state, increasing the likelihood of survival for those animals.

Improving the timeliness of response would also increase the quality and quantity of data that can be collected from dead stranded cetaceans by decreasing decomposition time and ensuring that carcasses are fresher when they are recovered for necropsy. Testing fresher carcasses would improve the ability to diagnose causes of illness and death in cetaceans to better understand natural and anthropogenic threats, which would inform future restoration efforts, monitoring, and adaptive management.

1.2 Restoration Type Goals and Project Restoration Objectives

This project is being implemented as restoration for the DWH Natural Resource Damage Assessment (NRDA), consistent with the Programmatic Damage Assessment and Restoration Plan/Programmatic Environmental Impact Statement (PDARP/PEIS) Strategic Framework (DWH Trustees, 2017). The programmatic goals for the marine mammal restoration type are to:

- Implement an integrated portfolio of restoration approaches to restore injured Bay, Sound, and Estuary (BSE); coastal; shelf; and oceanic marine mammals across the diverse habitats and geographic ranges they occupy.
- Identify and implement restoration activities that mitigate key stressors to support resilient populations; and collect and use monitoring information, such as population and health assessments and spatiotemporal distribution information.
- Identify and implement actions that support ecological needs of the stocks; improve resilience to natural stressors; and address direct human-caused threats such as bycatch in commercial fisheries, vessel collisions, noise, industrial activities, illegal feeding and harassment, and hook-and-line fishery interactions.

The restoration approach for this project is to increase marine mammal survival through better understanding of causes of illness and death as well as early detection and intervention of anthropogenic and natural threats. The restoration techniques for this project include expanding the MMSN's capabilities along the Gulf of Mexico coast, enhancing capabilities to rapidly diagnose causes of

marine mammal morbidity and mortality, and developing and increasing the technical and infrastructure capabilities to respond to major stranding events or disasters.

For this project, the specific restoration objectives are listed below.

- Enhance capacity for marine mammal stranding response
- Improve capabilities to collect, store, and analyze samples from stranded cetaceans
- Enhance rehabilitation capabilities and care facilities for live, stranded marine mammals
- Increase reporting of stranded marine mammals

This project is anticipated to have positive impacts on the survival and health of many marine mammal species in the Gulf of Mexico, but in particular for coastal and estuarine stocks of bottlenose dolphins. Other offshore species that are subject to mass stranding or die-offs, such as short-finned pilot whales and rough-toothed dolphins, may also benefit if stranded in the network area.

1.3 Conceptual Setting

The conceptual model, described below, forms the basis of this monitoring plan and includes a summary of the project activities, the expected product or output of those activities, and the desired project outcomes. Currently, the MMSN's capacity in Louisiana is limited by funding and resources for personnel, training, supplies, equipment, sample storage, and sample analysis costs. This project would meet the immediate need to provide resources to address gaps in funding and enhance capacity in the MMSN's capabilities. This project would improve timeliness of response, enhance likelihood of survival, and improve diagnosis of illness and cause of death in cetaceans. Monitoring results would be reported annually and evaluated by the Louisiana TIG each year. A small working group composed of Trustee agency staff would meet annually to determine the need for corrective actions and for reallocation of project funds, if necessary, to ensure that project goals are achieved. In addition, the project would improve understanding of natural and anthropogenic threats to marine mammals, which would inform restoration planning, monitoring and adaptive management.

Table 1 provides a conceptual model of the relationship between restoration actions and goals of the project**.**

Table 1. Conceptual Model for Increasing Capacity and Expanding Partnerships along the Louisiana Coastline for Marine Mammal Stranding Response to Increase Survival of Stranded Cetaceans and Inform Future Restoration Efforts.

Restoration Actions	As-Built	Interim	Restoration Goal
Enhance capacity of Louisiana's MMSN	Identify and hire Marine Mammal Stranding Coordinator for Louisiana; evaluate the capacity to rehabilitate live,	Improve Louisiana's MMSN response time; improve capacity to store and analyze samples; improve sample analysis and	Improve survival of stranded cetaceans and improve diagnosis of illness and cause of death and inform

	stranded marine mammals; enhance resources for and effectiveness of Louisiana's MMSN	evaluation of data; if necessary, improve capacity to rehabilitate live, stranded marine mammals; increase reporting of strandings	future restoration efforts

1.3.1 Sources of Uncertainty

Uncertainties or information gaps have the potential to affect adaptive management decisions for restoration projects. These decisions may include how to improve the likelihood of achieving favorable project outcomes or selecting corrective actions in the event a project is not performing as intended. Sources of uncertainty, the degree of uncertainty, and the level of uncertainty associated with projects varies.

There are a number of potential sources of uncertainty that could affect project performance and success. Potential sources of uncertainties for this project include:

- The number of strandings
- The state of decomposition when reported (which limits quality of samples collected)
- Timely reporting of stranded animals
- Emerging threats and diseases not yet identified
- The ability to hire qualified personnel at appropriate locations
- The ability to cultivate buy-in and involvement from stakeholders and potential new MMSN partners (e.g., stakeholders reporting strandings)
- The ability to contract with appropriate partners
- The degree to which restoration actions would reduce sublethal effects to, and mortality of, cetaceans
- Changes in cetacean activity and behavior in the future (e.g., responding to changing environmental conditions, human activities)
- The ability to attribute restoration benefits from implemented actions

This list should not be considered exhaustive; additional uncertainties may be identified as the project is implemented and/or monitored.

2 Project Monitoring

The proposed monitoring for this project is outlined below and is organized by project objective, with one or more monitoring parameters for each objective. For each of the identified parameters, the plan includes information on the monitoring methods, timing, frequency, sample size, and sites. NOAA would perform monitoring activities with modifications as needed to address project objectives.

Objective #1: Enhance capacity for marine mammal stranding response.

Parameter #1: Stranding Coordinator for Louisiana's MMSN.

a) Purpose: To provide MMSN program continuity and increase program capacity.
b) Method: Hire qualified Stranding Coordinator.
c) Timing, Frequency, and Duration: Hiring completed initially during year one; position is continuously filled through year five; Report annually.
d) Sample Size: N/A.
e) Sites: N/A.

Parameter #2: Spatial coverage of MMSN partnerships.

a) Purpose: To increase program capacity and improve existing MMSN coverage throughout Louisiana.
b) Method: Stranding coordinator maintains and expands established partnerships and facilitates the development of new partnerships with individuals and agencies throughout Louisiana; evaluate response actions and average response times to determine what improvements are needed.
c) Timing, Frequency, and Duration: Project performance data for the three years preceding project implementation is collected and evaluated during year one to establish baseline performance; Project performance data collected continuously years one through five; Report annually.
d) Sample Size: N/A.
e) Sites: N/A.

Parameter #3: Network of trained and authorized MMSN personnel.

a) Purpose: To increase program capacity and improve existing MMSN coverage throughout Louisiana.
b) Method: Recruit additional personnel; organize and conduct trainings for stranding network personnel.
c) Timing, Frequency, and Duration: Project performance data for the three years preceding project implementation is collected and evaluated during year one to establish baseline performance; Project performance data collected continuously years one through five; Report annually.
d) Sample Size: N/A.
e) Sites: N/A.

Objective #2: Improve capabilities to collect, store, and analyze samples from stranded cetaceans.

Parameter #1: Spatial coverage of equipment and resources.

a) Purpose: To increase program capacity and diagnoses of illness and cause of death for marine mammals in Louisiana.
b) Method: Procure equipment and supplies needed for MMSN activities; evaluate response actions and average response times to determine what improvements are needed.

c) Timing, Frequency, and Duration: Project performance data for the three years preceding project implementation is collected and evaluated during year one to establish baseline performance; Project performance data collected continuously years one through five; Report annually.
d) Sample Size: N/A.
e) Sites: N/A.

Parameter #2: Resources and expertise for sample analysis and data evaluation.

a) Purpose: To increase program capacity and diagnoses of illness and cause of death for marine mammals in Louisiana.
b) Method: Provide material resources and procure subject matter expertise to improve analysis and data evaluation for samples collected from stranded cetaceans (i.e., improved analyses).
c) Timing, Frequency, and Duration: Project performance data for the three years preceding project implementation is collected and evaluated during year one to establish baseline performance; Project performance data collected continuously years one through five; Report annually.
d) Sample Size: All samples collected during a given year.
e) Sites: N/A.

Objective #3: Enhance rehabilitation capabilities and care facilities for live, stranded marine mammals to increase the likelihood of survival.

Parameter #1: The quality and effectiveness of rehabilitation capabilities.

a) Purpose: To evaluate and potentially improve rehabilitation of stranded marine mammals in Louisiana.
b) Method: Evaluate the effectiveness of the rehabilitation capabilities, and if needed, provide personnel and/or material resources to improve rehabilitation and survival of injured marine mammals (e.g., improvements to rehabilitation facility; reduced response time to live stranding report).
c) Timing, Frequency, and Duration: Evaluate performance year one to year three to determine the need for any corrective actions; Report annually.
d) Sample Size: All individual marine mammals sent to rehabilitation center during a given year.
e) Sites: N/A.

Objective #4: Improve reporting of stranded marine mammals.

Parameter #1: Effectiveness of outreach program.

a) Purpose: To increase the number of marine mammal strandings that are reported by the public.
b) Method: Develop outreach materials (e.g., brochures, posters, cards, stickers, signs) and distribute to the public; gather information (i.e., monitor number of reports being made

through whale help hotline) to evaluate effectiveness of outreach materials and for informing reports of stranded marine mammals.

c) Timing, Frequency, and Duration: Project performance data for the three years preceding project implementation is collected and evaluated during year one to establish baseline performance; Project performance data collected continuously years one through five; Report annually.
d) Sample size: N/A.
e) Sites: N/A.

3 Adaptive Management

As discussed in the Final PDARP/PEIS, adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). It is an iterative process that aligns decision-making to the natural scale so that it is more dynamic and responsive. Adaptive management generally involves setting management goals, monitoring outcomes, determining impacts, and refining goals to incorporate lessons learned (Craig, 2010; Ruhl, 2011).

In this project, adaptive management is incorporated in the periodic re-evaluation of response capacity gaps and response needs. Data, analysis, and information obtained from this project would be used to help inform future restoration plan development, priorities, and project selection.

4 Evaluation

Evaluation of monitoring data is needed to assess the performance of the project in meeting its restoration objectives, resolve key uncertainties, and determine whether corrective actions are needed. During year one, the Stranding Coordinator would summarize existing stranding network data (from the three years preceding project implementation) in order to establish baseline levels of performance for project metrics (e.g., number of trained personnel in each parish, average response time to live and dead stranded animals, number of samples collected). The baseline information would be used to establish performance criteria for year two and to measure project performance through year five.

On an annual basis, the Stranding Coordinator would evaluate and summarize all of the monitoring parameters identified in this plan for consideration by Trustee agency staff during an annual workshop to be held in Baton Rouge, Louisiana. The workshop would be held in February of each year, providing sufficient time to summarize and evaluate the previous year's data, but early enough in the current year to implement corrective actions if necessary. Recommendations from workshop participants would be presented to the Louisiana Trustee Implementation Group (TIG) in March, and a consensus would be made on any decisions, including corrective actions or termination of project elements, as appropriate.

As part of the larger decision-making context beyond the project scale, the evaluation of monitoring data from the project would be compiled and assessed at the restoration type and the TIG level, and the results would be used to update the knowledge base to inform decisions such as future TIG project

prioritization and selection, implementation techniques, and the identification of critical uncertainties. The results of the project evaluation analysis will be used to answer the following questions:

- Were project restoration objectives achieved? If not, is there a reason why they were not met?
- Was the project implemented as designed?
- Did the restoration project produce unanticipated effects?
- Were any of the uncertainties identified prior to project implementation resolved?
- Were any new uncertainties identified?
- Have data been summarized and characterized in a way that allows for a clear understanding of results?
- What broader insights might be gained from implementation/monitoring of this project?

These questions would be answered and compiled in annual monitoring reports for the project by the Stranding Coordinator. This Monitoring and Adaptive Management (MAM) plan would be revised if needed and project funds may be reallocated to support necessary corrective actions.

5 Project-Level Decisions: Performance Criteria and Potential Correction Actions

Specific, measurable performance criteria are defined for monitoring parameters associated with each of the restoration objectives. Measurement against performance criteria will determine restoration success or need for corrective action (15 CFR 990.55(b)(1)(vii)). Performance criteria and potential corrective actions have been developed for each monitoring parameter for the proposed project (Table 2). Additional corrective actions may be identified during project implementation, as well as during post-implementation, as appropriate. Trustee agency staff would determine the need for, and methods to implement corrective actions during their annual workshop held in February of each year during project implementation. The Louisiana TIG would provide consensus on these decisions. If additional corrective actions are identified, this section of the MAM plan would be updated to reflect changes throughout project implementation.

Table 2. Performance Criteria and Potential Corrective Actions by Monitoring Parameter.

Objective	Monitoring Parameter	Final Performance Criteria	Potential Corrective Action
Enhance capacity for stranding response	Stranding Coordinator for Louisiana's MMSN	Louisiana Stranding Coordinator hired and retained	Advertise the Stranding Coordinator position more broadly if the position is not filled within the first year; re-advertise if the position becomes vacant
	Spatial coverage of MMSN partnerships	Spatial coverage of partnerships is improved so that response times are minimized to 48 hours for a dead stranded animal and eight	Reallocate project funds to maintain and expand network of partners in order to reduce response

		hours for a live stranded animal in year three; and 24 hours for a dead stranded animal and four hours for a live stranded animal in year five	times
	Trained and authorized MMSN stranding network personnel	Increasing trend in the number of trained response personnel in each parish is observed during years three through five	Reallocate project funds to (1) recruit additional stranding network personnel; (2) increase training opportunities; and/or (3) increase trainings in geographic areas where stranding network personnel coverage is insufficient
Improve capabilities to collect, store, and analyze samples from stranded cetaceans	Spatial coverage of equipment and resources	Equipment and supplies are purchased and spatially distributed so that response times are minimized to 48 hours for a dead stranded animal and eight hours for a live stranded animal in year three; and 24 hours for a dead stranded animal and four hours for a live stranded animal in year five	Reallocate project funds to procure additional personnel and/or material resources; redistribute resources as needed to achieve the optimal geographic coverage
	Resources and expertise for sample analysis and data evaluation	100 percent return on necropsy and histopathology samples annually during years three through five	Reallocate project funds to identify and procure any resources potentially limiting the analysis of necropsy and histopathology samples and evaluation of data
Enhance rehabilitation capabilities and care facilities for live, stranded marine mammals to	The quality and effectiveness of rehabilitation capabilities	Maintain capacity to rehabilitate live, stranded marine mammals	If after year three, the need to improve rehabilitation capabilities is identified, reallocate project funds to procure additional personnel and/or material resources for the rehabilitation facility

increase the likelihood of survival			
Improve reporting of stranded marine mammals	Effectiveness of outreach program	Updated outreach materials are distributed to list of repositories annually; increasing trend in the number of stranding reports made using information from the outreach materials (e.g., whale help hotline) during years three through five	Reallocate project funds to (1) consider alternative formats for outreach materials; (2) revise outreach material content; and/or (3) identify geographic areas where additional outreach is needed

6 Monitoring Schedule

The schedule for project monitoring is shown in Table 3, separated by monitoring activity. The duration of the project is five years; performance monitoring will occur during years two through five.

This plan assumes that project-specific monitoring would begin in summer 2020. The plan is limited to the five-year period for which funding is being requested and does not describe MMSN monitoring that may occur or be funded after that time.

Table 3. Monitoring Schedule.

Core Parameter	Year 1 (to establish baseline data)	Years 2-5 (evaluation of project performance)
Stranding Coordinator for Louisiana's MMSN		X
Spatial coverage of MMSN partnerships	X	X
Trained and authorized MMSN stranding network personnel	X	X
Spatial coverage of equipment and resources	X	X
Enhance resources and expertise for sample analysis and data evaluation	X	X
The quality and effectiveness of rehabilitation capabilities	X	X
Effectiveness of outreach program	X	X

7 Data Management

7.1 Data Description

The type of data to be collected, as well as how those data would be collected, processed, reviewed, stored, and shared, would follow the data standards outlined in the MAM Procedures and Guidelines Manual Version 1.0 (MAM Manual; DWH Trustees, 2018) and this MAM plan. Specific data to be collected would be determined during project and study planning, and this MAM plan would be updated accordingly.

All MAM data would be collected either by hand on monitoring or survey forms, or by tablet on electronic forms. If data are recorded on hardcopy field datasheets, these entries would be scanned to a Portable Document Format (PDF) file and archived, along with the hardcopy. All photographs, datasheets, notebooks, and revised data files would be retained. All data would have properly documented metadata, a data dictionary (defines codes and fields used in the dataset), and/or a Readme file as appropriate (e.g., how data were collected, QA/QC procedures, other information about data such as meaning, relationships to other data, origin, usage, and format). Geospatial data would adhere to FGDC/ISO standards. All electronic files would be stored in a secure location, such as on Data Integration Visualization Exploration and Reporting (DIVER), in such a way that the Louisiana TIG would have guaranteed access to all versions of the data. The final versions will be available through DIVER as files or links to CRMS or another database.

Electronic data files would be named with the date on which the file was created and would include a ReadMe file that describes when the file was created and by whom, and any explanatory notes on the file contents. If a data file is revised, a new copy would be made and the original preserved.

7.2 Data Review and Clearance

All MAM data collected would undergo proper QA/QC protocols following the process outlined in Section 3.1.2 of the MAM Manual, summarized below (DWH Trustees, 2018).

1. Data verification:
    i. For data that have been transcribed, verify that the data are correctly entered from the original hardcopy datasheets and/or notebooks. Any corrections to transcription errors would be made as appropriate before data are used for any analyses or distributed outside of the implementing Trustee's agency.
    ii. The implementing Trustee's agency would review MAM data and would ensure that all data is entered or converted into an agreed upon/commonly used digital format that may be imported into the DIVER Restoration Portal, consistent with the data standards described in Section 3.2 of the MAM Manual (DWH Trustees, 2018). Data would be labeled with metadata following FGDC/ISO standards to the extent practicable and in accordance with implementing Trustee agency requirements.
    iii. Perform an initial validation check for suspected errors other than data entry/transcription errors (e.g., units, expected value range).

iv. Address any suspected errors, and document the changes made to correct actual errors and suspected errors that were found to be valid data. Any corrections to errors would be made as appropriate before the data are used for analyses or distributed outside of the implementing Trustee's agency.
v. After identified errors have been addressed, the implementing Trustee would give the other TIG members time to review the data before making the data publicly available.
vi. Before submitting the monitoring data and information package, co-implementing Trustees shall confirm with one another that the package is approved for submission (as applicable).

2. Data procurement: Data should be made available to the Louisiana TIG at least yearly during years when monitoring is being conducted. Data submitted to DIVER or another data repository should be verified. Submissions may also include scanned datasheets, raw data, and/or analyzed data. As the implementing Trustee, NOAA is responsible for ensuring that the data submitted are consistent with the data standards described in the MAM Manual, and that the data transfer is documented (e.g., chain of custody form, README file).
3. Data validation and final QA/QC: In accordance with the MAM Plan and/or QA/QC procedures outlined in the project's scope of work (SOW), NOAA is responsible for reviewing submitted verified data and verified processed data, and checking for suspected non-data entry errors (e.g., units, expected value range, date/time, latitude/longitude). After any and all suspected errors are addressed, the data are considered to have gone through the QA/QC process.
4. Information package creation: NOAA is responsible for creating an information package for public release, to be approved by the Louisiana TIG prior to release. The package should include the following documents, if applicable:
    i. Monitoring data.
    ii. Metadata – Geospatial metadata following ISO standards; Data dictionary; README file (e.g., how data were collected; QA/QC procedures; other information about data such as meaning, relationships to other data, origin, usage, and format – can reference other documents).

Additional details on data review and clearance processes would be outlined in the project's SOW.

7.3 Data Storage and Accessibility

MAM data would be stored in the DIVER Restoration Portal. Data would be submitted as soon as possible, but no more than one year from when the data were collected. Data storage and accessibility would be consistent with the guidelines in Section 3.1.3 of the MAM Manual (DWH Trustees, 2018).

7.4 Data Sharing

The Louisiana TIG would ensure that data sharing follows standards and protocols set forth in the Open Data Policy (DWH TC, 2016; Section 10.6.6). No data release can occur if it is contrary to federal or state laws (DWH TC, 2016; Section 10.6.4). The DWH NRDA Trustees would provide notification to the Cross-TIG MAM work group when new data and information packages have been uploaded to DIVER (DWH

Trustees, 2018). In the event of a public records request related to project data and information that are not already publicly available, the Trustee to whom the request is addressed would provide notice to the other Louisiana TIG members prior to releasing any project data that are the subject of the request.

As noted in Section 7.3, the project's data would be stored in the DIVER Restoration Portal. These data would be shared with the public by publishing the data to the Trustee Council website (DWH TC, 2016; Section 10.6.6). For further instructions on this process, see the DIVER Restoration Portal User Manual (NOAA DWH Data Management Team, n.d.).

Some of the data collected may be protected from public disclosure under federal and state law (e.g., personally identifiable information under the Privacy Act) and therefore would not be publicly distributed.

8 Reporting

Annual reports would be provided by the Stranding Coordinator and would include all parameter metrics. This information would be used by Trustee agency staff during the annual workshop to evaluate project performance, determine the need for corrective actions, and ultimately inform future restoration efforts.

Reporting should follow the guidelines set forth in Section 2.6.3 and Attachment D of the MAM Manual (DWH Trustees, 2018). Information to be reported includes the following:

1. An introduction that provides an overview of the project, location, and restoration activities, as well as restoration objectives and performance criteria applicable to the project.
    a) This information can be taken from this MAM plan and repeated in all reports.
2. A detailed description of the methods used for implementation of the MAM plan.
    a) This information can be taken from this MAM plan and repeated in all reports.
3. Results from the reporting period or, in the case of the final report, a comprehensive summary of results from the entire MAM plan implementation period.
    a) Results should be presented clearly and show progress that has been made toward performance criteria and/or restoration objectives. Information that can be used to present results includes tables or graphs, site visit summaries, and other datasets that support analysis of the project's progress toward meeting performance standard.
4. A discussion of the results (optional for interim reports, required for final report).
5. Conclusions that summarize the findings, progress toward meeting performance criteria and restoration objectives, and recommendations for corrective actions (optional for interim reports, required for final report).
6. Project highlights showcasing lessons learned to inform future project planning and implementation.
7. Transmission of data and metadata used in the report, as well as a description of all data collected during the reporting period, even if they were not used in the report.
8. A complete list of references.

Five reports would be submitted by the Stranding Coordinator, excluding any additional reports deemed necessary as a result of corrective actions that require an extension of the monitoring period. The first report would be submitted after the first year of monitoring and provide a summary of the program's baseline performance (based on data compiled for three years preceding program implementation). Additional reports would be submitted each year summarizing annual performance and evaluation with respect to baseline for each year of the five-year monitoring period.

The DWH Trustees, as stewards of public resources under OPA, should inform the public on the restoration project's progress and performance. Therefore, the Louisiana TIG would report the status of the proposed project via the DIVER Restoration Portal, as outlined in Chapter 7 of the Final PDARP/PEIS (DWH Trustees, 2016).

9 Roles and Responsibilities

The Louisiana TIG is responsible for "addressing MAM objectives that pertain to their restoration activities and for communicating information to the Trustee Council or Cross-TIG MAM work group" (DWH Trustees, 2016). This includes reviewing and approving MAM plans, identifying MAM priorities for the Louisiana restoration area, ensuring that MAM implementation is compatible with the MAM Manual guidelines and that data are submitted to the DIVER Restoration Portal, aggregating and evaluating MAM data, ensuring quality control of MAM data, and communicating regarding implementation status and results of MAMs with the Trustee Council and Cross-TIG MAM work group.

As the implementing Trustee, NOAA is responsible for developing the MAM plan, conducting all monitoring activities, evaluating project progress toward restoration objectives using the identified performance criteria, identifying and proposing corrective actions to the Louisiana TIG, and submitting MAM data and project information into the DIVER Restoration Portal in accordance with the data management procedures outlined within this MAM plan (DWH TC, 2016).

NOAA is responsible for all maintenance activities and costs related to this project, including any repairs needed over the life of the project.

10 Monitoring and Adaptive Management Budget

The estimated cost of project monitoring and reporting for this project is included within the Stranding Coordinator's salary of $130,000 annually, totaling $650,000 over five years. Additional project costs (approximately $3.1 million over five years) cover enhancements to stranding response vehicles and equipment, travel to stranding locations, sample collection and analysis, trainings for personnel, and the development and distribution of public outreach materials.

11 References

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12 MAM Plan Revision History

Old Version #	Revision Date	Changes Made	Reason for Change	New Version #

Monitoring and Adaptive Management Plan for *Deepwater Horizon* NRDA Project:

Enhancing Oyster Recovery Using Brood Reefs

Prepared by: Louisiana Natural Resource Trustees

Draft Version Date: 3/6/2020

Table of Contents

1 Introduction

The Louisiana Natural Resource Trustees (Trustees) developed this monitoring plan (plan) for the Enhancing Oyster Recovery Using Brood Reefs Project (project). This project is included as a preferred alternative for the oyster restoration type in the *Louisiana Draft Restoration Plan/Environmental Assessment (RP/EA) #5, Living Coastal and Marine Resources (LCMR): Marine Mammals and Oysters*. The goal of this project is to construct a network of spawning stock oyster reefs to increase spawning oyster populations and offset impacts resulting from exposure to Deepwater Horizon (DWH) oil, dispersant, and response activities.

The purpose of this plan is to describe monitoring activities that would be conducted to evaluate and document restoration effectiveness, including performance criteria for determining the success of restoration or need for interim corrective action (15 CFR 990.55(b)(1)(vii)). This plan would be implemented by the Louisiana Department of Wildlife and Fisheries (LDWF) and may be modified over time based on the management needs for the project.

1.1 Project Overview

This project would develop a network of brood reefs that would serve as a spawning stock to improve and maintain oyster production on Louisiana's Public Oyster Seed Grounds (POSG) and Public Oyster Seed Reservations (POSR). Reef material, when placed in oyster spawning areas, provides a substrate on which free floating oyster larvae can attach and grow. Brood reefs are composed of both cultch material (e.g., limestone rock, oyster shell, or fossilized oyster shell) that is clean and free of contaminants, and non-harvestable vertical artificial reef material (e.g., boulders), which provide substrate to support dense populations of oysters. Areas suitable for brood reef restoration typically have good spat production and appropriate bottom composition (i.e., hard substrate) to allow for reef expansion but are limited in vertical relief.

The specific project objectives are to create brood reef areas and inform site selection for future programmatic brood reef restoration projects. This project would entail constructing multiple brood reefs east of the Mississippi River, including four in the Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux area. In addition, the Louisiana Trustee Implementation Group (TIG) anticipates that up to 20 additional brood reefs may be constructed in Chandeleur Sound and at other sites on Public Oyster Seed Grounds (POSG) and Public Oyster Seed Reservations (POSR) within Louisiana in the future. Brood reefs would be closed to harvest for as long as they remain functioning spawning stock reserves.

One planned component of the brood reef project would establish four reefs: two in the Lake Machais/Mozambique Point area and two in the Petit Pass/Bay Boudreaux area. Reef locations for this alternative were selected based on trends in salinity, observed population response from previous mortality events, proximity to living shoreline projects, and available larval transport models (e.g., ADCIRC; Murray et al., 2015). In addition, these areas have been historically productive for oysters. Relic

reefs at and surrounding each site, indicate that conditions at these locations have been suitable for oyster reefs previously. These areas provide optimum hydrologic conditions, except for extreme events, but recruitment has been low. Enhancing the existing oyster resources with structurally complex brood reefs would provide resiliency and benefit the local systems by providing a source of larvae for surrounding areas.

In addition to the planned component described above, this alternative would include a programmatic component. Potential sites for additional brood reefs would be located in Chandeleur Sound and on any other state managed POSG or POSR in Louisiana.

The programmatic brood reef component of the project would construct up to 20 reefs in Chandeleur Sound. The 2009 closure of the Mississippi River Gulf Outlet (MRGO) shipping channel has improved surface water salinities in Biloxi Marsh and Chandeleur Sound, which is beneficial for oyster propagation. In the last decade, large investments of cultch have been made in this region, and landings from many private leases have been high; however, stocks on the POSG remain at record lows, possibly due to seasonal hypoxia at relic reefs. As part of the broader programmatic approach, surveys and ground-truthing would be conducted in Chandeleur Sound and at other potential sites on POSG and POSR to identify sediment types, monitor dissolved oxygen levels, and assess availability of larvae in order to confirm suitability for brood reef construction at specific sites.

Each of the four planned reefs in the Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux areas would be up to 10 acres in size, closed to oyster harvest, and constructed out of large, un-harvestable materials. Riprap cultch material, which is clean and free of contaminants, would be deposited by barge and excavator at a height of approximately 1.2 meters above the bottom to promote survival through bottom hypoxia. The size of the cultch material would reduce illegal harvest attempts, and LDWF would enforce the non-harvest designation. Brood reefs would generally be constructed upstream in the estuary to allow for transport of oyster larvae downstream to existing oyster reefs. Reef locations for this project were selected based on trends in salinity, observed population response from previous mortality events, proximity to living shoreline projects, and available larval transport models (e.g., ADCIRC; Murray et al., 2015).

The programmatic brood reefs proposed in Chandeleur Sound would be approximately one-half acre in size and would be composed of cultch on the bottom and vertical reef material on the perimeter. The brood reefs would be constructed within the POSG on relic reef or existing shell substrate, where environmental conditions are suitable, and would be closed to harvest for as long as they remain functioning spawning stock reserves. The vertical reefs would be 0.5 to 1.2 meters in height to promote oyster survival by reducing bottom hypoxia. In addition, the proposed size of the cultch material would reduce illegal harvest attempts, and LDWF would enforce the non-harvest designation. Reefs would be aligned in multiple directions to account for seasonal and annual variation in salinity. Brood reef designs would vary by site location based on local conditions (e.g., proximity to marsh edge). Brood reefs would be spaced sufficiently to allow for movement of aquatic species. Reefs would also be constructed near commercial private oyster leases to promote connectivity with existing oyster reefs.

In addition to the brood reef components described above, this alternative would include a programmatic component. Potential sites for additional brood reef locations include existing reef sites that are closed to harvest and on any state managed POSG or POSR in Louisiana. Specific locations would be identified using several information sources to identify sites with optimal conditions. The Lake Pontchartrain Basin Foundation (LPBF) Hydrocoast maps of isohaline lines (Connor et al., 2019), the Coastwide Reference Monitoring System (CRMS) and U.S. Geological Survey (USGS) hydrologic sampling station data, and LDWF discrete hydrological measurements collected during fisheries independent sampling would all be used to map the isohaline lines and identify optimal site locations within the potential programmatic areas. Available larval models (e.g., ADCIRC; Murray et al., 2015) will be referenced during additional site selections, where coverage allows, as further evidence to the suitability of proposed sites. Additional data acquisition (i.e., bottom surveys) may be conducted using alternative funds to identify potential locations for additional brood reef areas. In all cases, site selection would be coordinated with the Louisiana TIG, and compliance with the programmatic action of the RP/EA #5 would be affirmed ahead of final site selection and implementation. The size of the cultch material at programmatic sites would reduce illegal harvest attempts, and LDWF would enforce non-harvest designations.

1.2 Restoration Type Goals and Project Restoration Objectives

This project is being implemented as restoration for the DWH Natural Resource Damage Assessment (NRDA), consistent with the Final PDARP/PEIS (DWH Trustees, 2016). The programmatic goals for the oyster restoration type are to:

- Restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs.
- Restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time.
- Restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities.

The restoration techniques for this project are to restore or create oyster reefs through placement of cultch in nearshore and subtidal areas; enhance oyster reef productivity through spawning stock enhancement projects; and develop a network of oyster reef spawning reserves. The specific restoration objectives are to create brood reefs and inform site selection for future programmatic brood reef restoration projects.

Potential long-term benefits of this project include increasing oyster production and improving ecosystem services that result from high oyster abundance, including potential reduction in shoreline erosion, improved water quality, and recycling of nutrients. Brood reef projects may also improve oyster population connectivity, resilience, and stability.

1.3 Conceptual Setting

The conceptual model, described below, forms the basis of this monitoring plan and includes a summary of the project activities, the expected product or output of those activities, and the desired project outcomes. Stressors negatively impact habitat condition and habitat relationships, resulting in loss of habitat, function or capacity. For this project, the specific stressors addressed include habitat loss, as well as changes in local conditions (e.g., seasonal hypoxia) that have historically supported oysters. Predation and changes in water quality also impact oyster resources.

Table 1 provides a conceptual model of the relationship between restoration actions and the goals of the project.

Table 1. Conceptual Model for the Enhancing Oyster Recovery Using Brood Reefs.

Restoration Actions	As-Built	Interim	Restoration Goal
Place brood reef material on POSG and POSR water bottom	Up to 40 acres of brood reef material placed onto POSG and POSR in Lake Machais/Mozambique Point and Petit Pass/Bay Boudreaux	Oysters settle and grow to maturity	Produce spawning-size oysters on POSG and POSR to help compensate for oyster injuries in Louisiana; develop a network of brood reefs that would serve as spawning stock to improve and maintain oyster production

1.3.1 Sources of Uncertainty

Uncertainties or information gaps have the potential to affect adaptive management decisions for restoration projects. These decisions may include how to improve the likelihood of achieving favorable project outcomes or selecting corrective actions in the event a project is not performing as intended. Sources of uncertainty, the degree of uncertainty, and the level of uncertainty associated with projects varies.

The primary source of uncertainty for this project is related to the impact from potential storms and the ability to achieve connectivity of regional oyster reefs. The materials proposed to be utilized have proven effective in other areas, reducing the likelihood of project failure. Other uncertainties include:

- Maintenance of suitable hydrologic conditions for the sustainability of restored areas
- Natural variability in ecological and physical processes and conditions (e.g., temperature, salinity)
- Rates of sediment accretion
- Coastal acidification trends
- Effects from local resource management, such as water or sediment diversions

- Spatial effects from anoxia events
- Illegal harvest

This list should not be considered exhaustive; additional uncertainties may be identified as the project is implemented and/or monitored.

2 Project Monitoring

The proposed monitoring for this project is outlined below and is organized by project objective. For each of the identified parameters, the plan includes information on the monitoring methods, timing, frequency, sample size, and sites. LDWF would perform monitoring activities using standard state oyster monitoring methods (LDWF, 2018), with modifications to address project objectives.

Objective #1: Create brood reef areas.

Parameter #1: Spatial extent of constructed brood reef areas.

a) Purpose: To ensure that the desired brood reef dimensions are achieved and maintained.
b) Method:
    1. LDWF utilizes side-scan sonar units to allow rapid assessment of reef areas and creates profile maps of bottom hardness values to determine reef extent. Onsite side scan sonar would survey the brood reef area pre- and post-construction to ensure that the desired acreage of brood reef is achieved.
    2. During construction, LDWF representatives monitor the activities of the contractor and ensure that brood reef material deposition only occurs within the properly marked and permitted area. Brood reef height would be measured using side-scan equipment. Brood reef boundaries, location, and total area would be determined using GPS and sonar or depth finder with ground truthing.
c) Timing, Frequency, and Duration: Project footprint side-scan surveys will occur pre- and post-construction activities. Additionally, surveys may be conducted after major storm events.
d) Sample Size: The spatial extent (i.e., height and acreage) of the cultch plant will be surveyed.
e) Sites: All project brood reef sites would be monitored, including the sites currently planned and any additional sites within Louisiana's POSG and POSR identified in the future.

Objective #1: Create brood reef areas.

Parameter #2: Oyster resource development

a) Purpose: To ensure that the desired oyster demography is achieved by year two and maintained through the duration of the project (20 oysters per square meter that are 40 mm or larger).
b) Method: Oyster density (oysters/m^2), mortality (percent dead oysters), and size distribution (spat 0– 24 mm, seed 25–74 mm, and market-sized ≥ 75 mm) information would be

collected at each brood reef site via quadrat sampling to determine if oysters are settling, surviving, and growing to the desired density. The standard quadrat sampling methodology may be adapted to accommodate the vertical relief of brood reefs. All data would be collected on standard LDWF oyster sample data sheets (Attachment 1).

- For each quadrat sampling event, each brood reef would be divided into equally sized, consecutively numbered grid squares, and five grids would be randomly selected for sampling. Oyster density would be determined via 0.25-square-meter quadrat sampling following established LDWF sampling protocol on an annual basis (LDWF, 2018). Quadrat sampling would occur each summer following completion of construction to coincide with LDWF annual oyster stock assessment sampling. Within each randomly selected grid, field crews would deploy one 0.25-square-meter polyvinyl chloride (PVC) pipe quadrat off the sampling vessel onto the brood reef. From the quadrat, SCUBA divers would collect all oysters, surficial shell/cultch, and associated reef organisms for enumeration and analysis. The sample would consist of all materials collected from the quadrat. All live and recently dead oysters within each sample would be counted and returned to the water. Crew members would also record observations of brood reef material condition.

c) Timing, Frequency, and Duration: Project-specific monitoring as described in this plan would occur immediately following construction activities and would be repeated annually for four years post-construction. Quadrat sampling will occur each summer following completion of construction to coincide with LDWF annual oyster stock assessment sampling. Additionally, surveys may be conducted after any major storm event.

d) Sample Size: Project-specific sampling would be conducted in at least five grids, unless data analysis indicates sample size changes are warranted.

e) Sites: All project brood reef sites would be monitored, including the sites currently planned and any additional sites within Louisiana's POSG and POSR identified through the programmatic approach in the future.

Objective #2: Inform site selection for future programmatic brood reef restoration projects.

Parameter #1: Water quality.

a) Purpose: To ensure that water quality parameters (e.g., water temperature, salinity, dissolved oxygen) at brood reef sites are suitable for oyster survival, growth, and spawning.

b) Method: Water quality parameters would be monitored by LDWF in conjunction with the pre-construction, post-construction, and annual sampling described above. Measurements would be collected one foot above the brood reef surface in conjunction with each biological sample. This information would be recorded by field personnel on LDWF field sampling datasheets and field notebooks.

c) Timing, Frequency, and Duration: Discrete water quality readings would be collected monthly by LDWF.

d) Sample Size: Discrete data would be collected and recorded for each sites' surveys for oyster abundance and recruitment.

e) Sites: All project brood reef sites would be monitored, including the sites currently planned and any additional sites within Louisiana's POSG and POSR identified in the future. Discrete water quality readings would be collected by LDWF in each basin.

Table 2. Project Monitoring.

Monitoring Objective	Monitoring Parameter	Purpose	Method/ Core parameter
Create brood reef areas	Spatial extent of constructed brood reef areas	To ensure that the desired brood reef dimensions are achieved and maintained	Brood reef area (m^2)
	Oyster resource development	To ensure that the desired oyster demography is achieved by year two and maintained through year five	Density of seed-sized (40 mm or larger) oysters (#/m^2)
Inform site selection for future programmatic brood reef restoration projects	Water quality	To ensure that water quality parameters at brood reef sites are suitable for oyster survival, growth, and spawning	Water temperature, salinity, and dissolved oxygen

In addition to the performance indicators listed in Table 2, data collected on oyster recruitment would be evaluated to address learning goals. Two sets of settlement tiles would be deployed within each brood reef area and would be sampled every four weeks. Surveys would be repeated annually for four years post-construction. Data from the settlement tiles would inform productivity of regional spawning stock, the potential to achieve connectivity of regional oyster reefs, and optimize site locations for additional programmatic brood reefs in the future.

3 Adaptive Management

As discussed in the Final PDARP/PEIS, adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). It is an iterative process that aligns decision-making to the natural scale so that it is more dynamic and responsive. Adaptive management generally involves setting management goals, monitoring outcomes, determining impacts, and refining goals to incorporate lessons learned (Craig, 2010; Ruhl, 2011).

In this project, adaptive management is incorporated in the periodic re-evaluation of response capacity gaps and response needs. Data, analysis, and information obtained from this project would be used to help inform future restoration plan development, priorities, and project selection.

4 Evaluation

Evaluation of monitoring data is needed to assess the performance of the project in meeting its restoration objectives, resolve key uncertainties, and determine whether corrective actions are needed.

As part of the larger decision-making context beyond the project scale, the evaluation of monitoring data from the individual projects would be compiled and assessed at the restoration type and the TIG level. The results would be used to update the knowledge base to inform decisions such as future TIG project prioritization and selection, implementation techniques, and the identification of critical uncertainties. The results of the project evaluation analysis would be used to answer the following questions:

- Were project restoration objectives achieved? If not, is there a reason why they were not met?
- Was the project constructed as designed?
- Did oysters establish on the brood reefs successfully?
- Did the restoration project produce unanticipated effects?
- Were there unanticipated events unrelated to the restoration project that potentially affected the monitoring results (e.g., hurricanes)?
- Were any of the uncertainties identified prior to project implementation resolved?
- Were any new uncertainties identified?
- Have data been summarized and characterized in a way that allows for a clear understanding of results?
- What broader insights might be gained from implementation/monitoring of this project?

These questions would be compiled and evaluated by LDWF in annual monitoring reports for the project. This Monitoring and Adaptive Management (MAM) plan would be revised if needed.

5 Project-Level Decisions: Performance Criteria and Potential Correction Actions

Performance criteria are used to determine the success of restoration or the need for corrective actions (15 CFR 990.55(b)(1)(vii)). Performance criteria and potential corrective actions have been developed for each monitoring parameter for the proposed project (Table 3). Additional corrective actions may be identified during project implementation, as well as during post-implementation, as appropriate. If additional corrective actions are identified, this section of the plan would be updated to reflect changes throughout project implementation.

Table 3. Performance Criteria and Potential Corrective Actions by Monitoring Parameter.

Objective	Monitoring Parameter	Final Performance Criteria	Potential Corrective Action
Create brood reef areas	Spatial extent of constructed	Brood reef material is placed only within the properly marked and	Additional brood reef material may be added to

	brood reef areas	permitted area. Immediately following construction and throughout the duration of the project, the total area covered with brood reef material should be equal to the target area (up to 40 acres)	achieve target acreage and/or height. Other techniques may be identified by the Trustees
	Oyster resource development	An average density of 20 seed-sized oysters (40 mm or larger) per square meter is achieved in year two and maintained through year five. This will indicate successful recruitment and survival of oysters onto each brood reef site	Deploy hatchery raised larvae/spat onto the brood reef via direct release of larvae, spat on shell or aggregate deployment, or other technique identified by the Trustees
Inform site selection for future programmatic brood reef restoration projects	Water quality	Water quality parameters are within the range of conditions to support oyster survival, growth, and recruitment	If water quality parameters are found to be limiting oyster survival, growth, and spawning on brood reef sites, the TIG may consider redefining water quality requirements for additional brood reef locations in the future

6 Monitoring Schedule

The schedule for project monitoring is shown in Table 4, separated by monitoring activity. Pre-construction monitoring would occur before project implementation. As-built monitoring would occur within 90 days of when the project has been fully executed as planned. Performance monitoring would occur annually for four years following initial project execution. Additional monitoring may be required following severe weather events.

This plan assumes that project-specific monitoring would begin in summer 2020. The plan also assumes that project performance standards would be met by the end of 2024 and project-specific monitoring as described in this plan would cease by that time. The Trustees anticipate that after project-specific monitoring concludes, LDWF would continue to monitor oyster abundance using standard annual monitoring protocols throughout the time the sites are still producing oysters.

Table 4. Monitoring Schedule.

Core Parameter	Pre-Construction	As-Built (Year 0)	Post-Construction

			(Years 1-4)
Brood reef area (m^2)	X	X	X
Density of seed-sized (40 mm or larger) oysters (#/m^2)		X	X
Water temperature, salinity, and dissolved oxygen		X	X

Data on oyster recruitment would be collected to address learning goals. Two sets of settlement tiles would be deployed within each brood reef area and would be sampled every four weeks. Surveys would be repeated annually for four years post-construction.

7 Data Management

7.1 Data Description

Qualitative and quantitative data would be collected as part of this MAM plan. The type of data to be collected, as well as how those data would be collected, processed, reviewed, stored, and shared, will follow the data standards outlined in the MAM Procedures and Guidelines Manual Version 1.0 (MAM Manual; DWH Trustees, 2018) and this MAM plan.

All data would be collected by hand and recorded on standard LDWF oyster sample data sheets (Attachment 1). Hardcopy field datasheets would be scanned to a Portable Document Format (PDF) file and archived, along with the hardcopy at LDWF Headquarters. All photographs, datasheets, notebooks, and revised data files would be retained. Metadata would be developed for consistency for all data collected electronically. All electronic files would be shared on Data Integration Visualization Exploration and Reporting (DIVER), in such a way that the Louisiana TIG would have guaranteed access to all versions of the data.

7.2 Data Review and Clearance

Data would be recorded on LDWF field sheets and entered into the LDWF Data Management System, data transcription will be checked, and data will be verified. Data would be exported in excel file format for inclusion on the DIVER portal annually.

7.3 Data Storage and Accessibility

MAM data would be stored in the DIVER Restoration Portal. Data would be submitted as soon as possible, but no more than one year from when the data were collected. Data storage and accessibility would be consistent with the guidelines in Section 3.1.3 of the MAM Manual (DWH Trustees, 2018).

7.4 Data Sharing

The Louisiana TIG would ensure that data sharing follows standards and protocols set forth in the Open Data Policy (DWH TC, 2016; Section 10.6.6). No data release can occur if it is contrary to federal or state

laws (DWH TC 2016; Section 10.6.4). The DWH NRDA Trustees would provide notification to the Cross-TIG MAM work group when new data and information packages have been uploaded to DIVER (DWH Trustees, 2018). In the event of a public records request related to project data and information that are not already publicly available, the Trustee to whom the request is addressed would provide notice to the other Louisiana TIG Trustees prior to releasing any project data that are the subject of the request.

As noted in Section 7.3, the project's data would be stored in the DIVER Restoration Portal. These data would be shared with the public by publishing the data to the Trustee Council website (DWH TC, 2016; Section 10.6.6). For further instructions on this process, see the DIVER Restoration Portal User Manual (NOAA DWH Data Management Team, n.d.).

Some of the data collected may be protected from public disclosure under federal and state law (e.g., personally identifiable information under the Privacy Act) and therefore would not be publicly distributed.

8 Reporting

Reporting should follow the guidelines set forth in Section 2.6.3 and Attachment D of the MAM Manual (DWH Trustees, 2018). Information to be reported includes the following:

1. An introduction that provides an overview of the project, location, and restoration activities, as well as restoration objectives and performance criteria applicable to the project.
    a. This information can be taken from this MAM plan and repeated in all reports.
2. A detailed description of the methods used for implementation of the MAM plan.
    a. This information can be taken from this MAM plan and repeated in all reports.
3. Results from the reporting period or, in the case of the final report, a comprehensive summary of results from the entire MAM plan implementation period.
    a. Results should be presented clearly and show progress that has been made toward performance criteria and/or restoration objectives. Information that can be used to present results includes tables or graphs, site visit summaries, and other datasets that support analysis of the project's progress toward meeting performance standard.
4. A discussion of the results (optional for interim reports, required for final report).
5. Conclusions that summarize the findings, progress toward meeting performance criteria and restoration objectives, and recommendations for corrective actions (optional for interim reports, required for final report).
6. Project highlights showcasing lessons learned to inform future project planning and implementation.
7. Transmission of data and metadata used in the report, as well as a description of all data collected during the reporting period, even if they were not used in the report.
8. A complete list of references.

Six reports would be submitted by LDWF, excluding any additional reports deemed necessary as a result of corrective actions that require an extension of the monitoring period. The first report would be

submitted after the completion of pre-construction monitoring, the second report would be submitted after the completion of construction monitoring, and one report would be submitted after completion of each annual post-construction monitoring for four years.

The DWH Trustees, as stewards of public resources under OPA, should inform the public on the restoration project's progress and performance. Therefore, the Louisiana TIG would report the status of the proposed project via the DIVER Restoration Portal, as outlined in Chapter 7 of the Final PDARP/PEIS (DWH Trustees, 2016).

9 Roles and Responsibilities

The Louisiana TIG is responsible for "addressing MAM objectives that pertain to their restoration activities and for communicating information to the Trustee Council or Cross-TIG MAM work group" (DWH Trustees, 2016). This includes reviewing and approving MAM plans, identifying MAM priorities for the Louisiana restoration area, ensuring that MAM implementation is compatible with the MAM Manual guidelines and that data are submitted to the DIVER Restoration Portal, aggregating and evaluating MAM data, ensuring quality control of MAM data, and communicating regarding implementation status and results of MAM with the Trustee Council and Cross-TIG MAM work group.

As the implementing Trustee, LDWF is responsible for developing the MAM plan and annual reports, conducting all monitoring activities, evaluating project progress toward restoration objectives using the identified performance criteria, identifying and proposing corrective actions to the Louisiana TIG, and submitting MAM data and project information into the DIVER Restoration Portal in accordance with the data management procedures outlined within this MAM plan (DWH TC, 2016).

The project proponent, LDWF, is responsible for all maintenance activities and costs related to the Enhancing Oyster Recovery Using Brood Reefs, including any repairs needed over the life of the project.

10 Monitoring and Adaptive Management Budget

The estimated cost of project monitoring and reporting for each planned brood reef project is $6,500 for four years of monitoring and $30,000 for two sets of settlement plates per basin, totaling $86,000 for all four planned brood reef projects. The cost of the sidescan sonar surveys would be funded separately by LDWF's annual monitoring budget. Contingency for any storm-related monitoring and repairs would be covered by the alternative's programmatic budget, as would monitoring and adaptive management for any potential programmatic sites.

11 References

Deepwater Horizon Natural Resource Damage Assessment Trustees (DWH Trustees). 2016. *Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Final PDARP/PEIS). Available: http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

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Deepwater Horizon Trustee Council (DWH TC). 2016. Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the Deepwater Horizon (DWH) Oil Spill. November 15, 2016. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/DWH-SOPs.pdf

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Louisiana Department of Wildlife and Fisheries (LDWF). 2018. LDWF Marine Fisheries Independent Sampling Activities Field Manual. Internal document.

Murray, J., H. Roman, and J.J. Westerink. 2015. Technical Memorandum. Development of Oyster Larval Transport Analysis (ADCIRC). DWH Oyster NRDA Technical Working Group Report. Available at: https://www.fws.gov/doiddata/dwh-ar-documents/857/DWH-AR0270401.pdf. Accessed February 18, 2019.

National Oceanic and Atmospheric Administration Deepwater Horizon (NOAA DWH) Data Management Team. n.d. DIVER Restoration Portal User Manual, version 2.2.2.

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Pastorok, R.A., MacDonald, A., Sampson, J.R., Wilber, P., Yozzo, D.J., & Titre, J.P. 1997. An ecological decision framework for environmental restoration projects. Ecological Engineering, 9, 89-107.

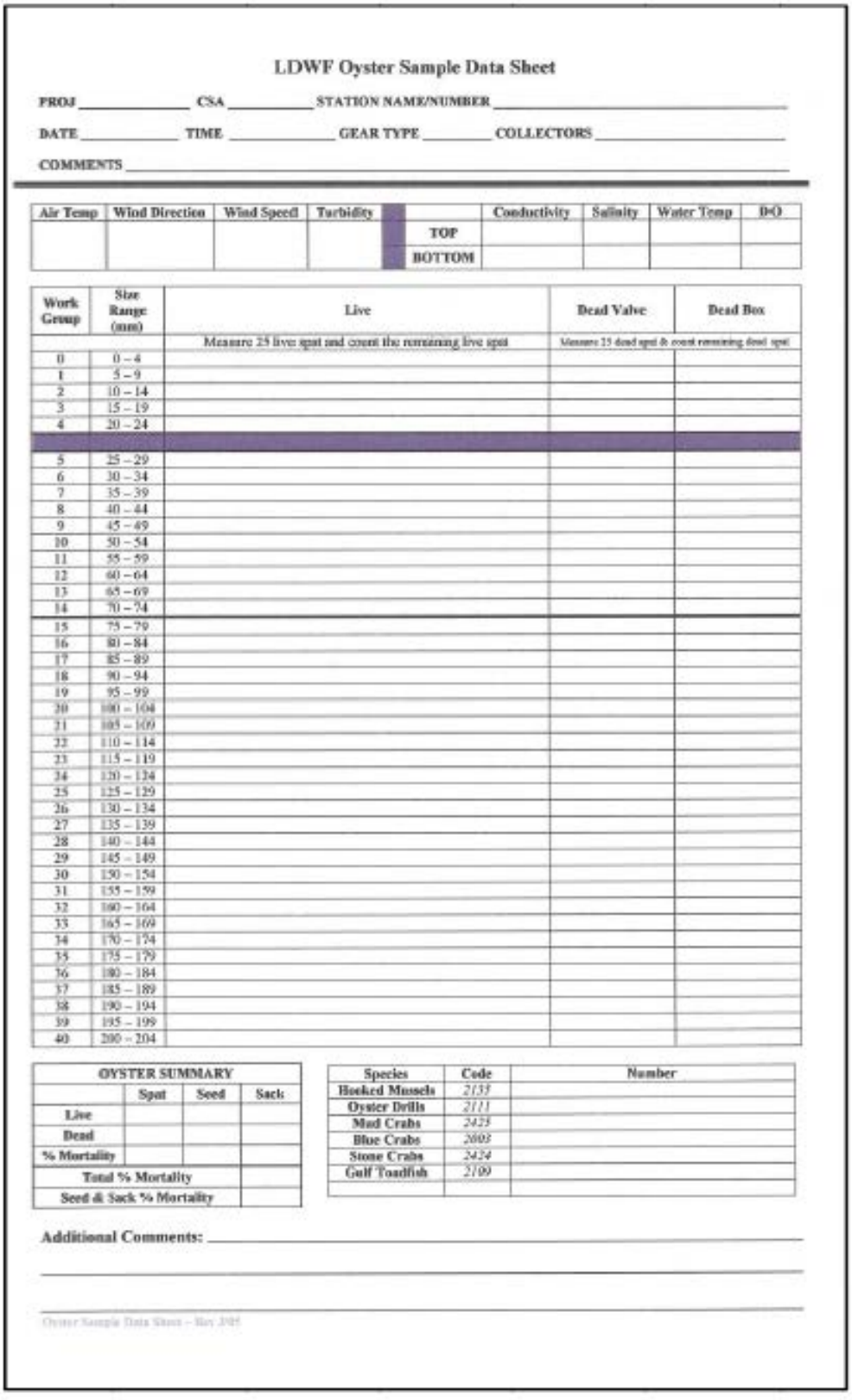
Steyer, G.D., and D.W. Llewellyn. 2000. Coastal Wetlands Planning, Protection and Restoration Act: A programmatic application of adaptive management. Ecological Engineering, 26, 27-39.

Williams, B.K. 2011. Adaptive management of natural resources - Framework and issues. Journal of Environmental Management, 92, 1346-1353.

12 MAM Plan Revision History

Old Version #	Revision Date	Changes Made	Reason for Change	New Version #

Attachment 1. Example LDWF Oyster Sample Data Sheet



LDWF Oyster Sample Data Sheet

PROJ _____ CSA _____ STATION NAME/NUMBER _____

DATE _____ TIME _____ GEAR TYPE _____ COLLECTORS _____

COMMENTS _____

Air Temp	Wind Direction	Wind Speed	Turbidity		Conductivity	Salinity	Water Temp	DO
				TOP				
				BOTTOM				

Work Group	Size Range (mm)	Live	Dead Valve	Dead Box
		Measure 25 live spat and count the remaining live spat	Measure 25 dead spat & count remaining dead spat	
0	0 – 4			
1	5 – 9			
2	10 – 14			
3	15 – 19			
4	20 – 24			
5	25 – 29			
6	30 – 34			
7	35 – 39			
8	40 – 44			
9	45 – 49			
10	50 – 54			
11	55 – 59			
12	60 – 64			
13	65 – 69			
14	70 – 74			
15	75 – 79			
16	80 – 84			
17	85 – 89			
18	90 – 94			
19	95 – 99			
20	100 – 104			
21	105 – 109			
22	110 – 114			
23	115 – 119			
24	120 – 124			
25	125 – 129			
26	130 – 134			
27	135 – 139			
28	140 – 144			
29	145 – 149			
30	150 – 154			
31	155 – 159			
32	160 – 164			
33	165 – 169			
34	170 – 174			
35	175 – 179			
36	180 – 184			
37	185 – 189			
38	190 – 194			
39	195 – 199			
40	200 – 204			

OYSTER SUMMARY			
	Spat	Seed	Sack
Live			
Dead			
% Mortality			
Total % Mortality			
Seed & Sack % Mortality			

Species	Code	Number
Hooked Mussels	2135	
Oyster Drills	2111	
Mud Crabs	2425	
Blue Crabs	2003	
Stone Crabs	2424	
Gulf Toadfish	2109	

Additional Comments: _____

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_____

Oyster Sample Data Sheet – May 2005

Monitoring and Adaptive Management Plan for *Deepwater Horizon* NRDA Project:

Cultch Plant Oyster Restoration

Prepared by: Louisiana Natural Resource Trustees

Draft Version Date: 3/6/2020

Table of Contents

1 Introduction

The Louisiana Natural Resource Trustees (Trustees) developed this monitoring plan (plan) for the Cultch Plant Oyster Restoration Project (project). This project is included as a preferred alternative for the oyster restoration type in the *Louisiana Draft Restoration Plan/Environmental Assessment (RP/EA) #5, Living Coastal and Marine Resources (LCMR): Marine Mammals and Oysters*. The goal of this project is to create oyster reefs through placement of cultch and to increase oyster abundance and spawning stocks in order to offset impacts resulting from exposure to Deepwater Horizon (DWH) oil, dispersant, and response activities.

The purpose of this plan is to describe monitoring activities that will be conducted to evaluate and document restoration effectiveness, including performance criteria for determining the success of restoration or need for interim corrective action (15 CFR 990.55(b)(1)(vii)). This plan will be implemented by the Louisiana Department of Wildlife and Fisheries (LDWF) and may be modified over time based on the management needs for the project.

1.1 Project Overview

This project would create productive oyster reefs across the Louisiana coastline at relic reef locations containing shell substrate, including one on Public Oyster Seed Grounds (POSG) in the Grand Banks area of Mississippi Sound, one on the Caillou (locally Sister) Lake Public Oyster Seed Reservation (POSR) in Terrebonne Parish, and would programmatically include additional cultch plant projects within the Biloxi Marsh Complex and the footprints of other POSG or POSR in the future (Figure 1). Where opportunities exist, cultch material will be placed as close to the shoreline as possible to promote restoration of shallow water fringing oyster reefs.

The specific project objectives are to increase reef area through cultch placement and inform site selection for future programmatic cultch plant restoration projects. This project would entail constructing cultch plants by placing cultch material (e.g., limestone rock, oyster shell, or fossilized oyster shell) that is clean and free of contaminants. When placed in suitable oyster habitat, cultch provides a substrate for free floating oyster larvae to attach and grow, which in time results in a mature productive oyster reef. All sites currently proposed for cultch plant construction exhibit suitable hydrology for oyster production and experience regular spatfall; however, current oyster recruitment appears to be primarily limited by the availability of suitable substrate at sufficient height or density. Therefore, cultch planting has been identified as the highest priority oyster restoration activity for these areas.

The approach and methods proposed for the cultch plant projects are well established and closely align with recently implemented, successful projects such as the Louisiana Oyster Cultch Phase I project. Many other cultch plants in Louisiana have demonstrated success. Since 1917, LDWF has placed over 1.5 million cubic yards of cultch material on nearly 30,000 acres with positive results, with 20 seed oysters per square meter typically observed as early as 17 months after cultch placement. The 2012 Caillou Lake

cultch plant continues to be one of the most productive in Louisiana, containing 48 percent of the available oyster resources west of the Mississippi. Estimated oyster stock on the Caillou Lake POSR increased 347 percent between 2016 and 2017 when the area was closed for harvest (LDWF, 2017). The Grand Banks and Biloxi Marsh areas are located in Coastal Study Area (CSA) 1 North, which is east of the Mississippi River and north of the Mississippi River Gulf Outlet; oyster stock decreased in this area by 76.5 percent between 2016 and 2017. However, cultch plants in this area, including the 2013 Drum Bay plant and Three Mile Pass plant, contribute the majority of production within CSA 1 North. In 2017, the highest density estimates of seed stock and market-size oysters were found at the Drum Bay cultch plant (9.6 per square meter) and Three Mile Pass cultch plant (2.2 per square meter), respectively (LDWF, 2017). Rates of oyster production vary over time and location.

The planned component of the cultch plant project would construct two cultch plants, one on the POSG in the Grand Banks area of Mississippi Sound, and another on the POSR in Caillou Lake. Mississippi Sound and Biloxi Marsh are home to the most productive and extensive public oyster areas in the state that are open to harvest. Caillou Lake is also one of the most productive oyster seed grounds in Louisiana. Oyster reproduction in these areas was most severely affected by the DWH spill (DWH Trustees, 2017). Natural growth of existing habitat occurs at a very slow rate in these systems (i.e., centimeters per year), and the recovery of oyster habitat due to losses from the DWH spill is not expected to occur without restoration actions. Therefore, the Louisiana Department of Wildlife and Fisheries (LDWF) proposes to contract for the placement of cultch material onto POSG in the Grand Banks reef area of Mississippi Sound and the POSR in Caillou Lake. LDWF intends to place cultch material on approximately 200 acres at both sites, with cultch materials placed at a planting density up to 200 cubic yards per acre, resulting in a depth of two to ten centimeters of substrate. Clean limestone would be acquired (the source to be determined following contract bidding) and used as cultch material. Because the cultch plants proposed for construction are large, the most cost-efficient method to deploy the cultch materials would be from an oyster barge with a high-pressure water spray. Measures would be implemented to reduce sediment disturbance and water turbidity during use of a high-pressure water spray. The cultch plants would be closed to harvest until oyster demography performance criteria are met (see Section 5).

In addition to the planned project components described above, this project would include a programmatic component. Potential sites for additional oyster cultch projects would be located in the Biloxi Marsh Complex and on any other state managed POSG or POSR in Louisiana.

Potential programmatic sites in the Biloxi Marsh Complex would build upon Phase I of the Louisiana Oyster Cultch Project, which was selected as an early restoration alternative by the Louisiana TIG in 2012 (Louisiana Natural Resource Trustees, 2015). An additional 800 to 1600 acres of cultch would be placed on POSG in the Biloxi Marsh Complex in order to support productive oyster reefs. Up to 400 acres of clean limestone cultch material would be constructed at each of four historic reefs on POSG within Drum Bay, Three Mile Bay, Karako Bay, and Morgan Harbor. Limestone that is clean and free of contaminants would be placed at a planting density not to exceed 200 tons per acre. All cultch plants constructed would be closed to harvest until performance criteria are met.

Additional programmatic locations would be identified using several information sources to determine optimal site locations. The Lake Pontchartrain Basin Foundation (LPBF) Hydrocoast maps of isohaline lines (Connor et al., 2019), the Coastwide Reference Monitoring System (CRMS) and U.S. Geological Survey (USGS) hydrologic sampling station data, available larval transport models (e.g., ADCIRC; Murray et al., 2015), and LDWF discrete hydrological measurements collected during fisheries independent sampling would all be used to map the isohaline lines and identify optimal site locations within these potential programmatic areas. Additional data acquisition (i.e., bottom surveys) may be conducted using project to site additional cultch plant areas. In all cases, site selection would be coordinated with the Louisiana TIG, and compliance with the programmatic action of the RP/EA #5would be affirmed ahead of final site selection and implementation.

1.2 Restoration Type Goals and Project Restoration Objectives

This project is being implemented as restoration for the DWH Natural Resource Damage Assessment (NRDA), consistent with the Final PDARP/PEIS (DWH Trustees, 2016). The programmatic goals for the oyster restoration type are to:

- Restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs.
- Restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time.
- Restore a diversity of oyster reef habitats that provide ecological functions for estuarine-dependent fish species, vegetated shoreline and marsh habitats, and nearshore benthic communities.

The restoration technique for this project is to restore or create oyster reefs through placement of cultch in nearshore and subtidal areas. The specific restoration objectives are to increase reef area through cultch placement and inform site selection for future programmatic cultch plant restoration projects.

Potential long-term benefits from increasing available cultch material include increased oyster production as well as oyster population connectivity, resilience, and stability. Healthy, interconnected oyster populations form reefs that provide the hard substrate needed for oyster larvae to settle, grow, and sustain the population. In addition to providing habitat for oysters, these reefs serve as habitat for a variety of marine organisms, from small invertebrates to large recreationally and commercially important species. Oyster reefs may also provide structural integrity, improve water quality, and depending on proximity to the shoreline, potentially reduce coastal erosion (DWH Trustees, 2017).

1.3 Conceptual Setting

The conceptual model, described below, forms the basis of this monitoring plan and includes a summary of the project activities, the expected product or output of those activities, and the desired project

outcomes. Stressors negatively impact habitat condition and habitat relationships, resulting in loss of habitat, function or capacity. For this project, the specific stressors addressed include habitat loss, as well as changes in local conditions that historically supported oysters. Predation and changes in water quality also impact oyster resources. The purpose of this project is to construct cultch plants that will result in productive restored oyster reef. This project is intended to increase oyster survival and reproduction using effective restoration methods in conditions suitable for oyster reef restoration.

Table 1 provides a conceptual model of the relationship between restoration actions and the goal of the project.

Table 1. Conceptual Model for the Cultch Plant Oyster Restoration.

Restoration Actions	As-Built	Interim	Restoration Goal
Place clean cultch material on POSG and POSR water bottom	400 acres of oyster cultch material placed onto POSG and POSR in Grand Banks and Caillou Lake	Oysters settle and grow to seed-size	Produce seed-size oysters on POSG and POSR to help compensate for oyster injuries in Louisiana

1.3.1 Sources of Uncertainty

Uncertainties or information gaps have the potential to affect adaptive management decisions for restoration projects. These decisions may include how to improve the likelihood of achieving favorable project outcomes or selecting corrective actions in the event a project is not performing as intended.

The primary source of uncertainty for this project is related to the construction of the cultch plants as designed, on schedule and on budget. The materials proposed to be utilized have proven effective in other areas, reducing the likelihood of project failure. Other uncertainties include:

- Natural variability in ecological and physical processes and conditions (e.g., temperature, salinity)
- Rates of oyster production
- Rates of sediment accretion
- Coastal acidification trends
- Effects from local resource management, such as water or sediment diversions
- Spatial effects from anoxia events
- Illegal harvest

This list should not be considered exhaustive; additional uncertainties may be identified as the project is implemented and/or monitored.

2 Project Monitoring

The proposed monitoring for this project is outlined below and in Table 2 and is organized by project objective. For each of the identified parameters, the plan includes information on the monitoring methods, timing, frequency, sample size, and sites. LDWF would perform monitoring activities using standard state oyster monitoring methods (LDWF, 2018), with modifications to address project objectives.

Objective #1: Increase reef area through cultch placement.

Parameter #1: Spatial extent of oyster cultch areas.

a) Purpose: To ensure that the desired cultch plant dimensions are achieved and maintained.
b) Method:
    1. LDWF utilizes side-scan sonar units to allow rapid assessment of reef areas and creates profile maps of bottom hardness values to determine reef extent. Onsite side scan sonar would survey the cultch plant area pre- and post-cultch plant construction to ensure that the desired acreage and volume (200 acres per site at a density of 200 tons per acre) of cultch planting is achieved.
    2. During construction, LDWF representatives monitor the activities of the contractor and ensure that cultch deposition only occurs within the properly marked and permitted area.
c) Timing, Frequency, and Duration: Project footprint side-scan surveys would occur pre- and post-cultch plant construction. Additionally, surveys may be conducted after major storm events.
d) Sample Size: The spatial extent of the cultch plant will be surveyed.
e) Sites: All project cultch sites will be monitored, including the sites currently planned (Figure 1) and any additional sites within Louisiana's POSG and POSR identified in the future.

Objective #1: Increase reef area through cultch placement.

Parameter #2: Oyster demography.

a) Purpose: To ensure that oysters are settling, surviving, and growing through the duration of the project.
b) Method: Oyster density (oysters/m^2), mortality (percent dead oysters), and size distribution (spat 0–24 mm, seed 25–74 mm, and market-sized ≥ 75 mm) information would be collected at each cultch plant site via quadrat and dredge sampling following established LDWF protocols (LDWF, 2018), with data recorded on standard LDWF oyster sample data sheets (Attachment 1).
    - Quadrat Sampling: For each quadrat sampling event, the cultch plant being sampled would be divided into equally sized, consecutively numbered grid squares, and 20 grids would be randomly selected for sampling. Oyster density would be determined via 0.25-square-meter quadrat sampling following established LDWF sampling protocol on an annual basis (LDWF, 2018). Quadrat sampling would occur each summer following completion of construction to coincide with LDWF annual oyster stock assessment sampling. Within each randomly

selected grid, field crews would deploy one 0.25-square-meter polyvinyl chloride (PVC) pipe quadrat off the sampling vessel onto the cultch plant. From the quadrat, SCUBA divers would collect all oysters, surficial shell/cultch, and associated reef organisms for enumeration and analysis. The sample would consist of all materials collected from the quadrat. All live and recently dead oysters within each sample would be counted, measured, and returned to the water. Crew members would also record observations of cultch condition.

- Dredge Sampling: LDWF would use dredge sampling to monitor oyster mortality and size between quadrat sampling events. For each dredge sampling event in the winter, spring, and fall, each cultch plant would be divided into equally sized, consecutively numbered grid squares, and 20 grids would be randomly selected for sampling. Within each randomly selected grid, field crews would deploy a 24-inch wide standard sampling dredge and tow for three minutes. All live and recently dead oysters within each sample would be counted, measured, and returned to the water. Crew members would also record observations of cultch condition.

c) Timing, Frequency, and Duration: Project-specific monitoring as described in this plan would occur immediately following construction activities and would be repeated annually for four years post-construction. Quadrat sampling would occur each summer following completion of construction to coincide with LDWF annual oyster stock assessment sampling. Dredge sampling would be conducted in winter, spring, and fall. Additionally, surveys may be conducted after any major storm event.

d) Sample Size: Project-specific sampling would be conducted in at least 20 grids, unless data analysis indicates sample size changes are warranted.

e) Sites: All project cultch sites will be monitored, including the sites currently planned and any additional sites within Biloxi Marsh and POSG and POSR identified, and constructed, in the future.

Objective #2: Inform site selection for future programmatic cultch plant restoration projects.

Parameter #1: Water quality.

a) Purpose: To ensure that water quality parameters (e.g., water temperature, salinity, dissolved oxygen) at brood reef sites are suitable for oyster survival, growth, and spawning.

b) Method: Water quality parameters would be monitored by LDWF in conjunction with the pre-construction, post-construction, and annual sampling described above. Measurements would be collected one foot above the cultch plant surface in conjunction with each biological sample. This information would be recorded by field personnel on LDWF field sampling datasheets and field notebooks.

c) Timing, Frequency, and Duration: Discrete water quality readings would be collected monthly by LDWF.

d) Sample Size: Discrete data would be collected and recorded for each sites' surveys for oyster abundance.

e) Sites: All project brood reef sites would be monitored, including the sites currently planned and any additional sites within Biloxi Marsh and POSG and POSR identified in the future. Discrete water quality readings would be collected by LDWF in each basin.

Table 2. Project Monitoring.

Monitoring Objective	Monitoring Parameter	Purpose	Method/ Core parameter
Increase reef area through cultch placement	Spatial extent of oyster cultch areas	To ensure that the desired cultch plant dimensions are achieved and maintained	Cultch plant area (m^2), cultch plant volume (m^3)
	Oyster demography	To ensure that oysters are settling, surviving, and growing throughout the duration of the project	Density of seed-sized (25 mm or larger) oysters (#/m^2)
Inform site selection for future programmatic cultch plant restoration projects.	Water quality	To ensure that water quality parameters (e.g., water temperature, salinity, dissolved oxygen) at brood reef sites are suitable for oyster survival, growth, and spawning	Water temperature, salinity, dissolved oxygen

3 Adaptive Management

As discussed in the Final PDARP/PEIS, adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). It is an iterative process that aligns decision-making to the natural scale so that it is more dynamic and responsive. Adaptive management generally involves setting management goals, monitoring outcomes, determining impacts, and refining goals to incorporate lessons learned (Craig, 2010; Ruhl, 2011).

In this project, adaptive management is incorporated in the periodic re-evaluation of response capacity gaps and response needs. Data, analysis, and information obtained from this project would be used to help inform future restoration plan development, priorities, and project selection.

4 Evaluation

Evaluation of monitoring data is needed to assess the performance of the project in meeting its restoration objectives, resolve key uncertainties, and determine whether corrective actions are needed.

As part of the larger decision-making context beyond the project scale, the evaluation of monitoring data from the individual projects would be compiled and assessed at the restoration type and the TIG

level. The results would be used to update the knowledge base to inform decisions such as future TIG project prioritization and selection, implementation techniques, and the identification of critical uncertainties. The results of the project evaluation analysis would be used to answer the following questions:

- Were project restoration objectives achieved? If not, is there a reason why they were not met?
- Was the project constructed as designed?
- Did oysters establish on the cultch plants successfully?
- Did the restoration project produce unanticipated effects?
- Were there unanticipated events unrelated to the restoration project that potentially affected the monitoring results (e.g., hurricanes)?
- Were any of the uncertainties identified prior to project implementation resolved?
- Were any new uncertainties identified?
- Have data been summarized and characterized in a way that allows for a clear understanding of results?
- What broader insights might be gained from implementation/monitoring of this project?

These questions would be compiled and evaluated by LDWF in annual monitoring reports for the project. This Monitoring and Adaptive Management (MAM) plan would be revised by LDWF if needed.

5 Project-Level Decisions: Performance Criteria and Potential Correction Actions

Performance criteria are used to determine the success of restoration or the need for corrective actions (15 CFR 990.55(b)(1)(vii)). Performance criteria and potential corrective actions have been developed for each monitoring parameter for the proposed project (Table 3). Additional corrective actions may be identified during project implementation, as well as during post-implementation, as appropriate. If additional corrective actions are identified, this section of the MAM plan would be updated to reflect changes throughout project implementation.

Table 3. Performance Criteria and Potential Corrective Actions by Monitoring Parameter.

Objective	Monitoring Parameter	Final Performance Criteria	Potential Corrective Action
Increase reef area through cultch placement	Spatial extent of oyster cultch areas	Cultch material is placed only within the properly marked and permitted area. Immediately following construction and throughout the duration of the project, the total area covered with cultch should be equal to the target area	Additional cultch material may be added to achieve target acreage. Other techniques may be identified by the Trustees

		(minimum 1200 acres at a density of 200 tons per acre)	
	Oyster demography[1]	An average density of 20 seed-sized oysters (25 mm or larger) per square meter is achieved and maintained through year five. This will indicate successful recruitment and survival of oysters onto each cultch plant site	Deploy hatchery raised larvae/spat onto the cultch plant or other technique identified by the Trustees
Inform site selection for future programmatic cultch plant restoration projects.	Water quality	Water quality parameters are within the range of conditions to support oyster survival, growth, and recruitment	If water quality parameters are found to be limiting oyster survival, growth, and spawning on brood reef sites, the TIG may consider redefining water quality requirements for additional cultch plant locations in the future

[1] Size distribution will be monitored to inform adaptive management; however, no performance criteria will be established due to high natural variability.

6 Monitoring Schedule

The schedule for project monitoring is shown in Table 4, separated by monitoring activity. Pre-construction monitoring would occur before project implementation. As-built monitoring would occur within 90 days of when the project has been fully executed as planned. Performance monitoring would occur annually for four years following initial project execution. Additional monitoring may be required following severe weather events.

This plan assumes that project-specific monitoring would begin in summer 2020. The plan also assumes that project performance standards would be met by the end of 2024 and project-specific monitoring as described in this plan would cease by that time. The Trustees anticipate that after project-specific monitoring concludes, LDWF would continue to monitor oyster abundance using standard monitoring protocols throughout the time the sites are still producing oysters.

Table 4. Monitoring Schedule.

Core Parameter	Pre-Construction	As-Built (Year 0)	Post-Construction (Years 1-4)
Cultch plant area (m^2) and volume (m^3)	X	X	X
Density of seed-sized (25 mm or larger) oysters (#/m^2)		X	X
Water temperature, salinity, dissolved oxygen		X	X

7 Data Management

7.1 Data Description

Qualitative and quantitative data would be collected as part of this MAM plan. The type of data to be collected, as well as how those data would be collected, processed, reviewed, stored, and shared, will follow the data standards outlined in the MAM Procedures and Guidelines Manual Version 1.0 (MAM Manual; DWH Trustees, 2018) and this MAM plan.

All data would be collected by hand and recorded on standard LDWF oyster sample data sheets (Attachment 1). Hardcopy field datasheets would be scanned to a Portable Document Format (PDF) file and archived, along with the hardcopy at LDWF Headquarters. All photographs, datasheets, notebooks, and revised data files would be retained. Metadata would be developed for consistency for all data collected electronically. All electronic files would be shared on Data Integration Visualization Exploration and Reporting (DIVER), in such a way that the Louisiana TIG would have guaranteed access to all versions of the data.

7.2 Data Review and Clearance

Data would be recorded on LDWF field sheets and entered into the LDWF Data Management System, data transcription will be checked, and data will be verified. Data would be exported in excel file format for inclusion on the DIVER portal annually.

7.3 Data Storage and Accessibility

MAM data would be stored in the DIVER Restoration Portal. Data would be submitted as soon as possible, but no more than one year from when the data were collected. Data storage and accessibility would be consistent with the guidelines in Section 3.1.3 of the MAM Manual (DWH Trustees, 2018).

7.4 Data Sharing

The Louisiana TIG would ensure that data sharing follows standards and protocols set forth in the Open Data Policy (DWH TC, 2016; Section 10.6.6). No data release can occur if it is contrary to federal or state laws (DWH TC, 2016; Section 10.6.4). The DWH NRDA Trustees would provide notification to the Cross-TIG MAM work group when new data and information packages have been uploaded to DIVER (DWH Trustees, 2018). In the event of a public records request related to project data and information that are

not already publicly available, the Trustee to whom the request is addressed would provide notice to the other Louisiana TIG Trustees prior to releasing any project data that are the subject of the request.

As noted in Section 7.3, the project's data would be stored in the DIVER Restoration Portal. These data would be shared with the public by publishing the data to the Trustee Council website (DWH TC, 2016; Section 10.6.6). For further instructions on this process, see the DIVER Restoration Portal User Manual (NOAA DWH Data Management Team, n.d.).

Some of the data collected may be protected from public disclosure under federal and state law (e.g., personally identifiable information under the Privacy Act) and therefore would not be publicly distributed.

8 Reporting

Reporting should follow the guidelines set forth in Section 2.6.3 and Attachment D of the MAM Manual (DWH Trustees, 2017). Information to be reported includes the following:

1. An introduction that provides an overview of the project, location, and restoration activities, as well as restoration objectives and performance criteria applicable to the project.
   a) This information can be taken from this MAM plan and repeated in all reports.
2. A detailed description of the methods used for implementation of the MAM plan.
   a) This information can be taken from this MAM plan and repeated in all reports.
3. Results from the reporting period or, in the case of the final report, a comprehensive summary of results from the entire MAM plan implementation period.
   a) Results should be presented clearly and show progress that has been made toward performance criteria and/or restoration objectives. Information that can be used to present results includes tables or graphs, site visit summaries, and other datasets that support analysis of the project's progress toward meeting performance standard.
4. A discussion of the results (optional for interim reports, required for final report).
5. Conclusions that summarize the findings, progress toward meeting performance criteria and restoration objectives, and recommendations for corrective actions (optional for interim reports, required for final report).
6. Project highlights showcasing lessons learned to inform future project planning and implementation.
7. Transmission of data and metadata used in the report, as well as a description of all data collected during the reporting period, even if they were not used in the report.
8. A complete list of references.

Six reports would be submitted by LDWF, excluding any additional reports deemed necessary as a result of corrective actions that require an extension of the monitoring period. The first report would be submitted after the completion of pre-construction monitoring, the second report would be submitted after the completion of construction monitoring, and one report would be submitted after completion of each annual post-construction monitoring for four years.

The DWH Trustees, as stewards of public resources under OPA, should inform the public on the restoration project's progress and performance. Therefore, the Louisiana TIG would report the status of the proposed project via the DIVER Restoration Portal, as outlined in Chapter 7 of the Final PDARP/PEIS (DWH Trustees, 2016).

9 Roles and Responsibilities

The Louisiana TIG is responsible for "addressing MAM objectives that pertain to their restoration activities and for communicating information to the Trustee Council or Cross-TIG MAM work group" (DWH Trustees, 2016). This includes reviewing and approving MAM plans, identifying MAM priorities for the Louisiana restoration area, ensuring that MAM implementation is compatible with the MAM Manual guidelines and that data are submitted to the DIVER Restoration Portal, aggregating and evaluating MAM data, ensuring quality control of MAM data, and communicating regarding implementation status and results of MAM with the Trustee Council and Cross-TIG MAM work group.

As the implementing Trustee, LDWF is responsible for developing the MAM plan and annual reports, conducting all monitoring activities, evaluating project progress toward restoration objectives using the identified performance criteria, identifying and proposing corrective actions to the Louisiana TIG, and submitting MAM data and project information into the DIVER Restoration Portal in accordance with the data management procedures outlined within this MAM plan (DWH TC, 2016).

The project proponent, LDWF, is responsible for all maintenance activities and costs related to the project, including any repairs needed over the life of the project.

10 Monitoring and Adaptive Management Budget

The estimated cost of project monitoring and reporting for each planned cultch plant project is $82,500 for four years of monitoring, totaling $165,000 for the two planned cultch plant projects. The cost of sidescan sonar surveys is funded separately by LDWF's annual monitoring budget. Contingency for any necessary monitoring and repairs following storms will be covered by the alternative's programmatic budget, as would monitoring and adaptive management for any potential programmatic sites.

11 References

Deepwater Horizon Natural Resource Damage Assessment Trustees (DWH Trustees). 2016. *Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Final PDARP/PEIS). Available: http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

_____. 2017. Deepwater Horizon Oil Spill Natural Resource Damage Assessment: Strategic Framework for Oyster Restoration Activities. June. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/Oyster_Strategic_Framework_06.23.17.pdf.

Deepwater Horizon Trustee Council (DWH TC). 2016. Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the Deepwater Horizon (DWH) Oil Spill. November 15, 2016. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/DWH-SOPs.pdf

_____. 2018. Monitoring and Adaptive Management (MAM) Procedures and Guidelines Manual Version 1.0. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/2018_01_TC_MAM_Procedures_Guidelines_Manual_12-2017_508_c.pdf

Louisiana Department of Wildlife and Fisheries (LDWF). 2018. LDWF Marine Fisheries Independent Sampling Activities Field Manual. Internal document.

Murray, J., H. Roman, and J.J. Westerink. 2015. Technical Memorandum. Development of Oyster Larval Transport Analysis (ADCIRC). DWH Oyster NRDA Technical Working Group Report. Available at: https://www.fws.gov/doiddata/dwh-ar-documents/857/DWH-AR0270401.pdf. Accessed February 18, 2019.

National Oceanic and Atmospheric Administration Deepwater Horizon (NOAA DWH) Data Management Team. n.d. DIVER Restoration Portal User Manual, version 2.2.2.

National Research Council (NRC). 2004. Adaptive Management for Water Resources Project Planning. Washington, DC: The National Academies Press.

Pastorok, R.A., MacDonald, A., Sampson, J.R., Wilber, P., Yozzo, D.J., & Titre, J.P. 1997. An ecological decision framework for environmental restoration projects. Ecological Engineering, 9, 89-107.

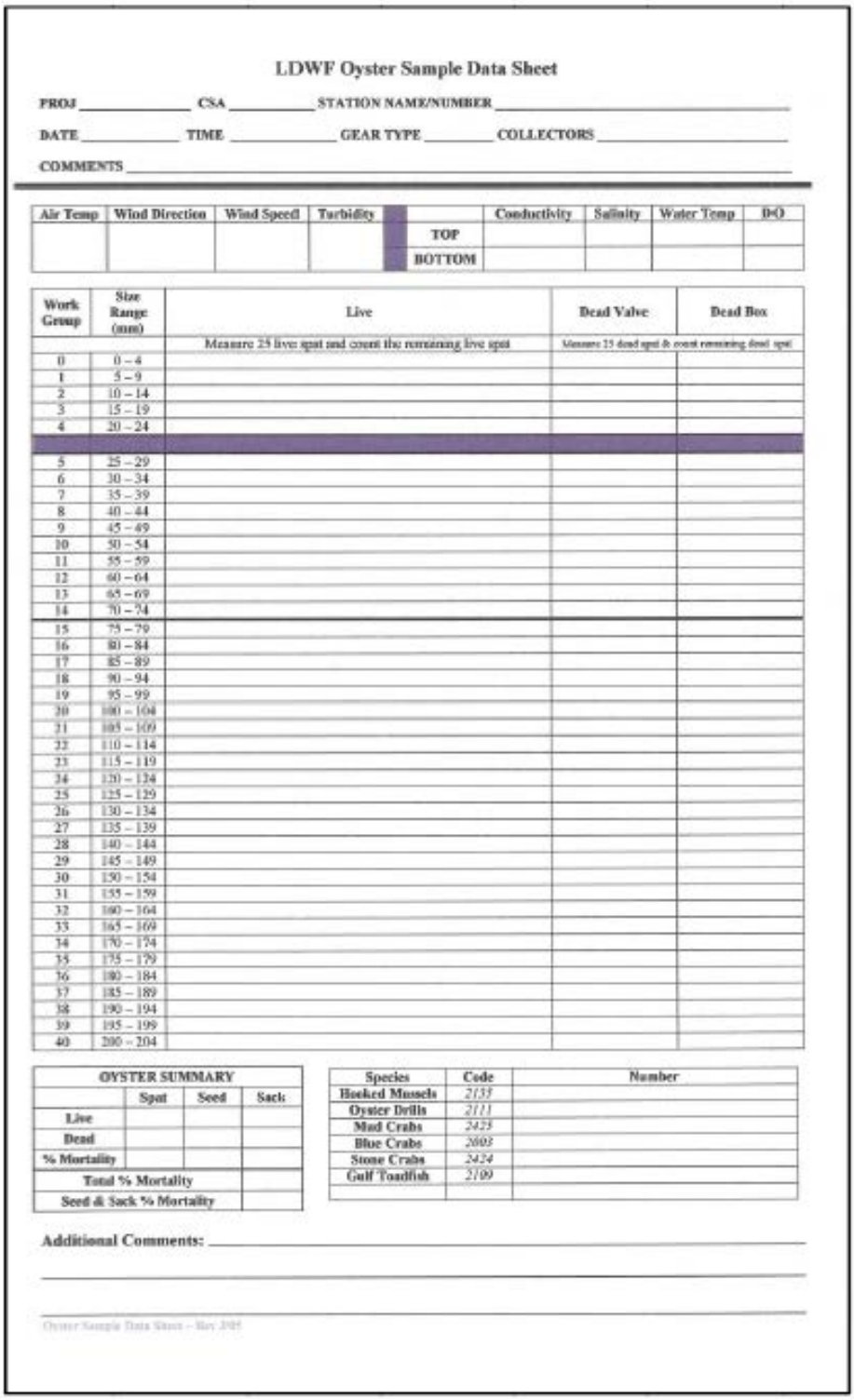
Steyer, G.D., and D.W. Llewellyn. 2000. Coastal Wetlands Planning, Protection and Restoration Act: A programmatic application of adaptive management. Ecological Engineering, 26, 27-39.

Williams, B.K. 2011. Adaptive management of natural resources - Framework and issues. Journal of Environmental Management, 92, 1346-1353.

12 MAM Plan Revision History

Old Version #	Revision Date	Changes Made	Reason for Change	New Version #

Attachment 1. Example LDWF Oyster Sample Data Sheet



LDWF Oyster Sample Data Sheet

PROJ _____ CSA _____ STATION NAME/NUMBER _____

DATE _____ TIME _____ GEAR TYPE _____ COLLECTORS _____

COMMENTS _____

Air Temp	Wind Direction	Wind Speed	Turbidity		Conductivity	Salinity	Water Temp	DO
				TOP				
				BOTTOM				

Work Group	Size Range (mm)	Live	Dead Valve	Dead Box
		Measure 25 live spat and count the remaining live spat	Measure 25 dead spat & count remaining dead spat	
0	0 – 4			
1	5 – 9			
2	10 – 14			
3	15 – 19			
4	20 – 24			
5	25 – 29			
6	30 – 34			
7	35 – 39			
8	40 – 44			
9	45 – 49			
10	50 – 54			
11	55 – 59			
12	60 – 64			
13	65 – 69			
14	70 – 74			
15	75 – 79			
16	80 – 84			
17	85 – 89			
18	90 – 94			
19	95 – 99			
20	100 – 104			
21	105 – 109			
22	110 – 114			
23	115 – 119			
24	120 – 124			
25	125 – 129			
26	130 – 134			
27	135 – 139			
28	140 – 144			
29	145 – 149			
30	150 – 154			
31	155 – 159			
32	160 – 164			
33	165 – 169			
34	170 – 174			
35	175 – 179			
36	180 – 184			
37	185 – 189			
38	190 – 194			
39	195 – 199			
40	200 – 204			

OYSTER SUMMARY			
	Spat	Seed	Sack
Live			
Dead			
% Mortality			
Total % Mortality			
Seed & Sack % Mortality			

Species	Code	Number
Hooked Mussels	2135	
Oyster Drills	2111	
Mud Crabs	2423	
Blue Crabs	2003	
Stone Crabs	2424	
Gulf Toadfish	2109	

Additional Comments: _____

Monitoring and Adaptive Management Plan for *Deepwater Horizon* NRDA Project:

Hatchery-based Oyster Restoration

Prepared by: Louisiana Natural Resource Trustees

Draft Version Date: 3/6/2020

Table of Contents

1 Introduction

The Louisiana Natural Resource Trustees (Trustees) developed this monitoring plan (plan) for the Hatchery-based Oyster Restoration Projects (project). This project is included as a preferred alternative for the oyster restoration type in the *Louisiana Draft Restoration Plan/Environmental Assessment (RP/EA) #5, Living Coastal and Marine Resources (LCMR): Marine Mammals and Oysters*. The goal of this project is to enhance oyster reef productivity in Louisiana through spawning stock enhancement projects in order to offset impacts resulting from exposure to Deepwater Horizon (DWH) oil, dispersant, and response activities. Spawning stock enhancement projects include hatchery production of oyster larvae, planting hatchery-raised oysters, and relocating oysters to restoration sites. Maintaining regional hatchery production capacity for spat on shell supports other oyster restoration projects in the region that depend on the availability of spat to enhance spawning stock on existing reefs.

The purpose of this plan is to describe monitoring activities that would be conducted to evaluate and document restoration effectiveness, including performance criteria for determining the success of restoration or need for interim corrective action (15 CFR 990.55(b)(1)(vii)). This plan would be implemented by the National Oceanic and Atmospheric Administration (NOAA) in partnership with the Louisiana Department of Wildlife and Fisheries (LDWF) and may be modified over time based on the management needs for the project.

1.1 Project Overview

This project would support multiple hatchery-based and hatchery-reliant projects that would help to replenish Louisiana's natural oyster populations lost due to the DWH oil spill response and related freshwater releases. The specific project objectives are to provide funding to support 10 years of operations at an existing and currently operating hatchery and provide larvae and seed resources for Public Oyster Seed Grounds (POSG) restoration and water-based oyster culture. This project would contribute to the enhancement of natural oyster reefs and increased oyster abundance which may provide some ecosystem services that result from high oyster abundance, such as reduction in shoreline erosion, improved water quality, increased biodiversity of reef-dependent organisms, and recycling of nutrients.

More specifically, the hatchery-based project would provide up to 10 years of operational funds for the Michael C. Voisin Oyster Hatchery in Grand Isle, Louisiana and support deployment monitoring of hatchery-produced product. Construction of the hatchery began in 2013 and was completed in 2015. The facility is jointly operated by LDWF and Louisiana State University (LSU) to produce oysters for use in rehabilitating public oyster areas. From 2015 to 2017, the hatchery produced approximately 651 million oyster larvae and 4.6 million seed oysters. LDWF estimates that 80 to 99 percent of the oysters produced were used by LDWF for oyster population rehabilitation or restoration purposes.

The deployment of hatchery-produced oysters to areas with low oyster abundance is a technique described in the DWH PDARP/PEIS Strategic Framework (DWH Trustees, 2017b). Hatchery-produced oysters offer the opportunity to artificially increase oyster production in areas with suitable hydrology and substrate. The proposed operation of the hatchery and subsequent spat-on-shell deployment is one component of a larger oyster restoration plan for the POA of the state. Potential short-term benefits of spat-on-shell deployment include directly increasing oyster abundance and improving the reproductive potential for oysters regionally. Potential long-term benefits include increasing oyster production and associated ecosystem services resulting from high oyster abundance, and improved oyster population connectivity, resilience, and stability.

The hatchery-based restoration project incorporates multiple DWH PDARP/PEIS Strategic Framework oyster restoration activities to increase oyster abundance and improve oyster population connectivity, resilience, and stability in Louisiana (DWH Trustees, 2017). Many current and future restoration projects would benefit from the continued production of oyster larvae and seed oyster. Areas that would benefit from spat-on-shell deployments include areas with existing shell substrate, such as relic reefs, cultch plants on POSG, along with un-harvestable brood reefs and inshore artificial reef structures. In addition to supporting continued hatchery production of oysters, this project would support programs to increase commercial production of off-bottom oysters, which will increase oyster production and reduce commercial pressure on natural oyster reefs into the foreseeable future.

Through support of the Michael C. Voisin Oyster Hatchery, LDWF would work with Louisiana Sea Grant to continue producing oyster larvae for use in oyster rehabilitation activities. These larvae would be placed into tanks and induced to set on oyster shell or other cultch material. The oyster shell would be provided through a partnership with the Coalition to Restore Coastal Louisiana's Oyster Shell Recycling Program.[20] Shells collected from the recycling program are stored in Buras, Louisiana, where they are dried for a minimum of six months before being transported to the hatchery for setting purposes. Once developed, live oyster spat would be transported for deployment onto POSG or Public Oyster Seed Reservations (POSR) in need of rehabilitation.

The hatchery would produce at least 500 million diploid oyster larvae per year, of which a minimum of 25 percent would be dedicated for use in oyster restoration activities within areas protected from harvest (i.e., brood and artificial reefs, or living shorelines). Planting locations and monitoring would vary based on oyster population needs and the amount and type of available spat, but placement would be on a POSG or POSR with suitable oyster habitat (i.e., existing shell substrate).

An additional potential benefit of maintaining hatchery operations is the production of diploid oyster larvae and seed resources for oyster farming. While not included in this project's funds, hatchery-raised oysters could be used to support an existing effort led by LDWF and Louisiana Sea Grant to provide training to Louisiana coastal residents interested in pursuing commercial oyster farming.

[20] More information about the Coalition to Restore Coastal Louisiana is available on their website: https://www.crcl.org/.

The availability of hatchery-raised oysters could also help support the establishment of a state program for off-bottom oyster culture. Although setting up such a program is not included in this project, the success of such a program would depend on the availability of oyster larvae. Funding for continued operations of the hatchery facility is likely to support local job creation and increased oyster production throughout Louisiana.

1.2 Restoration Type Goals and Project Restoration Objectives

This project is being implemented as restoration for the DWH Natural Resource Damage Assessment (NRDA), consistent with the Final PDARP/PEIS (DWH Trustees, 2016). The programmatic goals for the oyster restoration type are to:

- Restore oyster abundance and spawning stock to support a regional oyster larvae pool sufficient for healthy recruitment levels to subtidal and nearshore oyster reefs.
- Restore resilience to oyster populations that are supported by productive larval source reefs and sufficient substrate in larval sink areas to sustain reefs over time.

The restoration technique for this project is to enhance oyster reef productivity through spawning stock enhancement. The specific restoration objectives are to enhance regional hatchery capacity and produce and deploy larvae and seed resources for POSG restoration and water-based oyster culture.

Potential short-term benefits of spat-on-shell deployment include directly increasing oyster abundance and improving the reproductive potential for oysters regionally. Potential long-term benefits include increasing oyster production and associated ecosystem services resulting from high oyster abundance, and improved oyster population connectivity, resilience, and stability.

1.3 Conceptual Setting

The conceptual model, described below, forms the basis of this monitoring plan and includes a summary of the project activities, the expected product or output of those activities, and the desired project outcomes. Project activities include the support and enhancement of an existing hatchery facility and the subsequent production and deployment of larvae and seed resources to restore oyster populations in Louisiana. This project addresses losses in oyster production and will result in increased oyster survival and reproduction in Louisiana.

Table 1 provides a conceptual model of the relationship between restoration actions and the goals of the project.

Table 1. Conceptual Model for the Hatchery-based Oyster Restoration.

Restoration Actions	As-Built	Interim	Restoration Goal
Enhance regional hatchery capacity and remote settling facilities	Maintain hatchery operations	Maintain and enhance hatchery operations	Produce 500 million diploid oyster larvae per year

Produce and deploy larvae and seed resources for POSG restoration and water-based oyster culture	Maintain hatchery production and deployment	Maintain and enhance hatchery production and deployment	Improve hatchery operations, transfer, and deployment of hatchery-raised oysters

1.3.1 Sources of Uncertainty

Uncertainties or information gaps have the potential to affect adaptive management decisions for restoration projects. These decisions may include how to improve the likelihood of achieving favorable project outcomes or selecting corrective actions in the event a project is not performing as intended.

The primary source of uncertainty for this project is related to natural variability in ecological or physical processes that have the potential to impact oyster survival. Whether the project is implemented as designed, on-time and on-budget is one source of uncertainty. The deployment of hatchery-based products and subsequent attachment depends on the placement of spat in areas that are conducive to oyster survival. The techniques and methods proposed to be utilized have proven effective in other areas, reducing the likelihood of project failure. Other uncertainties associated with deployment of hatchery-based products and water-based oyster culture include:

- Natural variability in ecological and physical processes and conditions (e.g., temperature, salinity)
- Rates of sediment accretion
- Coastal acidification trends
- Adjacent land use
- Effects from local resource management, such as water or sediment diversions
- Spatial effects from anoxia events

This list should not be considered exhaustive; additional uncertainties may be identified as the project is implemented and/or monitored.

2 Project Monitoring

The proposed monitoring for this project is outlined below and in Table 2 and is organized by project objective. For each of the identified parameters, the plan includes information on the monitoring methods, timing, frequency, sample size, and sites, if applicable. LDWF would perform monitoring activities with modifications as needed to address project objectives.

Objective #1: Enhance regional hatchery capacity.

Parameter #1: Hatchery production.

a) Purpose: To produce oyster larvae and seed products for oyster restoration.
b) Method: On-site monitoring of facility operations and hatchery production.
c) Timing, Frequency, and Duration: Continuous through Year 10; Report annually.
d) Sample Size: N/A.

e) Sites: Michael C. Voisin Oyster Hatchery in Grand Isle, Louisiana.

Objective #2: Produce and deploy larvae and seed resources for POSG restoration and water-based oyster culture.

Parameter #1: Oyster resource development (Growth).

a) Purpose: To ensure that the desired oyster demography is achieved.
b) Method: Spat would be monitored for growth. All plots would be sampled by hand or hand tonging. Size would be measured for up to 100 live oysters from the 60 shells sampled for oyster survival. All data would be collected on standard LDWF oyster sample data sheets (Attachment 1).
c) Timing, Frequency, and Duration: Plots will be sampled one-, six-, and 18-months post-deployment.
d) Sample Size: 60 shells per plot.
e) Sites: TBD

Table 2. Project Monitoring.

Monitoring Objective	Monitoring Parameter	Purpose	Method/ Core parameter
Enhance regional hatchery capacity	Hatchery production	On-site monitoring of facility operations and hatchery production	Number of oyster larvae produced; percent larvae allocated to restoration
Produce and deploy larvae and seed resources for POSG restoration and water-based oyster culture	Oyster growth	To ensure that the desired oyster demography is achieved and maintained	Density of seed-sized (40 mm or larger) oyster (#/m^2)

In addition to the performance indicators listed in Table 2, data collected on oyster survival would be evaluated to address learning goals. Percent survival data would provide information to evaluate resilience of hatchery-produced larvae post-deployment in order to optimize setting locations and densities at hatchery-raised deployment sites in the future.

3 Adaptive Management

As discussed in the Final PDARP/PEIS, adaptive management is a form of structured decision-making applied to the management of natural resources in the face of uncertainty (Pastorok et al., 1997; Williams, 2011). It is an iterative process that aligns decision-making to the natural scale so that it is more dynamic and responsive. Adaptive management generally involves setting management goals,

monitoring outcomes, determining impacts, and refining goals to incorporate lessons learned (Craig, 2010; Ruhl, 2011).

In this project, adaptive management is incorporated in the periodic re-evaluation of response capacity gaps and response needs. Data, analysis, and information obtained from this project would be used to help inform future restoration plan development, priorities, and project selection.

4 Evaluation

Evaluation of monitoring data is needed to assess the performance of the project in meeting its restoration objectives, resolve key uncertainties, and determine whether corrective actions are needed.

As part of the larger decision-making context beyond the project scale, the evaluation of monitoring data from the individual projects would be compiled and assessed at the restoration type and the TIG level. The results would be used to update the knowledge base to inform decisions such as future TIG project prioritization and selection, implementation techniques, and the identification of critical uncertainties. The results of the project evaluation analysis would be used to answer the following questions:

- Were project restoration objectives achieved? If not, is there a reason why they were not met?
- Was the project implemented as designed?
- Did the restoration project produce unanticipated effects?
- Were there unanticipated events unrelated to the restoration project that potentially affected the monitoring results (e.g., hurricanes)?
- Were any of the uncertainties identified prior to project implementation resolved?
- Were any new uncertainties identified?
- Have data been summarized and characterized in a way that allows for a clear understanding of results?
- What broader insights might be gained from implementation/monitoring of this project?

These questions would be compiled and evaluated by LDWF in annual monitoring reports for the project. This Monitoring and Adaptive Management (MAM) plan would be revised by LDWF if needed.

5 Project-Level Decisions: Performance Criteria and Potential Correction Actions

Performance criteria are used to determine the success of restoration or the need for corrective actions (15 CFR 990.55(b)(1)(vii)). Performance criteria and potential corrective actions have been developed for each monitoring parameter for the proposed project (Table 3). Additional corrective actions may be identified during project implementation, as well as during post-implementation, as appropriate. If additional corrective actions are identified, this section of the MAM plan would be updated to reflect changes throughout project implementation.

Table 3. Performance Criteria and Potential Corrective Actions by Monitoring Parameter.			
Objective	Monitoring Parameter	Final Performance Criteria	Potential Corrective Action
Enhance regional hatchery capacity	Hatchery production	Produce 500 million diploid oyster larvae per year; allocate 25 percent to areas protected from harvest	Evaluate hatchery operations and maintenance to ensure the facility is operating effectively and any issues are expeditiously addressed; reallocate larvae as needed to maintain threshold of allocation for restoration
Produce and deploy larvae and seed resources for POSG restoration and water-based oyster culture	Oyster growth	An average density of 20 seed-sized oysters (38mm or larger) per square meter is achieved and maintained. This will indicate successful growth of oysters	Deploy additional hatchery-produced larvae/spat or other technique identified by the Trustees

6 Monitoring Schedule

The schedule for project monitoring is shown in Table 4, separated by monitoring activity. Hatchery production would be monitored annually with a goal of producing 500 million diploid oyster larvae per year. Deposition of hatchery-produced oysters would be monitored to confirm that 25 percent of diploid oyster larvae produced annually are allocated to oyster restoration activities on areas protected from harvest. At select deployment sites, the number of spat deployed and their survival would be monitored for a period of 18 months to address learning goals and evaluate the success of hatchery-raised oyster deployment. Production monitoring would be reported annually for 10 years following initial project execution. Additional monitoring may be required following severe weather events.

This plan assumes that project-specific monitoring would begin in summer 2020. The plan also assumes that project would be complete by 2030 and project-specific monitoring as described in this plan would cease by that time.

Table 4. Monitoring Schedule.			
Core Parameter	Pre-Execution	As-Built (Year 0)	Post-Execution (Years 1-10)
Number of oyster larvae produced; percent larvae allocated to restoration			X
Density of seed-sized (40 mm or larger) oyster (#/m^2)			X (measured for 18 months post deployment)

7 Data Management

7.1 Data Description

The type of data to be collected, as well as how those data would be collected, processed, reviewed, stored, and shared, will follow the data standards outlined in the MAM Procedures and Guidelines Manual Version 1.0 (MAM Manual; DWH Trustees, 2018) and this MAM plan. Specific data to be collected would be determined during project and study planning, and this MAM plan would be updated accordingly.

All data would be collected either by hand on monitoring or survey forms or by tablet on electronic forms. If data are recorded on hardcopy field datasheets, these entries would be scanned to a Portable Document Format (PDF) file and archived, along with the hardcopy. All photographs, datasheets, notebooks, and revised data files would be retained. Metadata would be developed for consistency for all data collected electronically. All electronic files would be stored in a secure location, such as on Data Integration Visualization Exploration and Reporting (DIVER), in such a way that the Louisiana TIG would have guaranteed access to all versions of the data.

7.2 Data Review and Clearance

Data would be recorded on LDWF field sheets and entered into the LDWF Data Management System, data transcription will be checked, and data will be verified. Data would be exported in excel file format for inclusion on the DIVER portal annually.

7.3 Data Storage and Accessibility

MAM data would be stored in the DIVER Restoration Portal. Data would be submitted as soon as possible, but no more than one year from when the data were collected. Data storage and accessibility would be consistent with the guidelines in Section 3.1.3 of the MAM Manual (DWH Trustees, 2017).

7.4 Data Sharing

The Louisiana TIG would ensure that data sharing follows standards and protocols set forth in the Open Data Policy (DWH TC, 2016; Section 10.6.6). No data release can occur if it is contrary to federal or state laws (DWH TC, 2016; Section 10.6.4). The DWH NRDA Trustees would provide notification to the Cross-TIG MAM work group when new data and information packages have been uploaded to DIVER (DWH

Trustees, 2017). In the event of a public records request related to project data and information that are not already publicly available, the Trustee to whom the request is addressed would provide notice to the other Louisiana TIG Trustees prior to releasing any project data that are the subject of the request.

As noted in Section 7.3, the project's data would be stored in the DIVER Restoration Portal. These data would be shared with the public by publishing the data to the Trustee Council website (DWH TC, 2016; Section 10.6.6). For further instructions on this process, see the DIVER Restoration Portal User Manual (NOAA DWH Data Management Team, n.d.).

Some of the data collected may be protected from public disclosure under federal and state law (e.g., personally identifiable information under the Privacy Act) and therefore would not be publicly distributed.

8 Reporting

Reporting should follow the guidelines set forth in Section 2.6.3 and Attachment D of the MAM Manual (DWH Trustees, 2018). Information to be reported includes the following:

1. An introduction that provides an overview of the project, location, and restoration activities, as well as restoration objectives and performance criteria applicable to the project.
   a) This information can be taken from this MAM plan and repeated in all reports.
2. A detailed description of the methods used for implementation of the MAM plan.
   a) This information can be taken from this MAM plan and repeated in all reports.
3. Results from the reporting period or, in the case of the final report, a comprehensive summary of results from the entire MAM plan implementation period.
   a) Results should be presented clearly and show progress that has been made toward performance criteria and/or restoration objectives. Information that can be used to present results includes tables or graphs, site visit summaries, and other datasets that support analysis of the project's progress toward meeting performance standard.
4. A discussion of the results (optional for interim reports, required for final report).
5. Conclusions that summarize the findings, progress toward meeting performance criteria and restoration objectives, and recommendations for corrective actions (optional for interim reports, required for final report).
6. Project highlights showcasing lessons learned to inform future project planning and implementation.
7. Transmission of data and metadata used in the report, as well as a description of all data collected during the reporting period, even if they were not used in the report.
8. A complete list of references.

The DWH Trustees, as stewards of public resources under OPA, should inform the public on the restoration project's progress and performance. Therefore, the Louisiana TIG would report the status of the proposed project via the DIVER Restoration Portal, as outlined in Chapter 7 of the Final PDARP/PEIS (DWH Trustees, 2016).

9 Roles and Responsibilities

The Louisiana TIG is responsible for "addressing MAM objectives that pertain to their restoration activities and for communicating information to the Trustee Council or Cross-TIG MAM work group" (DWH Trustees, 2016). This includes reviewing and approving MAM plans, identifying MAM priorities for the Louisiana restoration area, ensuring that MAM implementation is compatible with the MAM Manual guidelines and that data are submitted to the DIVER Restoration Portal, aggregating and evaluating MAM data, ensuring quality control of MAM data, and communicating regarding implementation status and results of MAM with the Trustee Council and Cross-TIG MAM work group.

As the implementing Trustee, LDWF is responsible for developing the MAM plan and annual MAM reports, conducting all monitoring activities, evaluating project progress toward restoration objectives using the identified performance criteria, identifying and proposing corrective actions to the Louisiana TIG, and submitting MAM data and project information into the DIVER Restoration Portal in accordance with the data management procedures outlined within this MAM plan (DWH TC, 2016).

The project proponent, LDWF, is responsible for all maintenance activities and costs related to the hatchery-based oyster restoration project, including any repairs needed over the life of the project.

10 Monitoring and Adaptive Management Budget

The estimated cost of project monitoring and reporting for the hatchery-based projects is $85,000 per year, totaling $850,000 over 10 years. Contingency for any storm-related monitoring and repairs will be covered out of the alternatives' implementation budget.

11 References

Deepwater Horizon Natural Resource Damage Assessment Trustees (DWH Trustees). 2016. *Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Final PDARP/PEIS). Available: http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

_____. 2017. Deepwater Horizon Oil Spill Natural Resource Damage Assessment: Strategic Framework for Oyster Restoration Activities. June. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/Oyster_Strategic_Framework_06.23.17.pdf.

Deepwater Horizon Trustee Council (DWH TC). 2016. Trustee Council Standard Operating Procedures for Implementation of the Natural Resource Restoration for the Deepwater Horizon (DWH) Oil Spill. November 15, 2016. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/DWH-SOPs.pdf

_____. 2018. Monitoring and Adaptive Management (MAM) Procedures and Guidelines Manual Version 1.0. Available: https://www.gulfspillrestoration.noaa.gov/sites/default/files/2018_01_TC_MAM_Procedures_Guidelines_Manual_12-2017_508_c.pdf

Louisiana Department of Wildlife and Fisheries (LDWF). 2018. LDWF Marine Fisheries Independent Sampling Activities Field Manual. Internal document.

National Oceanic and Atmospheric Administration Deepwater Horizon (NOAA DWH) Data Management Team. n.d. DIVER Restoration Portal User Manual, version 2.2.2.

National Research Council (NRC). 2004. Adaptive Management for Water Resources Project Planning. Washington, DC: The National Academies Press.

Pastorok, R.A., MacDonald, A., Sampson, J.R., Wilber, P., Yozzo, D.J., & Titre, J.P. 1997. An ecological decision framework for environmental restoration projects. Ecological Engineering, 9, 89-107.

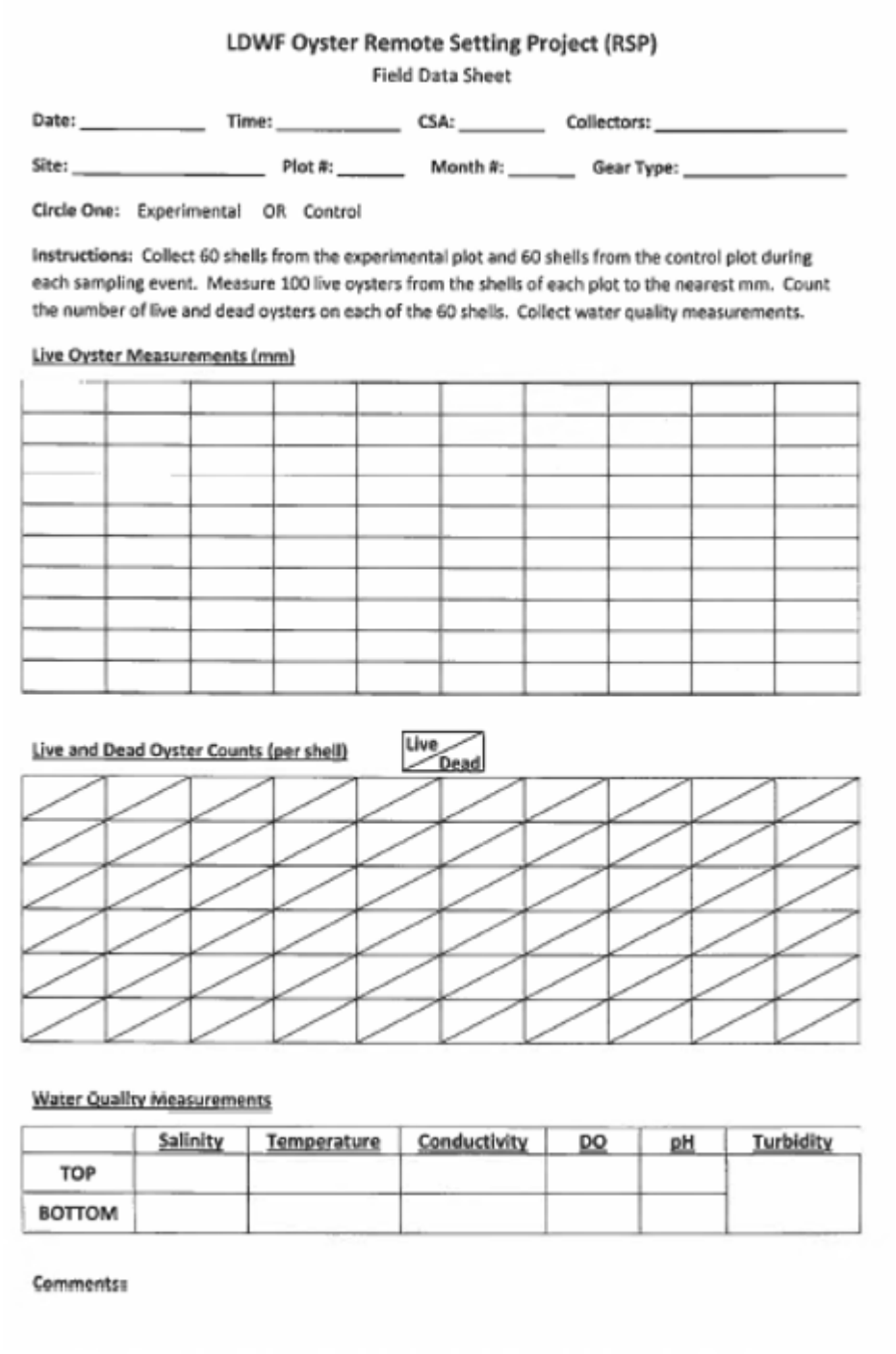
Steyer, G.D., and D.W. Llewellyn. 2000. Coastal Wetlands Planning, Protection and Restoration Act: A programmatic application of adaptive management. Ecological Engineering, 26, 27-39.

Williams, B.K. 2011. Adaptive management of natural resources - Framework and issues. Journal of Environmental Management, 92, 1346-1353.

12 MAM Plan Revision History

Old Version #	Revision Date	Changes Made	Reason for Change	New Version #

Attachment 1. Example LDWF Oyster Sample Data Sheet



LDWF Oyster Remote Setting Project (RSP)

Field Data Sheet

Date: _____ Time: _____ CSA: _____ Collectors: _____

Site: _____ Plot #: _____ Month #: _____ Gear Type: _____

Circle One: Experimental OR Control

Instructions: Collect 60 shells from the experimental plot and 60 shells from the control plot during each sampling event. Measure 100 live oysters from the shells of each plot to the nearest mm. Count the number of live and dead oysters on each of the 60 shells. Collect water quality measurements.

Live Oyster Measurements (mm)

Live and Dead Oyster Counts (per shell) Live / Dead

Water Quality Measurements

	Salinity	Temperature	Conductivity	DO	pH	Turbidity
TOP						
BOTTOM						

Comments:

Appendix E – FONSI

<to be determined>