BS-0030 Mid-Breton Sediment Diversion Project

DRAFT Existing Conditions Report

November 2019

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Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
ACM	asbestos-containing material
AHP	Above Head of Passes
AQCR	Air Quality Control Region
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
BACI	Before/After and Control/Impact
BSE	bay, sound, and estuary
BTEC	Barataria-Terrebonne Estuarine Complex
BTNEP	Barataria-Terrebonne National Estuary Program
˚C	degrees Celsius
CBRA	Coastal Barrier Resource Act
CBRS	Coastal Barrier Resources System
CEMVN	USACE Mississippi Valley Division New Orleans District
CFR	U.S. Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
cm	centimeters
CMP	Coastal Master Plan
cms	cubic meters per second
CNCP	Coastwide Nutria Control Program
CO	carbon monoxide
CO_2	carbon dioxide
CO_2eq	carbon dioxide equivalent
COC	contaminant of concern
CoNED	Coastal National Elevation Dataset
CPRA	Coastal Protection and Restoration Authority
CPUE	catch per unit effort
CRMS	Coastwide Reference Monitoring System
cSEL	cumulative sound exposure level
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
CZMA	Coastal Zone Management Act
dB	Decibel
dBA	A-weighted decibels
DE	diesel exhaust
DEM	Digital Elevation Model
DO	dissolved oxygen

DOSITS	Discovery of Sound in the Sea
DOT	Department of Transportation
DOTD	Department of Transportation and Development
DPM	diesel particulate matter
DPS	distinct population segment
DWH	Deepwater Horizon
EEDDMapS	Electronic Early Detection and Distribution Mapping System
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENSO	El Niño Southern Oscillation
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ERL	effects range low
ERM	effects range median
ESA	Endangered Species Act
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FHWG	Fisheries Hydroacoustic Working Group
FIA	Forest Inventory and Analysis
FIRM	Flood Insurance Rate Map
FIWG	Federal Interagency Working Group
FP	Fibropapillomatosis
FPPA	Farmland Protection Policy Act
Ft	Feet
FMP	Fishery Management Plan
GHG	greenhouse gas
GIS	Geographic Information System
GPS	Global Positioning System
$GtCO_{2eq}$	gigatonne carbon dioxide equivalent
GMFMC	Gulf of Mexico Fishery Management Council
HAP	Hazardous Air Pollutant
HAPC	Habitat Area of Particular Concern
HIP	Harvest Information Program
HSDRRS	Hurricane and Storm Damage Risk Reduction System
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
HUC	Hydrologic Unit Code
HUD	Housing and Urban Development

HWY	highway
Hz	Hertz
IBA	Important Bird Area
IBTrACS	International Best Track Archive for Climate Stewardship
IPCC	Intergovernmental Panel on Climate Change
LAC	Louisiana Administrative Code
LCRP	Louisiana Coastal Resources Program
LCWCRT	Louisiana Coastal Wetlands Conservation and Restoration Task Force
LCZ	Louisiana Coastal Zone
LDA	Louisiana Division of Archeology
LDAF	Louisiana Department of Agriculture and Forestry
LDEQ	Louisiana Department of Environmental Quality
LDHH	Louisiana Department of Health and Hospitals
Ldn	day-night equivalent level
LDNR	Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development
LDWF	Louisiana Department of Wildlife and Fisheries
Leq	equivalent continuous sound level
LNHP	Louisiana Natural Heritage Program
LPBF	Lake Pontchartrain Basin Foundation
µm	micrometer
µPa	micro Pascals
µS	microsecond
m	meter
m^3	cubic meter
MBTA	Migratory Bird Treaty Act
mcy	million cubic yard
Mgal/d	million gallons per day
mg/L	milligrams per liter
MLCC	Multi-Resolution Land Characteristics Consortium
MLG	Mean Low Gulf
mm	Millimeter
MMPA	Marine Mammal Protection Act
MPN	most probable number
mps	miles per second
MRC	Mississippi River Commission
MRD	Mississippi River Delta
MRGO	Mississippi River Gulf Outlet
MRIP	Marine Recreational Information Program
MR&T	Mississippi River and Tributaries

MSA	Metropolitan Statistical Area
N_2O	Nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAC	Noise Abatement Criteria
NAICS	North American Industrial Classification System
NAV88	North American Vertical Datum of 1988
NCDC	National Climatic Data Center
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NGUME	northern Gulf of Mexico cetacean UME
NGVD29	National Geodetic Vertical Datum of 1929
NLCD	National Land Cover Dataset
NMFS	National Marine Fisheries Service
NO	nitrogen oxide
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOV-NFL	New Orleans and Vicinity Non-Federal Levee
NO_x	Nitrous oxides
NPS	National Park Service
NRC	National Research Council
NRHP	National Register of Historic Places
NSA	Noise Sensitive Area
NS&T	National Status and Trends
NTU	nephelometric turbidity unit
NWI	National Wetland Inventory
NWIS	National Water Information System
NWR	National Wildlife Refuge
O_3	Ozone
OCM	Office of Coastal Management
ODMDS	Ocean Dredged Material Disposal Site
ozone	O_3
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PBR	Potential Biological Removal
PCB	polychlorinated biphenyl
$PM_{2.5}$	fine particulate matter
PM_{10}	respirable particulate matter
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
psi	pound per square inch

psu	practical salinity unit
PTS	permanent threshold shifts
RCPs	Representative Concentration Pathways
REC	recognized environmental condition
RIA	Regional Implementation Agreement
RL	received level
RM	River Mile
RMS	root-mean-square
R.S.	Revised Statutes
RSLC	relative sea level change
SAV	submerged aquatic vegetation
SEL	sound exposure level
SEL_{cum}	cumulative sound exposure level
SIC	standard industry code
SIP	State Implementation Plan
SL	source level
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SONRIS	Strategic Online Natural Resources Information System
SO_x	sulfur oxides
SSA	sole source aquifer
SWP	Southwest Pass
TDS	total dissolved solids
T&E	threatened and endangered
TED	turtle excluder device
TKN	total Kjeldahl nitrogen
TL	total length
TMDL	total maximum daily load
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
TTS	temporary threshold shifts
UME	unusual mortality event
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA/NRCS	U.S. Department of Agriculture – Natural Resources Conservation Service
USEIA	U.S. Energy Information Administration
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

VOCs	volatile organic compounds
WOTUS	waters of the United States
WRDA	1986 Water Resources Development Act
YOY	young-of-year

1.0 INTRODUCTION

1.1 PROJECT AREA

The project area for the proposed Mid-Breton Sediment Diversion project (Mid-Breton project) includes the entire Breton Sound Basin and Mississippi River Delta Basin (Figure 1.1-1). The combined area of these watersheds is almost 1.2 million acres. The Breton Sound Basin is bounded by the east bank of the Mississippi River on the southwest, the Mississippi River Gulf Outlet (MRGO) on the northeast, the greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) to the northwest, and the Gulf of Mexico to the southeast. The southwest part of the Breton Sound Basin, including the Mississippi River, is located in Plaquemines Parish and the northeast part is located in St. Bernard Parish. The Mississippi River Basin, entirely in Plaquemines Parish, is located south of the Breton Sound Basin and represents the entire Bird's Foot Delta. The Breton Sound Basin includes fresh, intermediate, brackish and saline marsh types, with a general gradient of fresh to saline wetlands from northwest to southeast. These wetlands are interspersed with open water areas and submerged aquatic vegetation (SAV). The Mississippi River Delta Basin is comprised almost entirely of fresh and intermediate marsh (Sasser et al 2014).

1.1.1 Project Construction Footprint

The proposed Mid-Breton project construction footprint is contained within Plaquemines Parish, Louisiana, on the left descending bank (east) of the Mississippi River at River Mile (RM) 68.6 Above Head of Passes (AHP). The construction footprint covers approximately 400 acres, begins in the Mississippi River on the west, and is generally oriented in an east-northeast direction (Figure 1.1-2). The footprint proceeds through the batture area of the Mississippi River and will cross the Mississippi River levee and LA Highway (HWY) 39. The construction footprint then proceeds eastward across land within the area protected by the levee system (i.e., land under forced drainage not subject to regulation by Louisiana Department of Natural Resources [LDNR]) comprised of residential, agricultural, and forested areas. Continuing eastward, the project will cross the non-federal hurricane protection levee and enter scrub-shrub wetland that quickly transitions to fresh/intermediate marsh. On average, the construction footprint is approximately 2,000 feet wide and 7,500 feet long, and these dimensions vary based on location. It should be noted that the length of the channel to be constructed east of the non-federal hurricane protection levee is currently under evaluation and layout is subject to change as design progresses.

Figure 1.1-1. Breton Project Area.

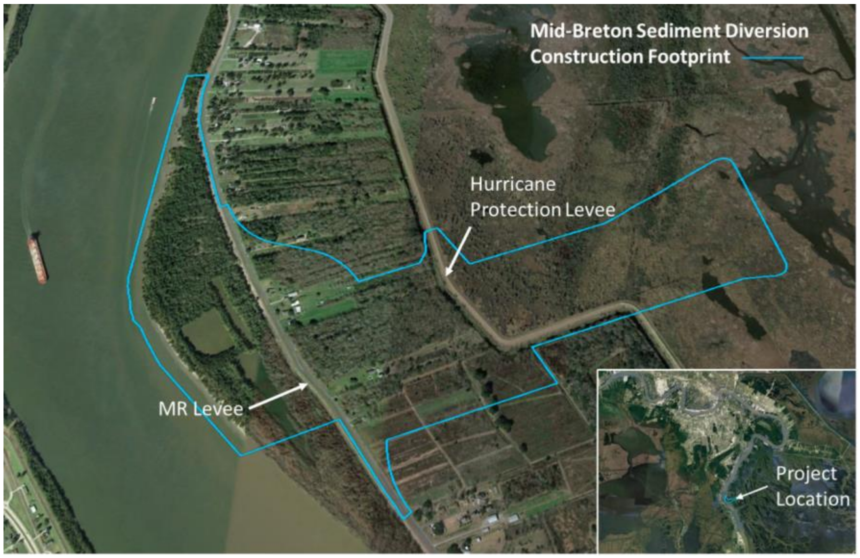


Figure 1.1-2. Breton Project Construction Footprint.

1.1.2 Overview and History of the Project Area

The mid-Breton Sound Basin and Mississippi River Delta Basin were historically hydrologically connected. Deltaic processes from the Mississippi River created the marshes, ridges, and bayous of the basins and periodic flooding nourished these wetlands. The construction of levees along the Mississippi River disrupted this process and corresponds with large increases in land loss throughout the basins.

1.1.2.1 Mississippi River

The Mississippi River is the second-longest river in North America and provides drainage to about 40% of the lower 48 states (Bahr et al. 1983). The delta of the Mississippi River is the result of 7,000 years of sediment deposition through overbank flooding. The river has switched courses to the Gulf of Mexico, resulting in a series of overlapping delta lobes (Bahr et al. 1983). This process of delta formation led to the development of numerous distributaries, creating a complex system of wetlands characterized by interspersed bayous and ridges.

The Mississippi River has long been important for navigation. In 1879, the Mississippi River Commission (MRC) was created by Congress and given legal jurisdiction over the river (USACE 2019). The great Mississippi River Flood of 1927 resulted in the 1928 Flood Control Act, which directed the MRC to create levees and floodways along the Mississippi River. The construction of these levees in Louisiana resulted in the hydrologic isolation of the river from the delta, removing its ability to provide nourishing fresh water, sediment, and nutrients to the wetlands created by the river. Along with the creation of levees, natural distributaries of the Mississippi River were cut off in order to force the water down the main channel.

1.1.2.2 Breton Sound Basin

The Breton Sound Basin is located between the Mississippi River and the MRGO, a 76-mile navigation channel connecting the Gulf of Mexico and New Orleans. Construction of the MRGO was completed in 1968. The Breton Sound Basin encompasses approximately 676,000 acres (CWPPRA 2019). Between 1932 and 2016, the Breton Sound Basin lost over 100,000 acres (Couvillion et al. 2017). The construction of these levees also removed the connection of the river to its main distributaries in the Breton Sound Basin (River aux Chenes, Bayou Terre au Boeufs, and Bayou la Loutre). This isolation has led to a lack of riverine inputs in the basin and increased salinities.

The dredging of canals for navigation and oil & gas exploration allowed for saltwater intrusion into the upper portions of the Breton Sound Basin that have traditionally supported fresh marsh. To combat the intrusion of saline water, the USACE constructed the Caernarvon Freshwater Diversion in 1991. The diversion was constructed to manage basin-side salinity within Breton Sound through controlled Mississippi River discharge into the estuary (Lopez et al., 2014). This diversion was built to allow a maximum discharge of 8,000 cfs into the basin, and is operated by the Coastal Protection and Restoration Authority (CPRA), with input from an advisory committee of stakeholders. When opened, the diversion doubles fresh water input, increasing flushing and decreasing residence time. The input changes fresh water, nutrient, and sediment supply, potentially overriding the natural seasonality within the estuary (Wissel et al. 2005). The discharge increases sheet flow over the marsh surface and can deliver large amounts of river sediments to the wetlands in the upper Breton Sound Basin (Snedden et al. 2007). However, this diversion is minimally used throughout the year, with periods when the diversion is open occurring during high river levels in the winter and spring, typically due to snowmelt and high precipitation in the upper midwestern United States (Wissel et al. 2005; Snedden et al. 2007).

In addition to Caernarvon, there are additional connections between Breton Sound and the Mississippi River south of Bohemia, including Mardi Gras Pass, the Bohemia Spillway, and the Fort St. Philip crevasse. These connections provide substantial riverine inputs into the lower portion of the basin.

A combination of anthropogenic (e.g., levee construction, dredging of canals) and natural processes (e.g., sea level rise, subsidence) have contributed greatly to the loss of wetlands in the Breton Sound Basin (CWPPRA 2019).

2.0 GEOLOGY AND SOILS

2.1 INTRODUCTION

This section provides a general description of the geology, topography, and geomorphology of the project area. It includes a discussion of the historical context and existing conditions for these resources. It also includes a general discussion of the mineral resources in the project area, including non-fuel resources and oil and gas resources. A description of these resources is provided for the project area, while a more specific description is provided for the oil and gas resources, the soils, and prime farmlands in the proposed project construction footprint.

2.2 GEOLOGY, TOPOGRAPHY, AND GEOMORPHOLOGY

2.2.1 Historical Context

The Project area is located within the central portion of the Mississippi River Delta, bounded by the current Mississippi River channel on the west and by the former St. Bernard delta lobe of the Mississippi River on the east. The modern Mississippi River Delta formed over the last approximately 7,000 years as the Mississippi River deposited sand, clay, and silt along its banks and in adjacent basins (Kolb and Van Lopik 1958). The Mississippi River Delta plain began to evolve approximately 7,500 years ago due to deceleration of sea level rise and the natural shifting of the river's course approximately every 1,000–1,500 years (Coleman et al. 1998). Over the past 7,000 years, six major delta complexes (also called "lobes") have formed, which resulted in the deposition of delta sediments throughout large areas of southern Louisiana.

The Project area has received sediments from the Mississippi River when it occupied the St. Bernard prehistoric delta complex and the Plaquemines-Balize modern delta complex. The St. Bernard delta complex formed 1,500–3,000 years ago following a change in the Mississippi River's course that relocated it to the east of present-day New Orleans. Modern-day delta development, within the past 1,500 years, formed the Plaquemines-Balize delta complex generally along the south and southwest sides of the prehistoric St. Bernard delta complex (Blum and Roberts 2012). The St. Bernard delta lobe was abandoned when the river mouth filled with sediment and the river switched to shorter, steeper routes to the Gulf of Mexico. The abandoned sediment delta (or lobes) began to subside and erode when the locus of deposition of riverine sediments moved.

Historically, the Breton Sound Basin was flushed with large quantities of fresh water and sediments during the spring. Prior to modern development, Mississippi River channel migration, crevasses, and overbank flooding deposited sediments, fresh water, and nutrients into the Breton Sound Basin, building land and sustaining freshwater wetlands. Beginning in the 1930s, flood protection levees were raised as far south as Bohemia in the Breton Sound Basin, which prevented these annual inputs of water, sediment, and nutrients (CWPPRA 2019). The combination of deprived sediment flow, creation of over 12.9 square miles of dredged canals (since 1940), and erosion of shorelines by wind-wave action has resulted in the loss of fresh water marshes and their replacement by saltwater marshes or open brackish or saltwater (Couvillion et al. 2011). One of the canals, the MRGO, was dredged to create a shortcut for commercial navigation between the Mississippi River and the Gulf of Mexico. Between 1932 and 2016, the land area in the Breton Sound Basin declined from approximately 274,000 acres to 169,000 acres (Couvillion et al. 2017). Figure 2.2-1 depicts the land area change within the project area between 1932 and 2016 (Couvillion et. al. 2017).

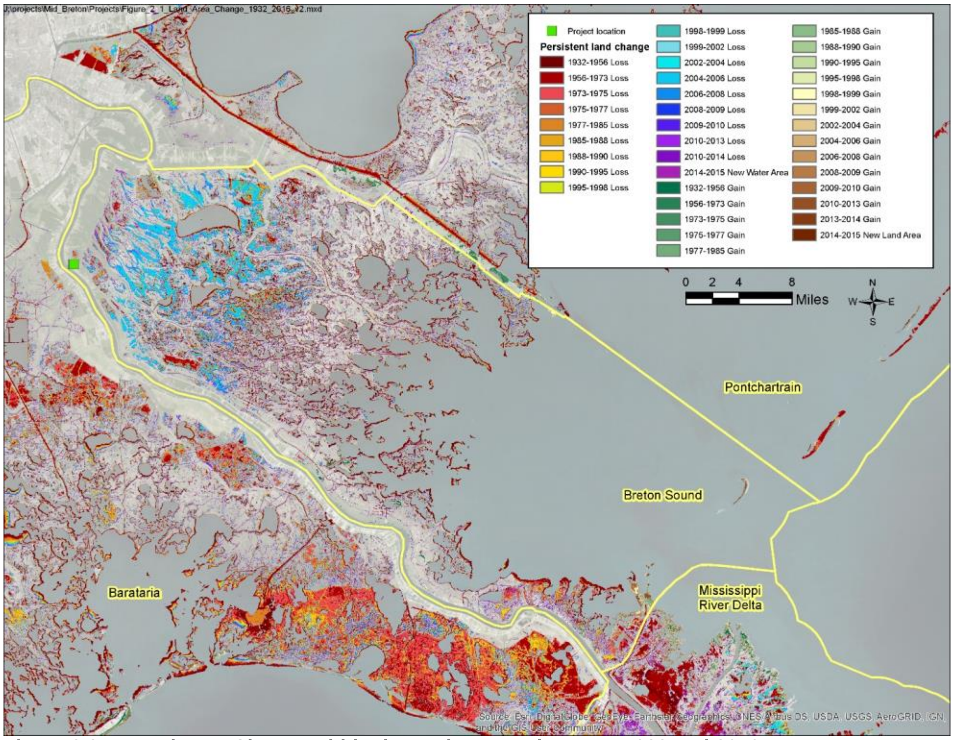


Figure 2.2-1. Land Area Change within the Project Area between 1932 and 2016.
Source: Couvillion, et at, 2017

2.2.2 Current Conditions

Surface and near subsurface geological conditions in the project area consist of natural levees, swamps, abandoned distributaries, interdistributary marshes, lakes, and bays. Sediment cores up to 16-feet in length were collected from the Breton Sound Basin (Bomer et al., 2016). The sequence of sediments found in the Mid-Breton Sound Estuary, which is immediately adjacent to the proposed project, is comprised of the following types of sediments: (1) organic-rich marsh peat at the surface, (2) interdistributary bay silts and clays at depths greater than 3 feet, (3) distributary channel sands and silts at depths greater than 6 feet, (4) pro-delta silts and clays at depths greater than 10 feet, and (5) open bay shell-rich clays at depths generally greater than 14 feet. Figure 2.2-2 shows the near-surface geologic cross section in the central section of the project area near the proposed diversion structure. The succession of sediments in the cores indicates that the sediments below the upper peat layer were deposited as crevasse splays (i.e., deposited through breaks in the natural Mississippi River levee). Splay thicknesses suggest that a levee breach occurred in the northern part of the study area and distributaries propagated in a south to southeast direction. While an open bay environment was present starting from 950 to 1,310 years ago, the ages of the peat (dated with the 14C isotope of carbon) indicated that sub-delta processes (organic marsh formation) occurred beginning approximately 470 years ago. The sandy crevasse splay deposits formed in the period between these time frames.

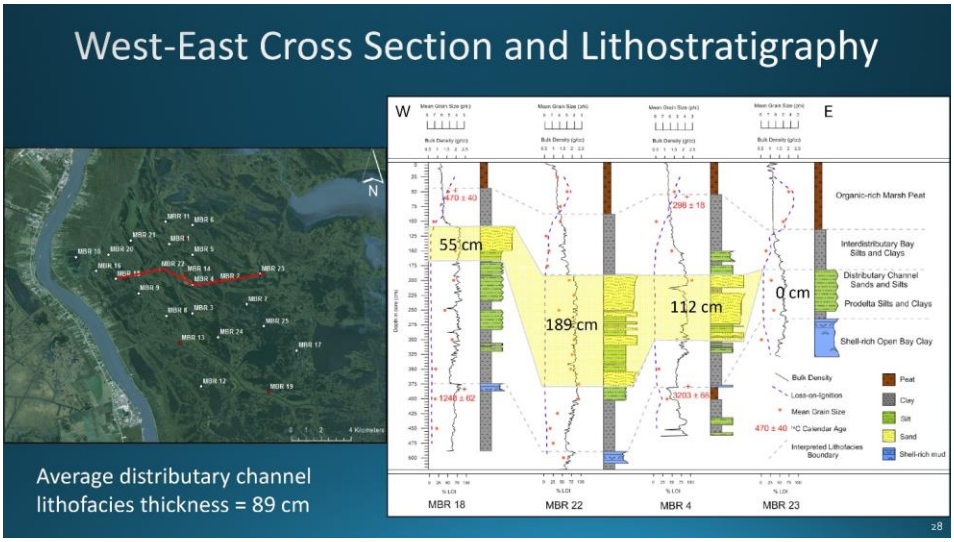


Figure 2.1-2 Geologic Cross-Section of the Project Area.

Southeastern Louisiana is located in a geological province called the Gulf Coast Salt Basin. It is underlain by a deep trough in the Earth's crust that has been filling with thousands of feet of sedimentary deposits. The Gulf Coast Salt Basin is riddled with faults (downward displacements) and salt domes related to the accumulation of sediment. The Breton Sound Basin is bounded on the south by the Golden Meadow fault zone and is bounded on the east and west, respectively, by the Pointe a La Hache and Terre Aux Boeufs structural features (Gagliano et al. 2003). Fault movement is driven by several processes: sediment loading, compaction, isostatic adjustment, migration of salt domes, gravity slumping related to river delta expansion, and tectonic movement. No salt domes were identified in the immediate area of the proposed diversion structure. Since the 1960s, the vertical movement in Southeastern Louisiana faults has been small, a few inches to 3.5 feet. The movement may be imperceptible over a period of years, but due to the low terrain in the region, the subsidence along faults has contributed to land loss.

Although faults are sometimes associated with earthquakes, the U.S. Geological Survey (USGS) estimates that peak ground acceleration of less than 2 percent of gravity would occur in the Project Area (USGS 2014). Therefore, the risk of strong ground shaking associated with the faults located in the project area is very low.

2.3 MINERAL RESOURCES

Mineral resources in the project area include non-fuel mineral resources, such as sand mines, and fuel-related resources, such as oil and gas extraction. Of these, oil and gas extraction and transmission facilities dominate the region and the project area, with significant infrastructure investment and economic importance.

2.3.1 Non-Fuel Mineral Resources

Reports from the USGS indicate that sand and gravel extraction from natural levee areas along the Mississippi River is the primary non-fuel mineral resource reported for the Breton Sound Basin (USGS 2009). The USGS identified three "Un-named Geothermal Prospects" in the northern and central sections of the Breton Sound Basin (USGS 2017b) as potential future non-fuel resources.

In addition to sand mines and sulfur production facilities, there are a number of U.S. Army Corps of Engineers (USACE)-approved contractor and government borrow pit site locations for supplying suitable materials for the Greater New Orleans HSDRRS projects. As of 2012, the USACE listed its sources of the clay material used in the HSDRRS. Nine locations within Plaquemines Parish provide clay to the USACE and are located in the Project area (USACE 2012b).

2.3.2 Oil and Gas Resources

Oil and gas production, distribution, and refining are some of the most significant industries in Louisiana and throughout the surrounding region. The project area is the location of extensive historical and ongoing oil and gas production and associated wells, pipelines, and infrastructure, as well as infrastructure associated with transportation of oil and gas from offshore to onshore processing facilities. There are dozens of well fields and thousands of wells within the Project Area. Based on review of LDNR Strategic Online Natural Resources Information System (SONRIS), there are 17,737 wells in Plaquemines Parish and 1,765 wells in St. Bernard Parish (LDNR 2019c). However, many of these wells are abandoned or otherwise no longer in use. Information from the U.S. Energy Information Administration (USEIA) indicates there are approximately 21 active gas wells and more than 145 active oil wells in the project area (USEIA 2019). Figure 2.3-1 shows the locations of active oil and gas wells within the project area.

There is one natural gas processing plant (the Toca Gas Processing Plant) located in the northern-most portion of the project area in St. Bernard Parish. The project area contains hundreds of miles of oil and gas pipelines. A review of the National Pipeline Mapping System (USDOT2019) and the USGS (National Wetland Research Center 1999) indicated over 400 miles of crude oil, petroleum product, and natural gas pipelines in the project area.

A review of the USEIA database did not identify any active gas or oil wells in the immediate vicinity of the proposed project construction footprint (Figure 2.3-1). A review of the National Pipeline Mapping System database did not identify any pipelines within the proposed project construction footprint or in the immediate vicinity of the proposed diversion structure. East-west co-located gas and hazardous liquid pipelines cross the Mississippi River approximately one mile south of the proposed project construction footprint. Similarly, an east-west hazardous liquids transmission pipeline crosses the Mississippi River approximately two miles north of the proposed project construction footprint. Figure 2.3-2 shows the locations of the pipelines in the vicinity of the proposed diversion structure.

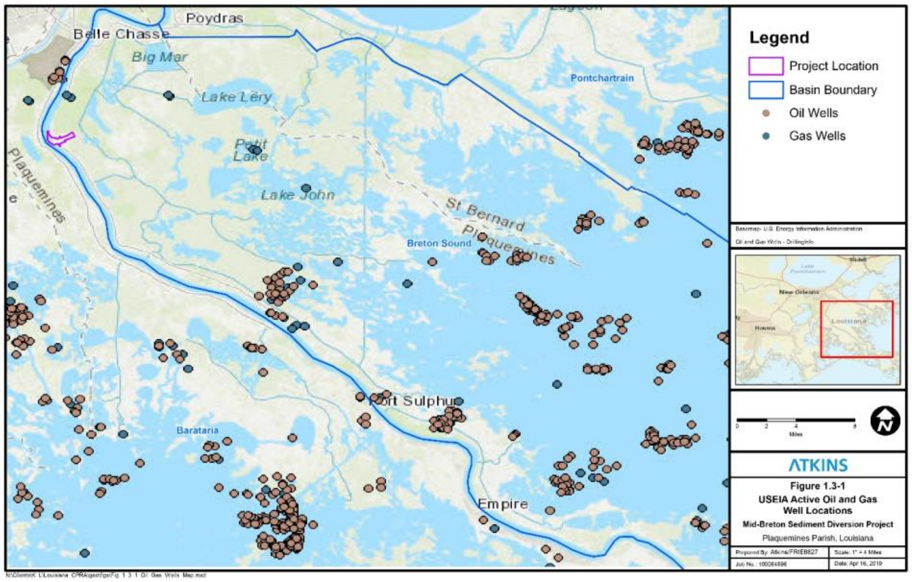


Figure 2.3-1 Active Oil and Gas Wells in the Project Area.

2.4 SOILS

Soils in the project area formed in alluvial sediments from distributary streams of former Mississippi River deltas. These soils are divided into frequently-flooded and poorly-drained soils found in marshes and swamps, soils on sandy ridges that are occasionally flooded, soils in former marshes and swamps that have been drained and are protected from flooding, and soils present on the natural levees that are more resilient to flooding. The soils in the project area were identified using the Soil Survey Geographic database (Soil Survey Staff 2019) provided by the U.S. Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). A Custom Soil Resource Report and soil map for the proposed project construction footprint were obtained from the USDA-NRCS.

There are six predominant soil types found within the proposed project construction footprint (Table 2.4-1): Clovelly muck, Cancienne silty clay loam, Carville silt loam, Carville-Cancienne-Schriever soils, Harahan clay, and Schriever clay. The remainder of the project construction footprint is water. Clovelly muck soils contain herbaceous organic material over clayey alluvium in marsh areas. They are very frequently flooded on 0 to 0.2% slopes. Cancienne silty clay loam soils consist of silty alluvium on natural levees, are somewhat poorly drained, and are found on 0 to 1% slopes. Carville silt loam soils consist of silty alluvium on natural levees, are somewhat poorly drained, and are found on 0 to 1% slopes. The Carville-Cancienne-Schriever soils are silty loam soils found on natural levees, depressions, and backswamps, all of which are frequently flooded. Harahan clay soils are poorly drained clayey alluvium materials found in backswamps on 0 to 1% slopes. Schriever clay soils are also poorly drained clayey alluvium materials found in backswamps on 0 to 1% slopes. The soil types identified in the proposed project construction footprint are shown on Figure 2.4-1. Table 2.4-1 lists the soil types found within the proposed project construction footprint**.**

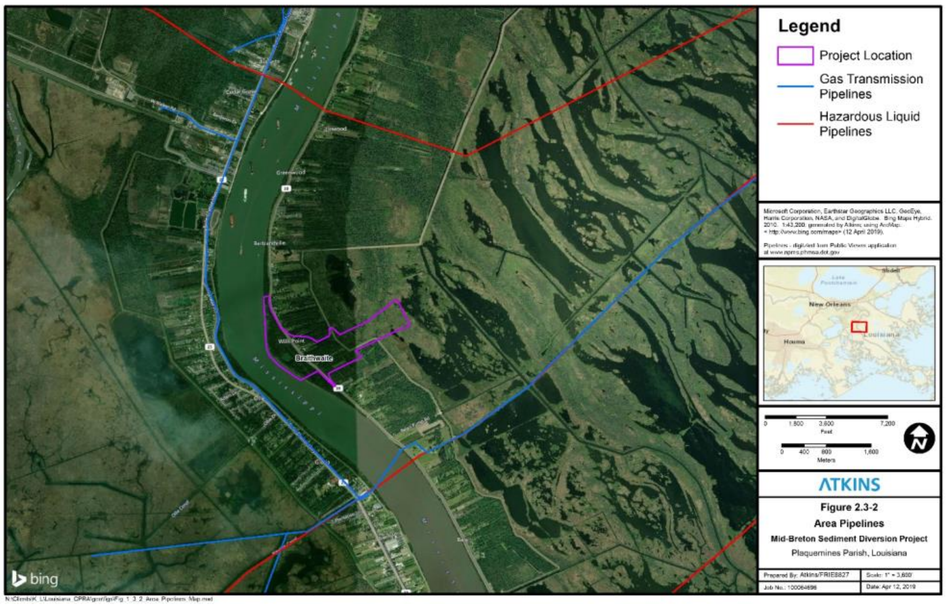


Figure 2.3-2 Pipelines within the Project Area.

The following soil types in the proposed project construction footprint have a hydric soil rating: Clovelly muck, Carville-Cancienne-Schriever soils, Harahan clay, and Schriever clay. The presence of hydric soils and water are two of the criteria used by the USACE to determine whether an area is classified as a wetland.

Table 2.4-1
Soil Types within the Proposed Project Construction Footprint

Map Unit Symbol	Map Unit Name	Acres in Project Construction Footprint	Percent of Project Construction Footprint (%)
CA	Clovelly muck, 0 to 2 percent slopes, very frequently flooded	56	14
Co	Canciennce silty clay loam, 0 to 1 percent slopes	40	10
Ct	Carville silt loam, 0 to 1 percent slopes	28	7
CV	Carville, Canciennce, and Schriever soils, frequently flooded	72	18
Ha	Harahan clay, 0 to 1 percent slopes	36	9
Sk	Schriever clay, 0 to 1 percent slopes	112	28
W	Water	56	14
TOTAL		**400**	**100**

2.5 PRIME FARMLAND

The Farmland Protection Policy Act of 1981 (FPPA) specifies that federal agencies must evaluate the effects of any activities that could result in the conversion of designated prime or unique farmland, or farmland of statewide or local importance, to non-agricultural purposes before taking any action. The USDA-NRCS identifies prime farmlands as those farmland soils that have the best combination of physical and chemical properties to produce fiber, feed, or food, and are available for these uses. Farmlands do not have to be currently in use for crop production to be subject to FPPA requirements. Areas of water, wetlands, and urbanized or previously developed land are not subject to FPPA requirements.

Areas along the inland margins of the project area, such as adjacent to the Mississippi River on higher-elevation natural levees or drained soils, are classified as Prime Farmland. However, most of the soil types in the project area are either frequently flooded or are not protected from flooding and therefore are not considered Prime Farmlands. Soil types in the proposed construction footprint that are considered Prime Farmland soils include: Cancienne silty clay loam, Carville silt loam, Harahan clay, and Schriever clay. Therefore, 54% of the proposed project construction footprint (approximately 216 acres) contains Prime Farmland soils.

3.0 SURFACE WATER, COASTAL PROCESSES, AND GROUNDWATER RESOURCES

3.1 INTRODUCTION

The following sections provide an overview of surface water features, the processes that impact water levels within the basin, and data characterizing the existing surface water conditions near the proposed diversion structure location.

3.2 COASTAL ZONE BOUNDARY

The nation's coastal areas are managed and protected according to the Coastal Zone Management Act (CZMA). Passed by the U.S. Congress in 1972, the CZMA calls for the effective management and protection of the nation's coastal resources and encourages state and local involvement to achieve these goals (NOAA 2019a). Further, the CZMA requires that participating states develop coastal management programs to implement the goals and objectives of the CZMA. In Louisiana, the Department of Natural Resources (LDNR), Office of Coastal Management (OCM) is charged with administering the Louisiana Coastal Resources Program (LCRP), established under the Louisiana State and Local Coastal Resources Management Act in 1978. Management of the Louisiana Coastal Zone (LCZ) falls within the OCM's purview as part of the LCRP (LDNR 2019a).

The spatial extent of the Louisiana Coastal Zone is shown in Figure 3.2-1 and consists of all or part of 20 parishes. In 2012, the inland boundary of the Louisiana Coastal Zone was modified by the Louisiana State Legislature, affecting 10 of the 20 parishes. The proposed project, located in Plaquemines Parish, falls entirely within the 2012 Louisiana Coastal Zone.

Figure 3.2-1. Boundary of the 2012 Louisiana Coastal Zone.

In addition, the Coastal Barrier Resource Act (CBRA; Public Law 97-348), passed by Congress in 1982, designated undeveloped coastal barriers along the U.S. coast as part of the Coastal Barrier Resources System (CBRS). The CBRA encourages the protection and conservation of hurricane prone coastal barriers by restricting federal funding that spurs development (e.g., federal flood insurance) in these areas. The U.S. Fish and Wildlife Service (USFWS) is the primary authority responsible for implementing the CBRA and monitoring the CBRS (USFWS 2019). Figure 3.2-2 shows the CBRS unit, LA-03P (Chandeleur Islands), which is closest to the project area.

Figure 3.2-2. CBRS Unit Closest to the Proposed Project.

3.3 WATERSHED CHARACTERIZATION

The proposed project is located entirely within the Breton Sound Basin. In terms of watersheds (HUC 8) defined by the U.S. Geological Survey (USGS), the proposed project partially overlaps the USGS's Eastern Louisiana Coastal and Lower Mississippi-New Orleans Hydrologic Units (HUC 8 units 08090203 and 08090100, respectively) (see Figure 3.3-1). Most of the Eastern Louisiana Coastal watershed consists of deltaic marshes, shallow-water ponds, lakes, bays, and a man-made canal system. Surface waters in the Eastern Louisiana Coastal watershed are mostly influenced by hydrological processes originating in the Gulf of Mexico.

The Lower Mississippi-New Orleans watershed consists only of the river channel itself and the adjacent levees upstream of Venice, Louisiana and branches out into coastal bays and deltaic marshes downstream of Venice. Surface water flow in the Lower Mississippi-New Orleans watershed is generally dominated by the Mississippi River itself except during very low river flows, during which time water levels are more sensitive to astronomical and meteorological tides (USACE 2010).

Both watersheds are further subdivided into smaller subbasins (HUC 12) by the USGS, as depicted in Figure 3.3-1. The three subbasins that intersect the construction limits of the project are: City of New Orleans-Mississippi River (HUC 12 unit 080901000102), Joe Brown Canal-Forty Arpent Canal (080902030505), and River aux Chenes-Forty Arpent Canal (080902030505).

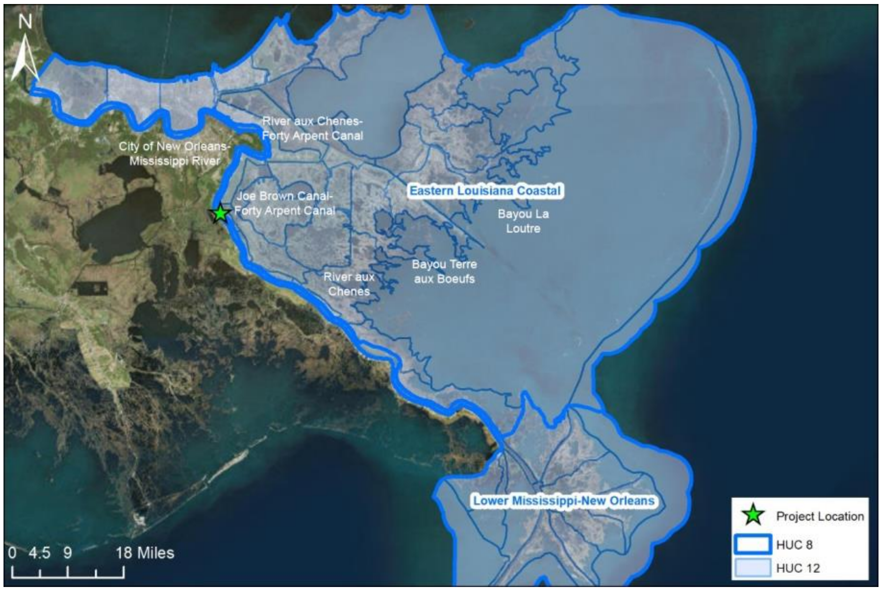


Figure 3.3-1. USGS Watersheds that Overlap the Proposed Project Location.

3.4 WATERBODIES IN THE PROJECT AREA

The Breton Sound Basin primarily consists of tidally influenced marshes connected to a large bay system and the Gulf of Mexico (Figure 3.4-1). Waterbodies within the Breton Sound Basin include many lakes (e.g., Lake Lery, Lost Lake, Grand Lake, Petit Lake, and Big Mar), a man-made canal system in the western and northern side of the basin, and several bays (e.g., Black Bay, California Bay, and Bay La Fourche) and the Gulf of Mexico in the southern and eastern side of the basin. In addition, the Lower Mississippi River forms the periphery for the western and southern side of the basin and is an important navigation channel that is regularly maintained by the USACE. The basin also contains numerous bayous, many of which are relic distributaries of the Mississippi River. The larger bayous in the Breton Sound Basin include the River aux Chenes, Bayou Terre au Boeufs, and Bayou La Loutre.

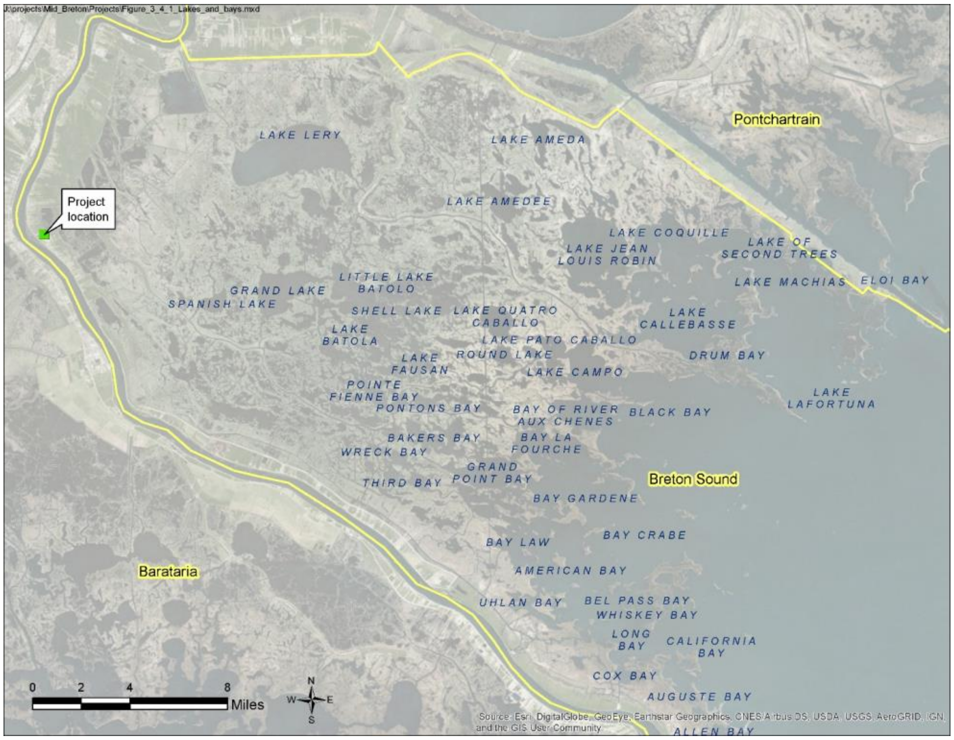


Figure 3.4-1. Lakes and Bays within the Breton Sound Basin.
Source: LDNR, 2019

3.5 HYDROLOGY AND HYDRODYNAMICS

3.5.1 Historical Context

The Mississippi River is the largest river in the United States, stretching approximately 2,300 miles and draining over 1.2 million square miles of watershed covering parts of 32 states and two Canadian Provinces (NPS 2018). Historically, the Lower Mississippi River was prone to frequent floods that caused catastrophic damage prior to the implementation of flood control measures (USACE 2010). As a result of the Flood Control Act of 1928, flood protection levees were built along the banks of the Lower Mississippi River, depriving the Breton Sound estuary of fresh water, sediment, and nutrient inputs. Flows exhibit a seasonal pattern that is linked to factors such as upstream snowmelt runoff and spring rains, leading to higher flows in the spring months. Lower flows typically occur in the summer/fall with occasional higher flows during these periods resulting from regional torrential rainfall events and/or tropical storm activity.

Additionally, there are several existing flow inputs that connect the Lower Mississippi River with the Breton Sound Basin: Caernarvon Freshwater Diversion, Bohemia Spillway (including Mardi Gras Pass), and the Fort St. Philip crevasse. The Caernarvon Freshwater Diversion is located at the northern end of the Breton Sound Basin and is designed to deliver up to 8,000 cubic feet per second (cfs) to the Basin when fully operated. In contrast, the Bohemia

Spillway is an 11-mile stretch along the east side of the Lower Mississippi River in the southern part of the Basin where the flood protection levee was removed to mimic a natural 'spillway' when water levels in the river are high. The Bohemia Spillway also includes Mardi Gras Pass, which is a newly-formed (possibly as early as 2008) channel across the spillway that has remained open and increased sustained flow exchange between the river and the estuary. Lastly, the Fort St. Philip crevasse is also at the southern end of the Breton Sound Basin and consists of natural and manmade crevasses connecting the river with the estuary.

3.5.2 Elevation Data

Figure 3.5-1 shows the elevation data for the Breton Sound Basin near the proposed Breton diversion channel via the 2014 USGS Coastal National Elevation Dataset (CoNED) Topobathymetric Digital Elevation Model (DEM). Elevations in the area are highest along the Lower Mississippi River levee system and lowest in Lake Lery. The deltaic marsh areas of the basin are generally within a few feet (above or below) mean sea level.

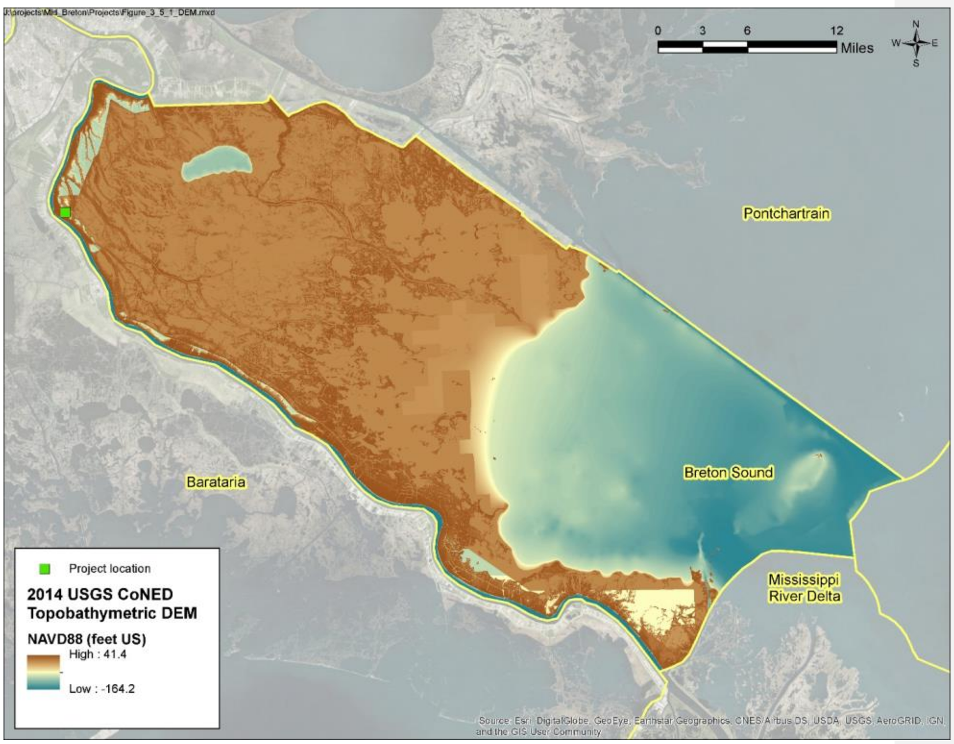


Figure 3.5-1. Elevation Data for Breton Sound Basin.
Source: OCM Partners, 2019

3.5.3 Water Levels

Multiple federal and state agencies have active water level monitoring programs spanning the Louisiana Coastal Zone, including the National Oceanic and Atmospheric Administration (NOAA), USGS, USACE, and CPRA. These monitoring programs record and catalogue site-specific water level data via a series of measurement gauges. Figure 3.5-2 below shows the location of the water level gauges closest to the project location. There are a number of gauges in the Breton Sound Basin; however, three gauges are located near the proposed diversion location (or project site) to characterize existing water levels (Table 3.5-1) and bracket both the current and future flow paths and provide a good representation of the existing water level conditions near the proposed diversion location.

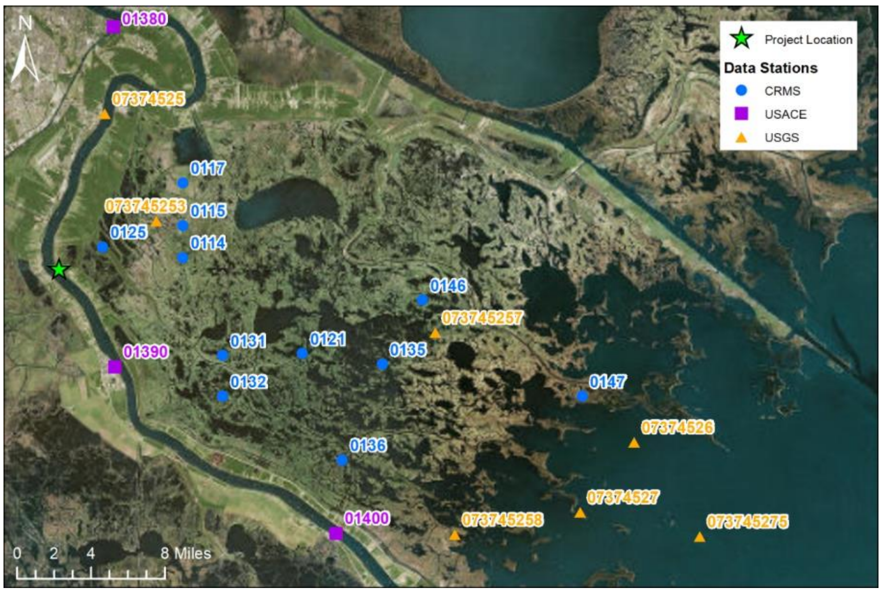


Figure 3.5-2. Location of Water Level and Flow Gauges in the Mississippi River and the Breton Sound Basin Closest to the Proposed Diversion Location.

Figure 3.5-3 shows measured water levels at each of the three gauges for a 10-year period from 2009 to 2019. A summary of the measured data is provided in Table 3.5-1. A couple observations are noted from the measured data. First, the data associated with the two gauges in the Mississippi River exhibit the seasonal behavior described in Section 3.5.1. Second, the water levels in the Mississippi River are usually higher than the water levels in Breton Sound, except during low flow periods. This suggests that there should likely be sufficient head difference across the diversion to drive flows from the Mississippi River into Breton Sound most of the time once the Mid-Breton project is constructed.

Commented [DL1]: (NEW) I suggest an additional analysis just showing the water levels within the Breton Sound Basin. So, CRMS 0125 and a couple of others spanning the length of the basin. This should help subsequent discussions in the Tides and Flow sections. Also, there should be some discussion of the factors controlling water levels within the basin. Snedden et al. (2007), Surface water hydrology in upper Breton Sound Basin.... should be a useful reference.

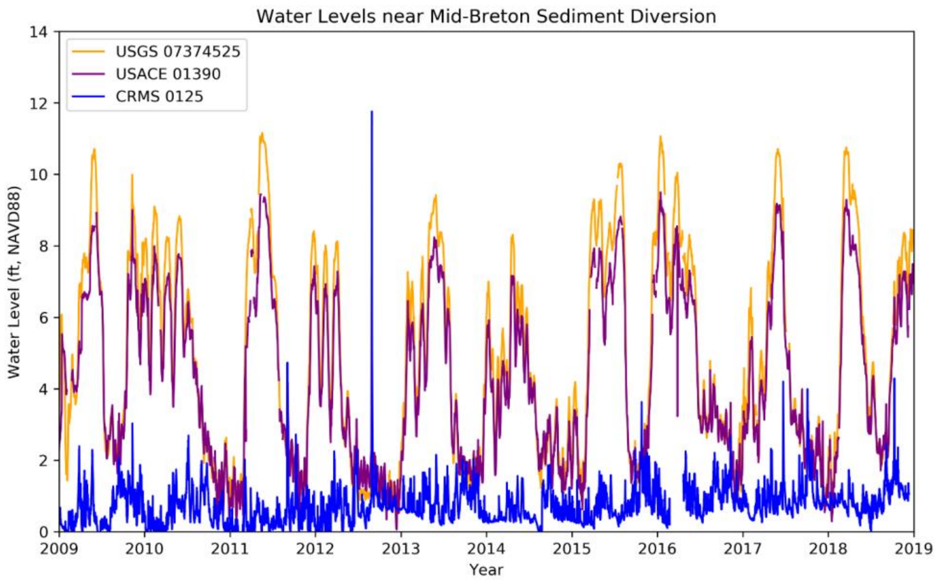


Figure 3.5-3. Measured Water Levels (2009–2019) at Data Collection Stations in the Mississippi River and Breton Sound Basin.

Table 3.5-1
Summary Water Level Data [feet, North American Vertical Datum of 1988 (NAVD88)] at Data Collection Stations in the Mississippi River and the Breton Sound Basin between 2009 and 2019

Station ID	Station Location	Average	Minimum	Maximum
USGS 07374525	Mississippi River – north of proposed project site	4.8	0.16	11.16
USACE 01390	Mississippi River – south of proposed project site	4.24	0.06	9.5
CRMS 0125	Breton Sound Basin – east of proposed project site	0.76	-0.1	11.76

3.5.4 Tides

Astronomic tides are an additional factor that influence water levels and flow in the Lower Mississippi River and Breton Sound. Tides in the Northern Gulf of Mexico are typically mixed with influence from both semi-diurnal (e.g., M2) and diurnal (e.g., K1 and O1) constituents. The tide range (difference between high tide and low tide) in Breton Sound varies slightly but is generally around 1.5–2 feet depending on the phase of the tide cycle. Further, the astronomic tide signal is dampened in the Mississippi River due to the magnitude of river flows, but during periods of low flow the tide signal tends to be more exaggerated (USACE 2010). The

Commented [DL2]: (NEW) Suggest that a figure be provided showing the tidal ranges in the Basin (see previous comment).

observed tide range at the USGS 07374525 Belle Chasse, LA gauge near the proposed diversion location can be upwards of 1 foot (USACE 2018).

3.5.5 Flow

Flows in the Breton Sound Basin can be characterized as either channelized flow or sheet/shallow flow. The Lower Mississippi River and man-made canal system exhibit channelized flow, whereas the deltaic marshes and wetlands in the estuary exhibit sheet and/or shallow flow. Flows in the Lower Mississippi River exhibit a seasonal pattern that is presumably linked to factors such as upstream snowmelt runoff and spring rains leading to higher flows in the spring months. Lower flows typically occur in the summer/fall with occasional higher flows during these periods resulting from regional torrential rainfall events and/or tropical storm activity. In the estuary, flows are dictated by local rainfall events, astronomic tides, and meteorological events originating from the Gulf of Mexico.

Discharge measurements are also available at some stations (typically USGS stations). In this case, discharge data is available at the upstream Mississippi River gauge USGS 07374525 (Figure 3.5-4; summarized in Table 3.5-2), but not at the Mississippi River gauge downstream of the project site (USACE 01390), as shown in Figure 3.5-2, to characterize flow near the proposed diversion location. Note that the pattern of the data in Figure 3.5-4 is similar to the corresponding water levels at this gauge as shown in Figure 3.5-3.

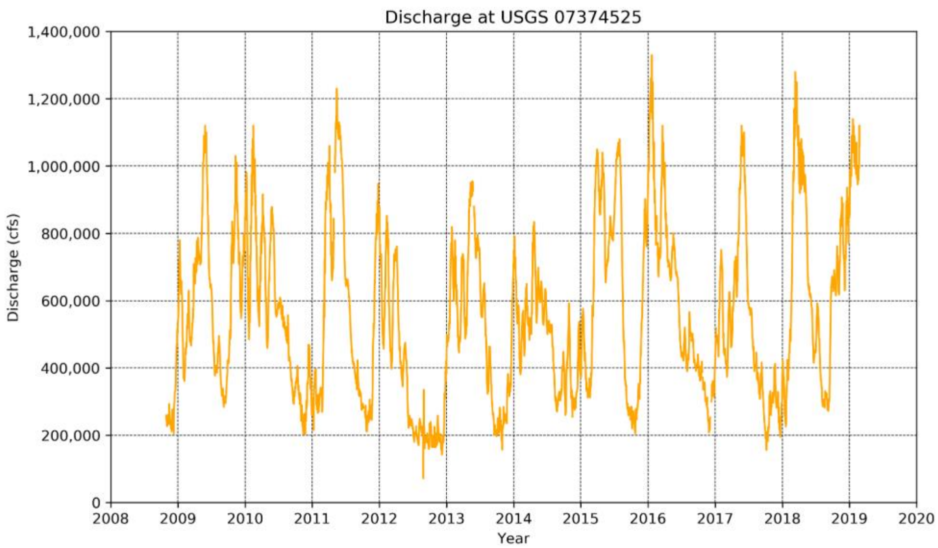


Figure 3.5-4. Measured Discharge at USGS Station 07374525.

3.5.6 Sediment Transport

3.5.6.1 Historical Context

Historically, the Mississippi River supplied the Breton Sound Basin with important freshwater, sediments, and nutrients to continually replenish and grow marsh areas within the basin. However, the construction of the flood protection levees in the Lower Mississippi River significantly reduced the naturally occurring sediment transport processes that are so important to the region. Prior to the construction of the man-made impediments, the Mississippi River was estimated to carry over 400 million tons of sediment annually (USACE 2018). Currently, the annual sediment load is estimated to be less than half the historical levels, with most of the current sediment load carried into the Gulf of Mexico, bypassing the Breton Sound Basin. This lack of freshwater, sediment, and nutrient supply, combined with persistent erosive forces (wind and wave action, storm surges, etc.) and relative sea level rise, has reduced the estuary's ability to naturally maintain wetlands and marsh areas.

The sediment transport process in the Mississippi River was reduced by locks and dams upstream, on the mainsteam and on the Missouri River. In addition, the levees on the lower river prevent sediment from entering the Breton Sound Basin through overbank flooding during periods of high river flow. Existing diversions (natural and anthropocentric) have been shown to have some benefits to wetlands in the Breton Sound Basin. This includes the Caernarvon Diversion that was primarily constructed to help control salinities in the Breton Sound Basin.

3.5.6.2 Existing Conditions

For the lower Mississippi River, the USGS has maintained a sediment data record at its Belle Chasse, LA gauge (Station ID 07374525). The Belle Chasse station was active from 1977-1997 and then reinstalled in 2007. In the lowermost Mississippi River, suspended sediment concentration and material size varies with discharge cycle (Allison and Meselhe 2010). Allison and Meselhe (2010) reviewed data from the lowermost Mississippi River, specifically, samples from the Belle Chasse gauge and samples collected near Empire, LA. They found that in December and January of 2008, at discharges below 10,000 cubic meters per second (cms), samples had reduced suspended sediment loads relative to stations that were upriver, suggesting a fallout of fines. In March, during the initial rising discharge phase, suspended loads were higher at Belle Chasse relative to upriver measurements (Allison and Meselhe 2010). Allison and Meselhe (2010) suggest that this may be due to the remobilization of bed-stored sediments. Suspended sand (> 63 micrometers, µm) loads behave differently than the fine fraction (< 63 µm). At discharges below 15,000 cms, little or no sand is in suspension (Allison and Meselhe 2010). With higher discharge there is a non-linear increase in sand load suspensions. Allison et al. (2012) reported that the average total suspended sediment load at Belle Chasse between the years of 2008 and 2010 was 88.3 million annual tons. Mud (< 62.5 µm) accounted for most of the sediment load, with an average discharge of approximately 70.5 million annual tons (Allison et al., 2012). The average sand (> 62.5 µm) discharge during this same period was 17.8 million annual tons (Allison et al., 2012).

The amount and fractional proportions of fine and coarse-grained material varies with river discharge. Sediment rating curves are site-specific, are used to estimate the amount of sediment carried in a river and are based on river discharge (Yang and Lee 2018). Traditional rating curves use a simple relationship between river discharge and suspended sediment based on a period of measured data. This method does not, however, account for the hysteresis behavior often observed in rivers. Hysteresis behavior describes the effect of a high river discharge occurring after periods of low flow; in this scenario, as the river rises, the "first flush" of sediment is resuspended and the sediment load peaks. As the river continues at a high flow rate, the sediment load is less than during this initial peak. As such, a simple relationship between river discharge and sediment load does not account for this effect (Liang et al. 2016).

In analyzing sediment load and discharge data collected at Belle Chasse between 2009 and 2015, The Water Institute of the Gulf developed a new sediment rating curve that captured the hysteresis effect (Liang et al. 2016). This new sediment rating curve for the Mississippi River at Belle Chasse is able to more accurately predict sediment load in the river near the proposed Mid-Breton diversion by accounting for the “first flush” effect on the rising limb. This method requires continuous discharge data as it incorporates discharge from the previous 120 days to incorporate the rising/falling limb effect.

3.6 STORM SURGE AND FLOODING

3.6.1 Floodplains

The Federal Emergency Management Agency (FEMA) is responsible for developing and implementing Flood Insurance Rate Maps (FIRMs) in coastal areas throughout the United States and its territories. FIRMs depict the flooding associated with the 1-percent annual exceedance probability risk level (100-year return period) and the base flood elevations and flood zones vary by location.

In Southern Louisiana, the dominant flood-causing mechanism is storm surge associated with tropical storms (hurricanes). For example, the spike in the CRMS 0125 water levels during 2012 (Figure 3.5-3) corresponds to the Hurricane Isaac storm surge. Multiple factors affect the severity of flooding associated with hurricane storm surge, including storm track, landfall location, forward speed, storm intensity, and storm size. A detailed technical analysis that factors in the sensitivity of flooding due to changes in these parameters is required to develop accurate FIRMs in hurricane prone areas. Most FIRMs in Southern Louisiana have either been updated in the past decade as a result of detailed coastal flood studies using state-of-the-art numerical modeling techniques or are in the process of being updated. In the case of Plaquemines Parish, the FIRMs are in the process of being updated, with the most recent preliminary FIRMs issued on February 26, 2019[1].

3.6.2 Eustatic Sea Level Change

Along most of the U.S. coastline, sea levels are increasing, and most estimates predicting the rate of sea level rise to increase in the future. In Louisiana, this effect is exacerbated due to local land subsidence, which is the gradual downward settling or sinking of the earth’s surface relative to a vertical datum. The combined effect of global sea level rise and local subsidence is termed relative sea level change (RSLC).

As part of the 2017 Coastal Master Plan (CMP), CPRA evaluated a range of future sea level conditions when considering project alternatives. Figure 3.6-1 below was obtained from the 2017 CMP (Figure 3.6 in CPRA, 2017). The green bar shows the range of future eustatic sea level conditions (by year 2100) incorporated into the CMP evaluation. Three scenarios were evaluated: low (approximately 3.1 feet), medium (4.9 feet), and high (6.5 feet) (note that the

[1] Status of the Preliminary FIRM: On August 21, 2019, FEMA issued a public notice inviting comments or appeals of the Preliminary FIRMs. The comment/appeal period runs through December 16, 2019. (FEMA, 2019).

values listed are an interpretation of the data shown in Figure 3.6-1). However, as noted in the 2017 CMP, these future scenarios are not exact predictions of what will happen, rather they provide insight into the uncertainty associated with planning for future conditions.

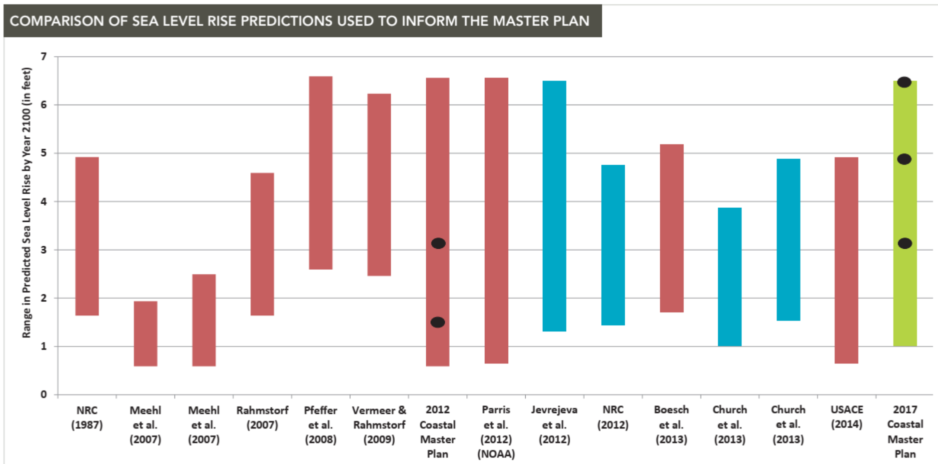


Figure 3.6-1. Eustatic Sea Level Change at USACE Station 01400 (Mississippi River at West Pointe a la Hache, LA).

Commented [JB3]: From my reading of the CMP, this graph shows eustatic sea level rise.

Subsidence can be added to each of these numbers. This calculation can be done using the CMP appendix c2-2 subsidence and figure 3.7 of the CMP.

3.6.3 Storm Hazards

Storm surge levels vary greatly depending on each storm's track and strength, but southern Louisiana experiences effects from tropical storms relatively frequently. In this case, a tropical storm is defined as a low-pressure cyclonic storm event that originates in tropical regions and is often referred to as a hurricane, typhoon, or tropical cyclone. According to NOAA's International Best Track Archive for Climate Stewardship (IBTrACS) database (https://www.ncdc.noaa.gov/ibtracs/), 65 tropical storms have passed within 60 miles of the proposed project site since 1855, which averages to approximately one tropical storm event making landfall near the proposed diversion location every 2.5 years.

3.6.4 Stormwater Management and Drainage

The dominant stormwater management features near the project area include flood protection levees, drainage canals, and stormwater pumps. The main residential areas in the upper part of the Breton Sound Basin are generally low-lying and located between levees protecting the properties against flooding from the Mississippi River as well as storm surge flooding from the Gulf of Mexico. In these areas, stormwater runoff enters a man-made canal drainage system that then transports the water to collection points for forced pumping into the Breton Sound estuary. Cable et al. (2007) documented pump stations at Bellevue, Braithwaite, Pointe a La Hache, and Scarsdale in the upper Breton Sound Basin that are used for local storm water management. The pumps are either on at full capacity or turned off and generally operated simultaneously. The proposed Mid-Breton project cuts through the sub-basin that relies on the Scarsdale and Braithwaite pumps for storm water management.

3.6.5 Risk Reduction Levees

The Mississippi River and Tributaries (MR&T) levee system is within the project area. It was constructed from 1917 to 1973 to provide flood protection for neighboring communities during high river flow events. Near the proposed project site, the levees generally follow a north-south alignment along the banks of the Mississippi River (USACE 2018). The levees were initially constructed to a design crest elevation of 16.25 feet,[2] but the current crest elevation near the diversion location is approximately 15.5[1] feet due to subsidence and settlement of the levee over time (USACE 2018). The MR&T levees are designed to contain flows up to 1.25 million cfs. Figure 17.4-1 shows the risk reduction levees relative to the location of the proposed project site.

3.7 GROUNDWATER RESOURCES

3.7.1 Introduction

In coastal areas of southeastern Louisiana, groundwater supplies are generally limited and surface water is primarily used. The project study area for groundwater resources is Plaquemines Parish in the Breton Sound Basin. There are no major sources of fresh groundwater (water with a chloride concentration of 250 milligrams per liter [mg/L] or less) in Plaquemines Parish. Limited so urces of fresh groundwater could be available from shallow aquifers (point-bar and natural levee deposits) at depths generally less than 140 ft below the National Geodetic Vertical Datum of 1929 (NGVD29), but these sources generally have not been developed or well documented. The components of groundwater discussed in this section include the underlying aquifers and groundwater usage (i.e., extraction and public and private water supply wells).

3.7.2 Aquifers

Aquifers along the coast typically contain saltwater that extends inland as a wedge along the base of the aquifer. Coastward, the saltwater wedge typically thickens and the overlying fresh water thins until the entire thickness of the aquifer contains saltwater. Salty groundwater is often defined as water containing a chloride concentration greater than 250 mg/L or a dissolved solids concentration greater than 1,000 mg/L. Pumping can lower fresh groundwater elevations and promote lateral and/or vertical saltwater encroachment into the aquifer.

The water table is at or near the surface throughout most of the coastal zone. The silt- and sand-rich depositional environments such as point bar, intradelta, natural levee, beach, and

[2] Reference does not specify vertical datum.

near shore gulf are generally connected hydraulically to the adjacent water body (i.e., river, lake, distributary channel) and the elevation of the water table in these deposits reflects the level/stage of the adjacent water body. This is especially true in deposits adjacent to the Mississippi and Atchafalaya Rivers.

Plaquemines Parish lies within the Coastal Lowlands Aquifer System, which underlies most of the Gulf Coastal Plain, extending from the Rio Grande River in west Texas to the panhandle of Florida (Renken 1998; USGS 2003). This aquifer system is a complex sequence of mostly unconsolidated beds of sand, silt, and clay deposited under fluvial, deltaic, and marine conditions. The sequence, which ranges in age from the Oligocene to Holocene epochs (approximately 34 million years ago to present), is generally wedge-shaped and thickens progressively seaward towards the Gulf of Mexico, where it is more than 2.7 miles thick (Renken 1998).

The U.S. Environmental Protection Agency (EPA) defines a sole source aquifer (SSA) as one where the aquifer supplies at least 50 percent of the drinking water for its service area and there are no reasonably available alternative drinking water sources should the aquifer become contaminated (U.S. EPA 2017). There are no SSAs within the project study area.

3.7.3 Groundwater Use and Extraction

Prior to 2001, there was no statewide groundwater law, other than a 1972 law authorizing the Louisiana Department of Transportation and Development (LDOTD) Department of Public Works to regulate wells drawing more than 50,000 gallons per day. In 2001, Act 446 provided for a commission and a task force to develop comprehensive ground water law. Act 446 also defined “critical groundwater area” and provided for a process for designation of these areas. In 2003, Act 49 (Louisiana Revised Statutes [R.S.] 38:3097.1-3097.6) modified or eliminated provisions of earlier laws and became the basis for groundwater law in Louisiana. Louisiana’s groundwater and its management is described in Title 43, Natural Resources, Part VI, Water Resource Management, Subpart 1, Ground Water Management (Ecology and Environment 2011).

In 2010, about 85.1 million gallons per day (Mgal/d) of water were withdrawn in Plaquemines Parish, Louisiana. Surface water sources (approximately 85.03 Mgal/d withdrawn from the Mississippi River and 0.05 Mgal/d withdrawn from miscellaneous streams and ponds) accounted for almost all withdrawals; groundwater sources accounted for only 0.04 Mgal/d. Industrial use accounted for about 92 percent of the total water withdrawn. Other categories of use included public supply, rural domestic, and livestock (Ecology and Environment 2011).

3.7.3.1 Public and Private Water Supply Wells

State well-registration records for Plaquemines Parish in 2009 listed only one active water well (Pl-13) screened in the natural levee deposits of the Mississippi River; however, this well is not within a 0.5-mile radius of the proposed construction footprint boundary (GeoSearch 2019c). Water well Pl-13 is a domestic well drilled in 1957 at a depth of 30 feet below land surface. Water from the well had a chloride concentration of 31 milligrams per liter (mg/L) in 1962 (USGS 2013). According to USGS National Water Information System inventory data and statewide water well registration data maintained by LDNR, Office of Conservation, no water supply wells occur within the vicinity of the proposed construction footprint (GeoSearch 2019c).

4.0 SURFACE WATER, GROUNDWATER, AND SEDIMENT QUALITY

4.1 INTRODUCTION

This section characterizes the water quality for existing surface and groundwater resources, as well as sediment quality within subsegments of the Mississippi River Delta Basin and Breton Sound Basin (project area).

The Louisiana Department of Environmental Quality (LDEQ) monitors the quality of Louisiana's surface and groundwater resources through extensive sampling programs. Section 303(d) of the Clean Water Act (CWA) requires states to identify waterbodies that are impaired or in danger of becoming impaired due to exceedances of federally approved water quality standards. The State of Louisiana and the EPA have established surface water quality standards, described below, to provide a metric to assess ambient water quality conditions (Louisiana Administrative Code (LAC) 33: IX.1101). The LDEQ divides waterbodies into subsegments for water quality assessment purposes. Seven designated uses were established for surface waters in Louisiana: agriculture (irrigation and livestock watering), primary contact recreation (swimming), secondary contact recreation (boating), fish and wildlife propagation (fishing), drinking water supply, outstanding natural resource, and oyster propagation (LAC 33:1X.1111.A).

If a waterbody subsegment does not meet water quality criteria appropriate for its designated use, then it is designated as "impaired" with respect to those constituents for which criteria are not met. The development of a total maximum daily load (TMDL) is most often the next step in the process. A TMDL is a determination of the maximum amount of a given pollutant that a waterbody can receive and not exceed the water quality standards for its designated use. Based on LDEQ's most recent water quality assessment (LDEQ 2018), a summary of the suspected causes and sources of impairment for impaired subsegments of the Mississippi River Delta Basin and Breton Sound Basin is provided below.

4.2 WATER QUALITY STANDARDS AND DESIGNATED USES

4.2.1 Mississippi River

The location of the proposed project is along subsegment LA070301_00 of the Mississippi River (Figure 4.2-1). This segment, extending from Monte Sano Bayou in Baton Rouge southeast to Head of Passes, is listed by LDEQ as fully supporting its designated uses, which include primary contact recreation, secondary contact recreation, fish and wildlife propagation, and drinking water supply.

4.2.2 Breton Sound Basin

For water quality management purposes, LDEQ included Breton Sound within the Lake Pontchartrain Basin (Figure 4.2-1). There are 287 subsegments within the Lake Pontchartrain Basin, 260 of which are listed as either not supporting designated uses for swimming, boating, fishing, outstanding natural resource, or oyster propagation, or do not have sufficient data to make a determination.

There are no LDEQ-designated subsegments within the vicinity of the proposed project site. Nearby subsegments located within the project area (Figure 4.2-1) and downstream from the proposed diversion structure, such as LA042102_00 (River Aux Chenes; also called Oak

River), LA042103_00 (Bayou Gentilly from Bayou Terre Aux Boeufs to Petit Lake), LA042104_00 (Petit Lake), and LA042105_00 (Lake Lery), are used below to characterize the area closest to the proposed project (see Figure 4.2-1). Each of these subsegments are listed by LDEQ as fully supporting their designated uses for swimming, boating, fishing, and oyster propagation.

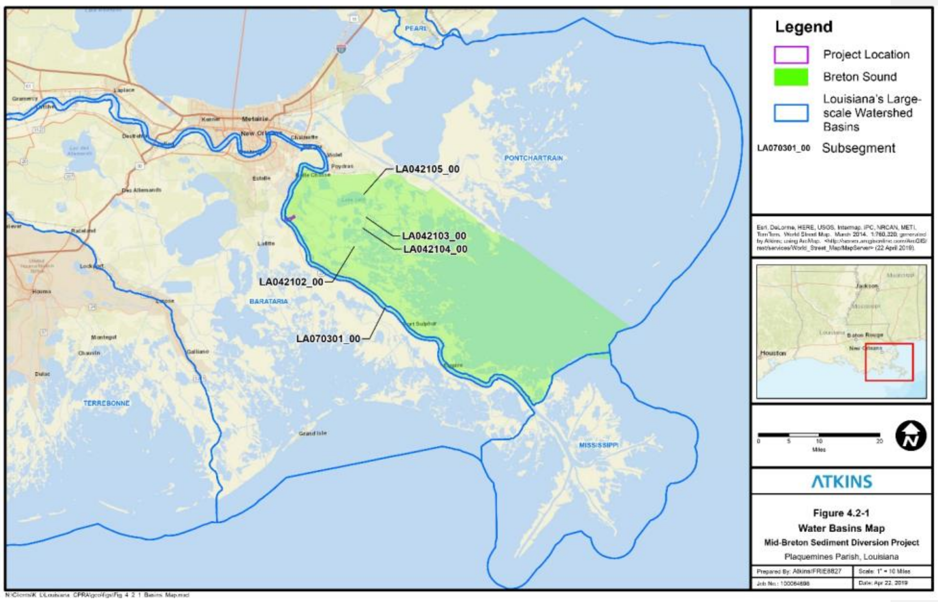


Figure 4.2-1 LDEQ Water Quality Management Subsections in the Project Area.

4.3 AMBIENT WATER QUALITY, INCLUDING SALINITY

This section provides descriptions of selected parameters of the ambient water quality conditions of the project area, based on available data from the USGS National Water Quality Monitoring Council (USGS 2019) and the LDEQ Ambient Water Quality Data Portal (LDEQ 2019) (Table 4.3-1). These data were gathered for the water quality stations representing the subsegments within Lake Pontchartrain Basin that are in Breton Sound (see Section 4.2 shown and Figure 4.3-1); nearby stations with insufficient and outdated data were excluded from analysis. Because the proposed project has the potential to have a large effect on salinity in the Breton Sound Basin, additional data from CRMS stations were also utilized to assess current conditions and trends.

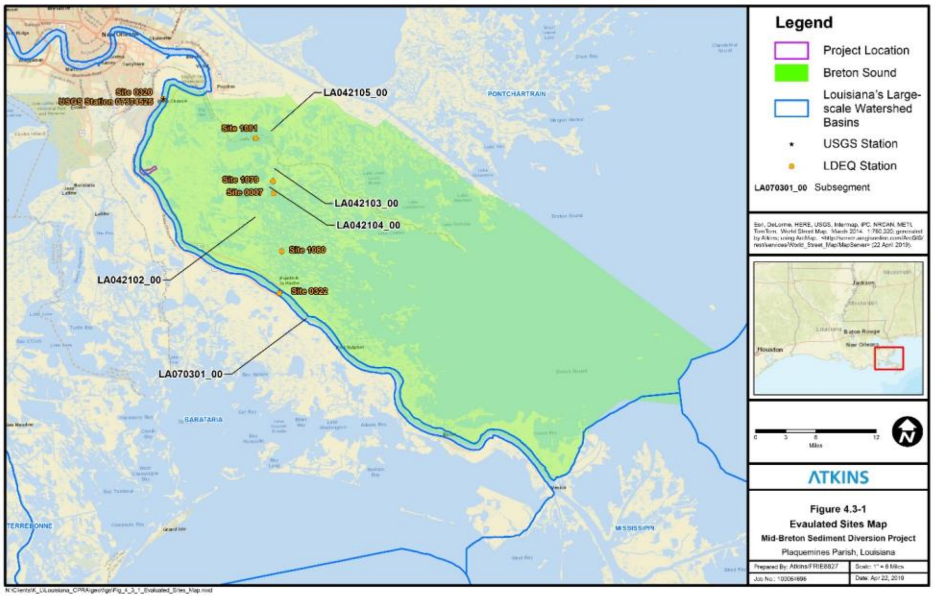


Figure 4.3-1. Water Quality Stations within Lake Pontchartrain Basin within Breton Sound.

Table 4.3-1
Ambient Water Quality Data Used to Describe Project Area[3]

Station ID	Station Description	Date Range	Data evaluated
Mississippi River			
07374525 (USGS)	Mississippi River at Belle Chasse, Louisiana	1977–2018	Specific Conductance, Temperature, Flow, Total Nitrogen, Dissolved Oxygen, Total Suspended Solids, Turbidity, Atrazine, Chloride, Sulfate, Fecal Coliform
0320 (LDEQ)	Mississippi River East of Belle Chasse, Louisiana	1966–2006	Specific Conductance, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
0322 (LDEQ)	Mississippi River Southwest of Pointe a la Hache, Louisiana	1970–1998	Specific Conductance, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Phosphorus as P, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
Lake Pontchartrain Basin Stations within Breton Sound Basin – LDEQ			
0007	Petit Lake South of Delacroix, Louisiana	1978–2018	Specific Conductance, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Phosphorus as P, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
1079	Bayou Gentilly South, Southeast of Saint Bernard, Louisiana	2001–2018	Specific Conductance, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Phosphorus as P, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
1080	Oak River Northeast of Davant, Louisiana	2001–2018	Specific Conductance, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Phosphorus as P, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
1081	Lake Lery South-Southeast of Saint Bernard, Louisiana	2001–2018	Specific Conductance, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Phosphorus as P, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform

Sources: USGS 2019; LDEQ 2018.

4.3.1 Specific Conductance

Specific conductance is a measure of the ability of a water mass to conduct electricity. Because the ability to conduct electricity varies with the concentration of ionized compounds, it is an indirect measurement of the concentration of ions in solution. It is one of the most

[3] This table includes stations that are inclusive of all water quality parameters.

frequently measured and useful water quality parameters, and it can be an indicator of salinity intrusion into fresh water or brackish water systems. It is also useful to quantify stress to aquatic communities, as many aquatic plants and organisms have an optimal salinity range. Significant fluctuations (magnitude and/or duration) above or below the optimal range can result in stress, mortality, or habitat shifts. The LDEQ has not adopted water quality standards for specific conductance.

The conversion of specific conductance to salinity incorporates both water temperature and pressure. The atmospheric pressure of surface water is 1 pound per square inch (psi); therefore, pressure does not need to be incorporated into salinity calculations. Table 4.3-2 provides a range of salinity values at 25 degrees Celsius (˚C; 77˚F [degrees Fahrenheit]) for corresponding specific conductance values.

Table 4.3-2
Specific Conductance versus Salinity at 25˚C (77˚F)

Salinity Content	Specific Conductance Range (µS/cm)	Salinity Range (ppt[a])
Fresh	<800	< 0.5
Oligohaline	800-8,000	0. -5
Mesohaline	8,000-30,000	5.0-18
Polyhaline	30,000-45,000	18.0–30
Euhaline	45,000-60,000	30.0-40
Hyperhaline	>60,000	>40

a. Parts per thousand.
Source: Cowardin et al., 1979.

Specific conductance values in the Mississippi River East of Belle Chasse (Station 0320) upstream of the proposed diversion structure ranged from 230 to 1156 µS/cm between 1966 and 2005, consistent with expected values for a fresh/oligohaline water system. Similarly, water quality samples collected at USGS Station 07374525 at Belle Chasse demonstrated specific conductance values ranging from 260 to 805 µS/cm between 1977 and 2018. Downstream of the proposed diversion structure, the most recent long-term data available indicate that specific conductance in the Mississippi River Southwest of Pointe a la Hache (Station 0322) ranged from 240 to 640 µS/cm between 1971 and 1998. Based on Table 4.3-2, this would correspond with a salinity value of 0 to 0.5 ppt (fresh water).

In the Lake Pontchartrain Basin within Breton Sound Basin, specific conductance concentrations were evaluated using data from LDEQ stations shown on Figure 4.3-1 and described in Table 4.3-3. All available data collected between 1978 and 2018 were reviewed. In summary, the Lake Pontchartrain Basin stations within the Breton Sound Basin exhibit higher and more variable specific conductance than the Mississippi River, consistent with expected values for a fresh to saline system.

Table 4.3-3
Comparison of Mississippi River and Lake Pontchartrain Basin Stations (within Breton Sound Basin)Temperature and Specific Conductance

Month	Mississippi River Average Flow[a] (cfs)	Monthly Average Temperature ºC (ºF)		Specific Conductance (microsecond, µS/cm)	
		Mississippi River[a]	Lake Pontchartrain Basin[b]	Mississippi River[a]	Lake Pontchartrain Basin[b]
January	536,025	7 (44)	11 (52)	368	7,136
February	557,544	7 (45)	12 (54)	363	4,777
March	687,611	10 (50)	18 (64)	358	5,034
April	710,400	16 (61)	25 (77)	329	6,184
May	726,329	20 (68)	25 (77)	368	6,742
June	696,667	26 (79)	29 (84)	411	6,545
July	550,789	29 (84)	30 (86)	433	6,953
August	418,288	30 (86)	30 (86)	472	6,283
September	313,789	29 (84)	31 (88)	490	7,849
October	321,071	23 (73)	24 (75)	479	9,375
November	345,811	17 (63)	18 (64)	489	11,610
December	472,889	11 (52)	14 (57)	427	8,796

a. USGS National Water Information System (NWIS) Belle Chasse Station, 1978–2018.
b. LDEQ Ambient Monitoring Stations within Breton Sound Basin 0007, 1079, 1080, 1081 (1978–2018).

4.3.2 Salinity

Salinity is a measure of dissolved salt in the water column, which can be calculated from specific conductance and water temperature. For stations in the Mississippi River, salinity data were collected by LDEQ East of Belle Chasse at Station 0320 between 1991 and 2005, and at Southwest of Pointe a la Hache at Station 0322 from 1971 to 1998 (Figure 4.3-1). Salinity values at both stations ranged from 0.1 to 1 parts per thousand (ppt). As with specific conductance, salinity concentrations at the Lake Pontchartrain Basin stations within the Breton Sound Basin were higher and more variable than the Mississippi River, supporting conditions consistent with a fresh to saline system. The LDEQ has not adopted water quality standards for salinity.

Salinity in the Breton Sound Basin has largely been managed since the construction of the Caernarvon Freshwater Diversion. Caernarvon was authorized by the Flood Control Act of 1965 and the 1974 and 1986 WRDA bills (Ko et al. 2017). The purpose of the project was to introduce water from the Mississippi River into the upper Breton Sound to enhance marsh growth, reduce marsh loss, and increase wildlife and fisheries productivity by reducing salinity. Before the construction of Caernarvon, rainfall was the predominant fresh water input into the upper Breton Sound Basin (Shaffer et al. 2009).

In 1991, the Caernarvon Freshwater Diversion was constructed by USACE near Caernarvon, LA (Figure 4.3-2). The structure consists of five box culverts with a maximum diversion capacity of 8,000 cfs (Ko et al. 2017). Caernarvon is managed by CPRA, the project's local sponsor. Annual operational plans are developed by CPRA with input from the Caernarvon Interagency Advisory Committee (CIAC). The CIAC consists of 16 representatives from various stakeholder groups. Annual management plans typically consist of setting salinity targets at specific geographic locations (isohalines) that trigger diversion operation. For example, the 2018 operational plan intended to maintain an average salinity of 15 ppt at the 15 ppt isohaline line shown in Figure 4.3-3 from December through May. From June through November, Caernarvon was operated to maintain a salinity of 5 ppt at the 5 ppt isohaline line in Figure 4.3-3. The management of the diversion at these salinities is based on data from eight USGS gauges located in the Breton Sound Basin (Figure 4.3-3).

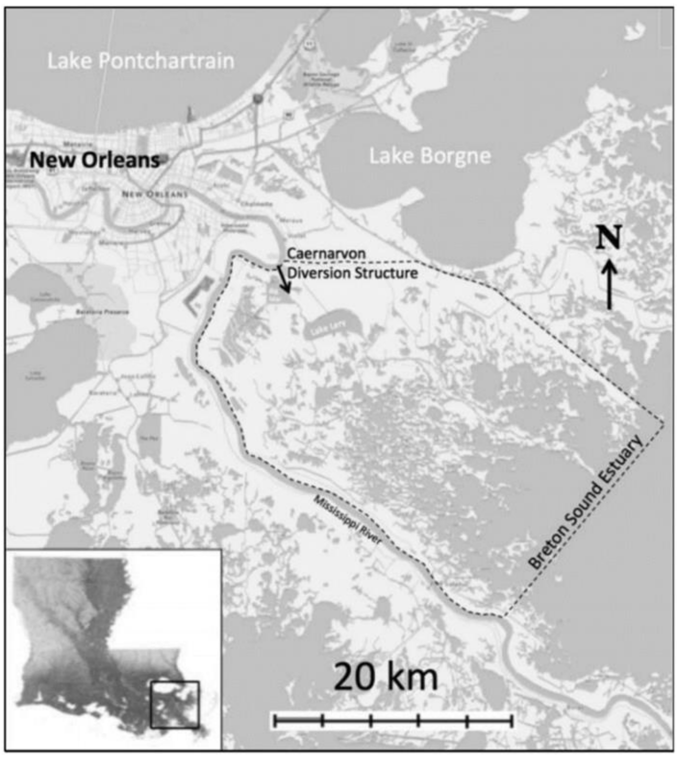


Figure 4.3-2. Location of Caernarvon Diversion Structure.
Source: Ko et al. 2017.

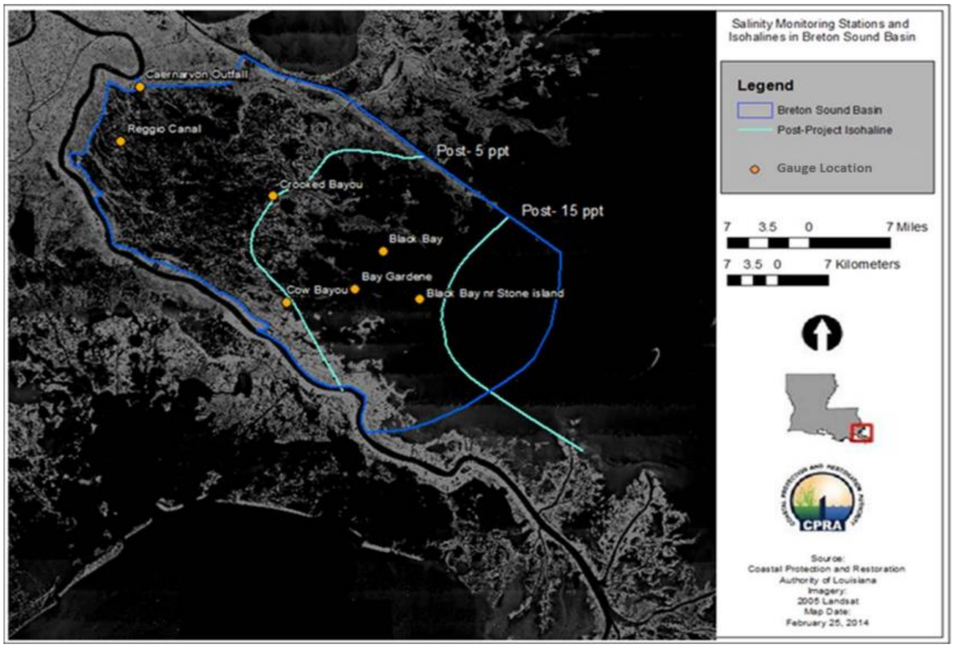


Figure 4.3-3. USGS Gauges and Isohaline Lines Used in the 2018 Caernarvon Operational Management Plan.

CPRA and USGS also monitor salinity in the Breton Sound Basin through the Coastwide Reference Monitoring System (CRMS). CRMS is a series of 390 data monitoring stations across coastal Louisiana funded by the CWPPRA program. The earliest of the 20 CRMS stations in the Breton Sound Basin began collecting salinity data in 2006. For the purposes of this assessment, 17 stations closest to the proposed project location were selected (Figure 4.3-4).

Figure 4.3-4 shows the salinity trends between 2006 and 2018 for each of these 17 CRMS stations. As one would expect, salinities in the lower basin are higher than salinities in the upper basin. Over the 12-year period, average monthly salinity ranged from 0 to 4 ppt in the upper part of the basin. In the middle basin, salinities ranged from 0 to 12 ppt. In the lower part of the basin, average monthly salinities got as high as 20 ppt, but generally peaked annually at around 15 ppt. In all regions, there is a seasonal trend of increasing salinities in the summer and fall.

Figure 4.3-4. CRMS stations in the Breton Sound Basin near the Project Location. The basin is divided into upper, middle, and lower portions in order to better present data.

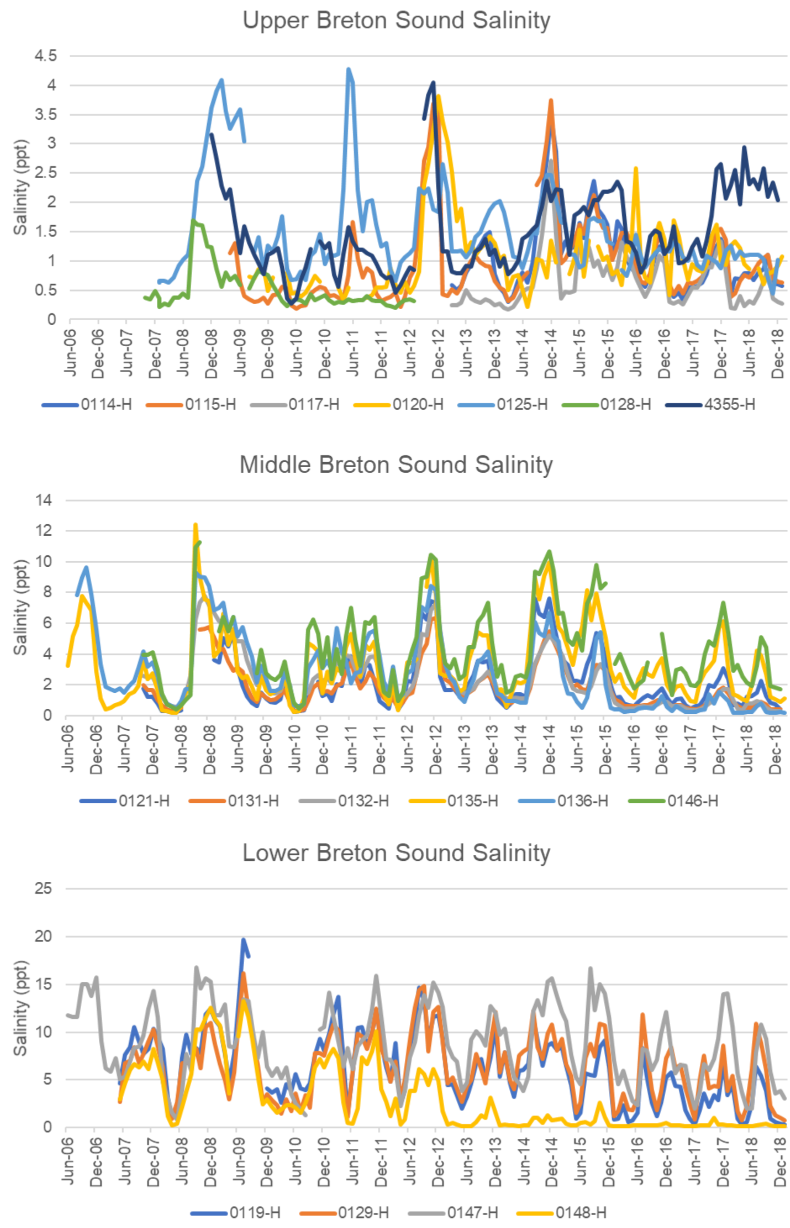


Figure 4.3-5. 2006–2018 salinities at 17 CRMS stations in the Breton Sound Basin.

In the Breton Sound Basin, there is much more connectivity between the Mississippi River and the receiving basin than exists in the Barataria Basin. This is largely due to the fact that the Mississippi River levee extends much further south in the Barataria Basin. In the Breton Sound Basin, the Mississippi River levee ends at Pointe a la Hache, below which there are connections between the river and the basin, including Mardi Gras Pass, the Bohemia Spillway, and Fort St. Philip. Fort St. Philip alone can convey more than 150,000 cfs into Breton Sound (Lake Pontchartrain Basin Foundation Hydrocoast data).

Mardi Gras Pass represents the newest connection between the Mississippi River and the Breton Sound Basin. This distributary began forming when a road along the natural levee breached during the 2011 Mississippi River flood event. Over the next year, the breach expanded and a permanent connection between the outfall canal and the Mississippi River formed. Since then, Mardi Gras Pass has expanded and represents a major point of connection between the river and the basin (Figure 4.3-6).

Figure 4.3-6. Evolution of Mardi Gras Pass between 2011 and 2016.

4.3.3 Temperature

Water temperature can directly impact biological activity and growth in aquatic plants and animals. It will also influence the decomposition and degradation rates in aquatic systems. Aquatic plants and other organisms often have a preferred temperature range in which they thrive. Temperatures that fluctuate above or below the optimal range and the optimal magnitude and/or duration may lead to stress or mortality. Numeric temperature water quality standards are defined in LAC 33:IX.1113.C.4 and 1123. Table 3 (LDEQ 2016). In general, the maximum temperature criterion in fresh water systems is 32.2°C (90°F) and the maximum criterion in estuarine and coastal waters is 35°C (95°F). Site specific temperature criteria are included in LAC 33:IX.1123 Table 3 and apply to locations in the vicinity of the proposed diversion structure.

In Mississippi River subsegment 070301, the maximum temperature criterion is 32.2°C (about 90°F); (see Figure 4.3-1 for locations of subsegments and associated sampling sites). Seasonal fluctuations in water temperature are evident with warmer temperatures during the summer months and cooler temperatures during the winter period. For example, the Mississippi River average monthly water temperature at East of Belle Chasse (subsegment 070301, Station 320) and at Southwest of Pointe a la Hache (subsegment 070301, Station 322) ranged from of 7°C (45.5°F) in January and February, to 30°C (86°F) in August between 1966 and 2005. Similarly, average monthly water temperature at USGS Station 07374525 at Belle Chasse ranged from 7°C in January and February, to 30°C in August between 1978 and 2018. LDEQ's 2018 Water Quality Integrated Report indicates that the Mississippi River subsegment within the proposed projects area meets the temperature standards criteria.

The maximum LDEQ water quality standards temperature criteria in all Lake Pontchartrain Basin subsegments evaluated within the Breton Sound Basin are 35°C (95°F). Average water temperatures at these subsegments between 1978 and 2018 ranged from 11°C (52°F) in January to 30°C (86°F) in August and did not exceed the criteria. Cooler temperatures were evident during winter (December to February) compared to summer months (June to September).

4.3.4 pH

Power of hydrogen, or pH, is a measure of the acidity of a solution. Most aquatic plants and animals are adapted to live in water with a pH between 5.0 and 9.0. Water quality standards for pH are defined in LAC 33:IX.1113.C.1 and 1123.Table 3 (LDEQ 2016). pH criteria within the Mississippi River Basin is within the range of 6.0 to 9.0, while the criteria for the subsegments evaluated in the Lake Pontchartrain Basin within the Breton Sound Basin are within the range of 6.5 and 9.0.

The monthly average pH of the Mississippi River at East of Belle Chasse ranged from 7.46 to 8.0 between 1966 and 2005. Similarly, average monthly pH levels downstream Southwest of Pointe a la Hache ranged from 7.08 to 7.91 between 1971 and 1998. pH levels at both locations remained within the criteria of between 5.0 and 9.0.

Average monthly pH at the Lake Pontchartrain Basin stations within the Breton Sound Basin ranged from 7.92 in January and 8.27 in July between 1978 and 2018 and did not exceed the criteria.

4.3.5 Nitrogen

Nitrogen is a necessary macronutrient for plant and animal growth but can be deleterious at elevated concentrations and result in eutrophic conditions. Anthropogenic eutrophication (excessive primary production due to nutrient supply from human activities) can lead to elevated phytoplankton production, which depletes the dissolved oxygen (DO) levels in the water column resulting in hypoxic conditions (low DO, see Section 4.3.7). From 2013 to

2015 the Lake Pontchartrain Basin Foundation (LPBF) conducted a series of surveys to capture the boundaries of hypoxia in Breton Sound and surrounding areas (LPBF, 2013, 2017). They found seasonal development of bottom hypoxia on an annual basis. The extent of hypoxia varied between years, in some years the hypoxia area was smaller than other years (LPBF, 2017). The size of the hypoxic zone also varied within the same season. LPBF (2017) reports that the dynamic nature of the hypoxic zone east of the Mississippi depends on the current environmental conditions, water quality, tides, currents and rainfall and may not be driven by the input of excess nutrients.

Nitrogen is available in both organic and inorganic (for example nitrate, nitrite, ammonium, and ammonia) forms. Examples of human sources of inorganic nitrogen include fertilizer, atmospheric deposition, domestic sewage, and industrial discharges. Plants and phytoplankton readily uptake inorganic nitrogen from the water column. Total nitrogen (TN) is the sum of total Kjeldahl nitrogen (TKN) and nitrate+nitrite.

Presently, Louisiana's nutrient criterion (LAC 33:IX.1113.B.8) states that the naturally occurring range of nitrogen: phosphorus shall be maintained. It is difficult to determine the naturally occurring range because many systems, including the Mississippi River and the Lake Pontchartrain Basin (including subsegments evaluated within the project area; Figure 4.3-1), were significantly impacted by anthropogenic sources of nutrients prior to the implementation of sampling programs. Louisiana is in the process of reevaluating nutrient criteria in accordance with EPA guidance. As such, EPA generated sub-ecoregion reference condition metrics for TN (0.76 mg/L) and Total Phosphorus (TP; 0.128 mg/L) for Mississippi River and Lake Pontchartrain Basin concentrations (U.S. EPA 2001). It is important to note that the reference metrics provide a numerical value to compare the Mississippi River and the Lake Pontchartrain Basin nutrient concentrations and are not intended to indicate failure to meet water quality standards.

TN was calculated using LDEQ data for the Mississippi River Southwest of Pointe a la Hache and Lake Pontchartrain Basin stations within Breton Sound Basin using available TKN and Nitrate+Nitrite values; TN data from USGS Station 07374525 for the Mississippi River at Belle Chase were also evaluated. Monthly average TN concentrations for the period of record for the Mississippi River upstream and downstream of the proposed diversion structure, and for the Lake Pontchartrain Basin stations within Breton Sound Basin, are summarized in Table 4.3-4.

Long-term data from the Mississippi River demonstrate similar TN concentrations at the Belle Chasse and Pointe a la Hache stations which, with the exception of October, are consistently higher than concentrations recorded within the Lake Pontchartrain Basin at the subsegments evaluated within the Breton Sound Basin. Average TN concentrations in the Mississippi River and at the Lake Pontchartrain Basin subsegments within the Breton Sound Basin exceed the EPA ecoregional reference concentration of 0.76 mg/L in all months (see Table 4.3-4).

In the Mississippi River at Belle Chasse, higher TN concentrations were recorded during the summer months of May–July (see Table 4.3-4). Monthly-average TN concentrations at this location in the river between 1978 and 2018 were highest in July and reached minimum levels in October. LDEQ has monitored long-term trends in TKN and NOx at Belle Chasse since 1978. TN concentrations have varied through the years with concentrations ranging from 1.6[4] mg/L to 2.7 mg/L (Figure 4.3-7; LDEQ, 2015). These data exceed the EPA ecoregional reference concentration of 0.76 mg/L in all years. At the Mississippi River Southwest of Pointe a la Hache higher TN concentrations were recorded in April–August. Data from the Lake Pontchartrain Basin stations within the Breton Sound Basin exhibit variable TN concentrations throughout the year, with greatest concentrations in October and August.

As noted above, for LDEQ stations, TN was calculated using available TKN and Nitrate+Nitrite values. A review of the raw data (LDEQ 2019) used to determine the monthly averages presented in Table 4.3-4 indicates that inorganic nitrate plus nitrite is the predominant form of nitrogen in the Mississippi River. At the Lake Pontchartrain Basin stations within Breton Sound Basin, TKN, a predominantly organic form, is the dominant form of nitrogen.

Table 4.3-4
Average Monthly Nutrient Concentrations
in the Mississippi River[a, b] and Lake Pontchartrain Basin within Breton Sound Basin[c]

Month	Mississippi River at Belle Chasse[a] TN (mg/L)	Mississippi River at Belle Chasse[a] Phosphorus as P (mg/L)	Mississippi River Southwest of Pointe a la Hache[b] TN (mg/L)	Mississippi River Southwest of Pointe a la Hache[b] Phosphorus as P (mg/L)	Lake Pontchartrain Basin within the Breton Sound Basin[c] TN (mg/L)	Lake Pontchartrain Basin within Breton Sound Basin[c] Phosphorus as P (mg/L)
January	2.1	0.27	2.1	0.18	1.3	0.12
February	2.2	0.24	2.3	0.21	1.5	0.18
March	2.1	0.27	2.3	0.21	1.3	0.10
April	2.3	0.23	2.6	0.19	1.3	0.14
May	2.4	0.23	2.7	0.22	1.2	0.11
June	2.5	0.22	2.5	0.22	1.6	0.16
July	2.9	0.27	2.5	0.22	1.4	0.18
August	2.1	0.23	2.9	0.20	1.7	0.19
September	2.0	0.17	1.9	0.15	1.4	0.16
October	1.6	0.22	1.4	0.17	1.8	0.13
November	1.8	0.22	1.8	0.14	1.2	0.10
December	2.0	0.24	2.0	0.24	1.1	0.10

a. USGS National Water Information System (NWIS) Belle Chasse Station, 1978–2018.

[4] TKN was below detection limits from 2010 to 2013; in those cases, TNK was set to the detection limit (0.5 mg/L).

Table 4.3-4
Average Monthly Nutrient Concentrations
in the Mississippi River[a, b] and Lake Pontchartrain Basin within Breton Sound Basin[c]

Month	Mississippi River at Belle Chasse[a] TN (mg/L)	Mississippi River at Belle Chasse[a] Phosphorus as P (mg/L)	Mississippi River Southwest of Pointe a la Hache[b] TN (mg/L)	Mississippi River Southwest of Pointe a la Hache[b] Phosphorus as P (mg/L)	Lake Pontchartrain Basin within the Breton Sound Basin[c] TN (mg/L)	Lake Pontchartrain Basin within Breton Sound Basin[c] Phosphorus as P (mg/L)

b. LDEQ Ambient Monitoring Station 0322 (1991–1998).
c. LDEQ Ambient Monitoring Stations within Breton Sound Basin 0007, 1079, 1080, 1081 (1978–2018).

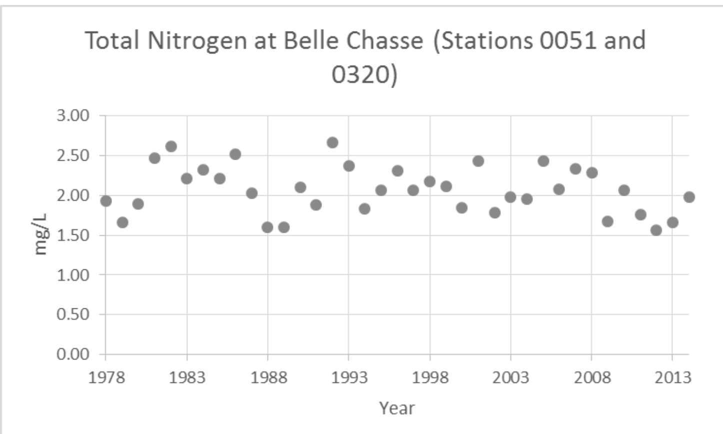


Figure 4.3-7. TN Concentrations Measured at Belle Chasse (stations 0051 and 0320).

Source: LDEQ (2015).

4.3.6 Phosphorus

Phosphorus is a primary macronutrient essential for plant and animal growth. Similar to nitrogen, phosphorus is available in organic and inorganic (for example, phosphate, ortho-phosphate) forms. The primary sources of phosphorus are mineral or anthropogenic sources such as fertilizer or sewage discharges. Excessive phosphorus concentrations can lead to eutrophication and potentially result in hypoxic conditions due to phytoplankton blooms. Phosphorus is typically measured as ortho-phosphate (soluble reactive phosphorus) and TP; TP includes both ortho-phosphate and the non-soluble phosphorus contained in plant and animal fragments. Robison and DeRosa (2014) indicated that particulate organic phosphorus is the dominant form of phosphorus within the Mississippi River.

LDEQ (2019) and USGS (2019) data for the Mississippi River and Lake Pontchartrain Basin stations evaluated within the Breton Sound Basin were limited to Phosphorus (as P) and therefore are not directly comparable to the Mississippi River ecoregional reference concentrations. Average phosphorus concentrations for the period of record for the Mississippi

River upstream and downstream of the proposed diversion structure, and for the Lake Pontchartrain Basin within the project area, are summarized in Table 4.3-4. LDEQ (2015) has reported long-term trends in TP at Belle Chasse since 1978. TP concentrations have generally declined through the years with concentrations ranging from below detection levels (0.1 mg/L) to 0.4 mg/L (Figure 4.3-8; LDEQ, 2015). Phosphorus levels in the Lake Pontchartrain Basin at subsegments evaluated within the Breton Sound Basin (collected from 1978 to 2018) were the lowest overall as compared to the Mississippi River sites.

In the Mississippi River, average monthly phosphorus concentrations are consistent with slight fluctuations throughout the year. At the Lake Pontchartrain Basin stations within the Breton Sound Basin, the highest total phosphorus concentrations were generally observed in the summer months between June and September, though February also demonstrated relatively high phosphorus levels.

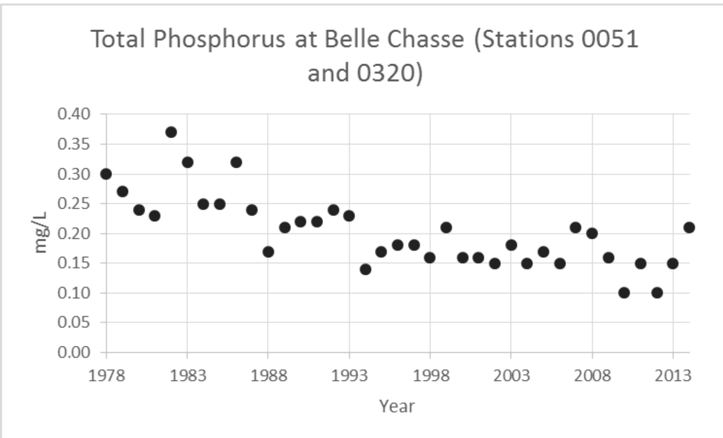


Figure 4.3-8. TP Concentrations Measured at Belle Chasse (stations 0051 and 0320). Samples from 2010 and 2011 were below the detection limit (0.5 mg/L). Data from LDEQ (2015).

4.3.7 Dissolved Oxygen

DO is a measure of the amount of oxygen that is dissolved within the water column, a requirement for most forms of aquatic life. Water temperature and specific conductance impact the DO capacity within a system. In the absence of effects from biological communities, lower DO values are observed when water temperatures are higher and are often higher when water temperatures are lower. Similarly, a more saline environment can result in lower DO values, as salinity influences the solubility of oxygen in water. In addition to these physical factors, biological processes (animal and plant respiration and organic material decomposition) utilize DO, which can in turn reduce the DO available to sustain aquatic life. Excessive nutrient (nitrogen and phosphorus) loads create algal blooms which in turn deplete DO levels due to the decomposition of the organic material. This creates hypoxic conditions, or “dead zones” that persist for a prolonged duration and can be detrimental for immobile organisms, such as oysters, which are unable to retreat to areas with higher concentrations of DO. These hypoxic events occur when DO concentrations are extremely low (less than 2 mg/L) (Rabalais et al. 1995; Rabalais et al. 2002; Turner and Rabalais 2017).

An analysis of LDEQ (2019) and USGS (2019) data showed that DO concentrations are not strongly correlated with river flow (Figure 4.3-9). Average monthly DO concentrations ranged from 5.8 mg/L (July) to 11.8 mg/L (January) at Mississippi River at Belle Chasse between 1978 and 2018, and from 5.8 mg/L (July) to 11.0 mg/L (February) at Mississippi River Southwest of Pointe a la Hache between 1972 and 1998. Individual sample concentrations have only been recorded below the water quality standard of 5.0 mg/L twice (4.6 mg/L in August 2015 and 2.7 mg/L in July 1988) at the upstream Mississippi River location since 1973 and once at the downstream location (4.7 mg/L in July 1991 since 1972).

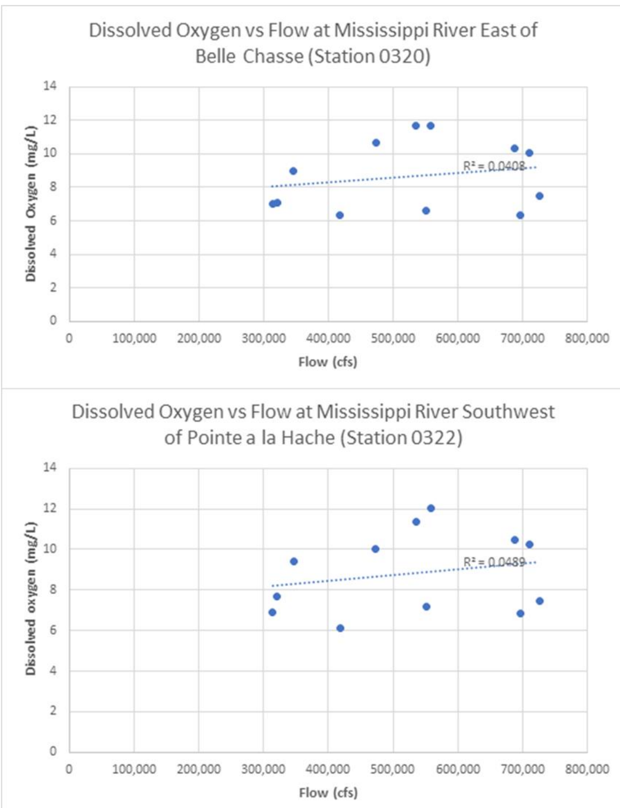


Figure 4.3-9. Relationship between Dissolved Oxygen and Mississippi River Discharge Upstream and Downstream of the Proposed Diversion Structure.

Many of the subsegments in the Lake Pontchartrain Basin have site-specific DO water quality standard criteria variably ranging from 3.0 to 5.0 mg/L (LAC 33:IX.1123.Table 3). Within subsegments near the proposed diversion structure (in the Breton Sound Basin), DO site-specific water quality standards range from 4.0 mg/L (subsegments LA042102 and LA042103) to 5.0 mg/L (subsegments LA042104 and LA042105). An analysis of the LDEQ data at the Lake Pontchartrain Basin stations within the Breton Sound Basin showed that average monthly DO concentrations ranged from 6 mg/L (July–September) to 11.5 mg/L (February) between 1978 and 2018 and have remained above 4.0 mg/L during all months since 2007. Individual concentrations fell below 4.0 mg/L in August 2001 and June and August 2007.

4.3.8 Total Suspended Solids

Total suspended solids (TSS) consist of those particles within the water column that are too large to pass through a specific pore size filter. Different methodologies suggest different filter pore sizes (e.g., EPA method 160.2, Standard Method 2540-D, American Society for Testing and Materials [ASTM] D5907). The majority of TSS particles are inorganic, consisting of clay, silt, sand, and/or gravel. TSS contribute to marsh sustainability and creation by building up existing or creating new emergent lands during deposition. Louisiana has not adopted water quality standards for TSS. While TSS is the amount of solid material suspended in water, Total dissolved solids (TDS) are those solid particles dissolved in the water. The TDS criteria within the Mississippi River Basin ranges from 400 to 700 mg/L, while those for the Lake Pontchartrain Basin range from 55 to 3,000 mg/L but are not applicable to those specific subsegments evaluated within the Breton Sound Basin (LAC 33:IX.1123.Table 3).[5]

Average monthly TSS concentrations in the Mississippi River East of Belle Chasse ranged from 20 mg/L in September to 148 mg/L in May over the period of 1966 to 2005. At Mississippi River Southwest of Pointe a la Hache, average monthly TSS concentrations ranged from 24 mg/L in September to 153 mg/L in December between 1971 and 1998. Average monthly TDS concentrations at both stations evaluated within the Mississippi River Basin remained below the criterion for the associated subsegment (400 mg/L). Average monthly TDS concentrations at Mississippi River East of Belle Chasse ranged from 230 mg/L in February to 311 mg/L in November between 1966 and 2005. Similarly, those at Southwest of Pointe a la Hache ranged from 214 mg/L in February to 327 mg/L in October between 1971 and 1998.

At the Lake Pontchartrain Basin stations within the Breton Sound Basin, the average monthly TSS concentrations over the period 1978 to 2018 ranged from 13 mg/L in December to 31 mg/L in February. Average monthly TDS concentrations ranged from 2,919 mg/L in March to 6,799 mg/L in November between 1978 and 2018. Comparatively, the Mississippi River typically has higher TSS and lower TDS concentrations than the Lake Pontchartrain Basin stations within the Breton Sound Basin.

4.3.9 Turbidity

Turbidity is an optical measure of the amount of suspended particles within the water column, which can affect water clarity. A decline in water clarity due to increased turbidity reduces light penetration within the water column, which can adversely impact primary productivity (for example, phytoplankton production). Turbidity is primarily influenced by TSS

[5] LAC 33:IX.1113.C.2. "Chlorides, Sulfates, and Total Dissolved Solids. The arithmetic mean of existing data from the nearest sampling location plus three standard deviations. For estuarine and coastal marine waters subsegments in Table 3 that have no listed criteria (i.e., designated N/A), criteria will be established on a case-by-case basis using field determination of ambient conditions and the designated uses.

and colored dissolved organic material. Louisiana has not adopted water quality standards for turbidity.

Mississippi River average monthly turbidity concentrations at the East of Belle Chasse station ranged from 21 nephelometric turbidity units (NTUs) in September to 92 NTU in March between 1966 and 2005. At Mississippi River Southwest of Pointe a la Hache, average monthly turbidity concentrations ranged from 12 NTU in September to 70 NTU in February between 1971 and 1998. Turbidity concentrations at both Mississippi River stations exhibit a positive linear trend with flow.

At the Lake Pontchartrain Basin stations within the Breton Sound Basin, the average monthly turbidity concentrations over the period of 1978 to 2017 ranged from 8 NTU in November to 26 NTU in February. Comparatively, the Mississippi River typically has higher turbidity concentrations than the subsegments of the Lake Pontchartrain Basin evaluated within the Breton Sound Basin.

4.3.10 Chloride

Chloride occurs naturally in fresh waters as a result of the dissolution of minerals. Chloride is the most common anion in seawater. Anthropogenic sources of chloride include sewage effluents and industrial wastes. In drinking waters, a chloride content exceeding 250 mg/L can affect taste. The Louisiana water quality standards for chloride are variable: in the Mississippi River at Belle Chasse and Southwest of Pointe a la Hache, the standard is 75 mg/L; in the Lake Pontchartrain Basin within the Breton Sound Basin, the standard ranges from 10 to 1,600 mg/L and is not applicable in the subsegments used to characterize the proposed diversion location (LAC 33:IX.1123.Table 3)[1].

In the Mississippi River East of Belle Chasse, average monthly chloride concentrations ranged from 25 mg/L (February–April and June) to 42 mg/L (November) between 1966 and 2005. At USGS Station 07374525 at Belle Chasse, average monthly chloride values ranged from 23 mg/L (April–May) to 45 mg/L (July) between 1978 and 2018. At Mississippi River Southwest of Pointe a la Hache, monthly chloride ranged from 22 mg/L (March–May) to 41 mg/L (November) between 1971 and 1998.

At the Lake Pontchartrain Basin stations within the Breton Sound Basin, chloride concentrations are significantly higher than in the Mississippi River, reflecting the mixing of river water with Gulf seawater. Average monthly chloride concentrations ranged from 82 mg/L (February) to 1,992 mg/L (January) between 1978 and 2018. The Lake Pontchartrain Basin data from within the Breton Sound Basin generally exhibit lower chloride concentrations in the spring and summer (March to August), and higher concentrations in the fall and winter (September to January).

4.3.11 Sulfate

Sulfates commonly occur in fresh waters as a result of the dissolution of minerals. Sulfate is the second-most common anion in seawater. Anthropogenic sources of sulfate include coal combustion residue, sewage effluents, and industrial wastes. High sulfate concentrations can cause corrosion or scaling in piping, boilers, or other public works. In anoxic environments, sulfate can be converted by bacteria to hydrogen sulfide and produce an offensive "rotten egg" odor and taste in the water. In drinking waters, sulfate may have a laxative effect. The Louisiana water quality standards for sulfate are variable: in the Mississippi River East of Belle Chasse and Southwest of Pointe a la Hache stations, the standard is

120 mg/L; in the Lake Pontchartrain Basin the standards range from 5 to 135 mg/L and are not applicable to those subsegments within the Breton project area (LAC 33:IX.1123.Table 3).

In the Mississippi River East of Belle Chasse, average monthly sulfate concentrations ranged from 42 mg/L (February) to 73 mg/L (August) between 1966 and 2005. At Mississippi River Southwest of Pointe a la Hache, average monthly sulfate concentrations ranged from 38 mg/L (February and April) to 79 mg/L (October) between 1971 and 1998.

In the Lake Pontchartrain Basin, sulfate concentrations are significantly higher than in the Mississippi River, as with chloride reflecting the mixing of river fresh water with Gulf seawater. Average monthly sulfate concentrations ranged from 233 mg/L (April) to 533 mg/L (November) between 1978 and 2018. The Lake Pontchartrain Basin station sulfate data from within the Breton Sound Basin exhibit trends generally similar to chloride with lower concentrations in the spring/summer, and higher concentrations in the fall/winter; like average chloride levels, sulfate concentrations in February were relatively low.

4.3.12 Fecal Coliform

While fecal coliform bacteria are not typically pathogenic, they are analyzed as an indicator of the potential health risk (specifically gastrointestinal diseases) of exposure to impacted waterbodies. Fecal coliform bacteria may occur as a result of sewage effluent discharges or nonpoint sources of human (e.g., on-site system overflows) and animal waste. The Louisiana criteria for fecal coliform vary dependent upon designated use. For subsegments with multiple uses in the project area, the more stringent of the following criteria apply:

- For subsegments designated for primary contact recreation, no more than 25% of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform density of 400 colonies/100 mL; and

- For subsegments designated for oyster propagation, the fecal coliform median most probable number (MPN) shall not exceed 14 fecal coliforms per 100 mL, and not more than 10% of the samples shall exceed an MPN of 43 per 100 mL for a 5-tube decimal dilution test in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

In the Mississippi River East of Belle Chasse, average monthly fecal coliform concentrations ranged from 77 MPN/100 mL (April) to 648 MPN/100 mL (September) between 1991 and 2005. At Mississippi River Southwest of Pointe a la Hache, average monthly fecal coliform ranged from 118 MPN/100 mL (April) to 628 MPN/100 mL (August) between 1991 and 1998.

At the Lake Pontchartrain Basin stations within the Breton Sound Basin (Figure 4.3-1), fecal coliform concentrations are considerably lower than in the Mississippi River. Average monthly fecal coliform concentrations ranged from 36 MPN/100 mL (May) to 226 MPN/100 mL (August) between 1978 and 2018. The Lake Pontchartrain Basin fecal coliform data from within the Breton Sound Basin do not exhibit an obvious trend but were especially high in August, likely resulting from one particularly elevated observation at site 0007 (see Figure 4.3-1) on August 11, 1981 (3,500 MPN/100 mL).

4.3.13 Atrazine

Atrazine is an herbicide commonly used in agriculture, particularly to prevent broadleaf and grassy weeds in corn, soybean, and sugarcane crops. Studies have shown that atrazine exposure can result in an alteration to the human reproductive system (ATSDR 2003). The EPA has established fresh water (1,500 µg/L) and saltwater aquatic life criteria (acute is 760 µg/L and chronic is 17 µg/L) for atrazine (U.S. EPA 2003).

LDEQ does not analyze atrazine at its ambient water quality stations and no atrazine data were available for the evaluated Mississippi River or Lake Pontchartrain Basin stations within the Breton Sound Basin. Atrazine data were available from USGS Station 07374525 at Belle Chasse (see Figure 4.3-1) from May and November of 1997 and from 2006 to 2012. Average monthly atrazine concentrations at this site ranged from 0.08 µg/L (February) to 0.67 µg/L (June), well below the acute and chronic criteria established by the EPA.

4.4 GROUNDWATER QUALITY

As explained in Section 3.7, the Breton project area lies within the Coastal Lowlands Aquifer System; however, it is not associated with any of the major fresh water aquifers (Renken 1998, USGS 2003). Groundwater of the Coastal Lowland Aquifer System becomes increasingly saline as it moves seaward due to the dissolution of aquifer minerals and sea water mixing. Groundwater movement is slow near the coast and not sufficient to flush salt water from the aquifer (Renken 1998).

The LDEQ runs an Aquifer Sampling and Assessment Program to monitor the quality of groundwater in Louisiana's major fresh water aquifers. The program samples groundwater wells across 14 aquifers on a rotational basis every three years and presents the results in a triennial report (LDEQ 2012). As the proposed diversion structure is not located within any of the 14 aquifers, no groundwater quality data are available.

The LDNR Office of Conservation has the authority to regulate groundwater usage by designating an Area of Ground Water Concern. Areas of Ground Water Concern are defined as areas where the sustainability of an aquifer is not being maintained due to either movement of a saltwater front, water level decline, or subsidence. Louisiana has three designated Areas of Ground Water Concern, all of which are in north Louisiana within the Sparta aquifer outside of the Breton project area (LDNR 2019).

4.5 SEDIMENT QUALITY

4.5.1 Mississippi River

The Mississippi River carries dissolved and suspended contaminants and bacteria that originate from a variety of municipal, agricultural, and industrial sources. The distribution of contaminants along the Mississippi River depends on the nature and location of their sources and the degree of wastewater treatment and organic contaminants such as polychlorinated biphenyls (PCBs) and inorganic contaminants such as lead, which are more likely to adhere to sediment particles than to remain in the dissolved phase (Meade 1995). The USGS summary of contaminant levels in the Mississippi River for the period 1987 to 1992 (Meade 1995) found that contaminant concentrations in suspended and bed sediments decreased from the northern to the southern regions of the drainage basin as a result of dilution with uncontaminated materials, evaporative losses, losses due to dissolution in water, chemical and microbial breakdown, and the geographic distribution of chemical discharges. While naturally occurring in sediments, the highest concentrations of contaminant metals are mostly found in coastal areas in close proximity to human activities that release metals (Kenicutt 2017).

The guidelines used to determine whether sediment contaminant concentrations might be expected to cause detrimental biological effects are called the effects range low (ERL) and effects range median (ERM) standards. The ERL is the concentration of a chemical in sediments that resulted in biological effects approximately 10% of the time based on the literature. The ERM is the concentration of a chemical in sediments that resulted in biological effects approximately 50% of the time based on the literature (Kenicutt 2017).

In support of federal navigation channel maintenance dredging projects, Mississippi River sediment quality is periodically assessed in various locations from Baton Rouge to Head of Passes (RM 0.0) to determine the presence of contaminants in river sediment and the potential for contaminant release at dredged material disposal areas, often in offshore locations. Periodic maintenance dredging, as frequent as once a year in some locations, is performed with hopper and cutterhead dredges. The USACE Mississippi Valley Division New Orleans District (CEMVN) is responsible for evaluation of proposed dredged material discharge, and the testing procedures are performed according to the Regional Implementation Agreement (RIA) for Evaluating Dredged Material Proposed for Ocean Disposal Off the Louisiana Coast (2003), as well as current national guidance jointly developed by EPA and USACE.

The RIA provides a list of potential contaminants of concern (COCs), which are EPA Priority Pollutants, to be included in the chemical analyses. COCs typically analyzed include metals, polycyclic aromatic hydrocarbons (PAHs), pesticides, total organic carbon (TOC), ammonia, organonitrogen compounds, and chlorinated hydrocarbons including, but not limited to PCBs (Table 4.5-1). Tests for physical parameters include percent solids/total solids and grain size analysis. The chemical analyses of the channel sediment and elutriate samples indicate any expected release of potential toxins from the sediment into the water column. The suspended particulate phase bioassays are designed to determine the potential impact to sensitive water column organisms from dredging and ocean placement. The solid phase bioassays are designed to determine the potential impact of the placement of the dredged material on designated sensitive marine organisms living on the bottom of the Gulf of Mexico. The bioaccumulation studies are designed to indicate any uptake of potential toxins by sensitive benthic, or bottom crawling, organisms. Physical analysis of the dredged material provides general information on the physical characteristics of the dredged material and can assist in assessing the impact of disposal on the benthic environment and the water column at the disposal site.

A review of the following recent sediment quality evaluations performed in support of Federal navigation projects provides information on the general conditions of sediment quality in the Mississippi River in proximity to the proposed diversion intake structure:

- Site Management Plan for the Southwest Pass Ocean Dredged Material Disposal Site (EPA and USACE 2017); and
- Integrated General Reevaluation Report and Supplement III to Final Environmental Impact Statement, Mississippi River Ship Channel, Baton Rouge to the Gulf, Louisiana Project (CEMVN 2018).

The 2017 Site Management Plan (EPA and USACE 2017) summarized results from the evaluation of contaminants in Southwest Pass (SWP) shoal material, reference sediment, and channel elutriates. All evaluations resulted in the detection of metals and ammonia at regional background levels and low levels of petroleum-related contaminants were found in the 2011 report. No ecologically significant bioaccumulation of contaminants was observed in sensitive benthic organisms exposed to shoal material. Similar levels of organism survival and contaminant bioaccumulation were observed between shoal material and reference sediment exposures. Exposure of sensitive water column organisms to channel elutriates did not result in significantly different survival rates than organisms exposed to laboratory-prepared dilution water. Ammonia was detected in elutriates at concentrations that may sometimes be above seasonally dependent water quality criteria.

In the 2018 assessment of the Mississippi River Ship Channel (CEMVN 2018) from Baton Rouge to the Gulf, metals were common in both solid and liquid fractions of dredge slurry from dustpan dredges performing maintenance on all maintained deep draft crossings and were detected at or below background levels in the Mississippi River. Solid samples infrequently contained low levels of chlordane pesticides and hydrocarbon exhaust products, with levels generally at or below 1 part per billion (ppb). All contaminant detects in the dredge slurry were below regulatory water quality criteria and ecological screening values.

The Mississippi River environmental assessments described above document general conditions of sediment quality in the Mississippi River in proximity to the proposed diversion intake structure, both north and south. The reports concluded that the Mississippi River sediments evaluated are free from COCs at concentrations that would result in detrimental impacts from placement of dredged sediments in either the Mississippi River or associated Ocean Dredged Material Disposal Site (ODMDS). The consistency in these findings provide some indication of the capacity of the Mississippi River to dilute both dissolved contamination and contamination bound to sediments. The interpretation of the conclusions of the above reports is limited. The quality of the sediment in the Mississippi River is dynamic and dependent upon a number of variables including the occurrence and conditions of point source and nonpoint source pollution. Nonetheless, these assessments provide a snapshot of the types and concentrations of COCs known to be present in Mississippi River sediments.

Table 4.5-1. Contaminants of Concern and Conventional Parameters.

METALS AND CYANIDE	LPAH Compounds	PESTICIDES
Antimony (Total)	Acenaphthene	Aldrin
Arsenic (Total)	Acenaphthylene	Alpha-BHC
Beryllium (Total)	Anthracene	Beta-BHC
Cadmium (Total)	Fluorene	Gamma-BHC (Lindane)
Chromium (Total)	Naphthalene	Delta-BHC
Chromium (+3)	Phenanthrene	Chlordane
Chromium (+6)		4,4'-DDT
Copper (Total)	HPAH Compounds	4,4'-DDE
Lead (Total)	Benzo(a)anthracene	4,4'-DDD
Mercury (Total)	Benzo(a)pyrene	Dieldrin
Nickel (Total)	Benzo(ghi)perylene	Alpha-endosulfan
Selenium (Total)	Benzo(b & k)fluoranthene	Beta-endosulfan
Silver (Total)	Chrysene	Endosulfan sulfate
Thallium (Total)	Dibenzo (a,h) anthracene	Endrin
Zinc (Total)	Fluoranthene	Endrin aldehyde
Cyanide (Total)	Indeno (1,2,3-cd) pyrene [2,3-o-	Heptachlor
	phenylene pyrene]	Heptachlor epoxide (BHC-
CONVENTIONAL PARAMETERS	Pyrene	hexachlorocyclohexane)
Grain Size		Toxaphene
TOC	Chlorinated Hydrocarbons	
TPH	1,2-Dichlorobenzene	PCBs
Ammonia	1,3-Dichlorobenzene	Total PCBs
Percent Solids/Total Solids	1,4-Dichlorobenzene	*PCB Congeners**
	2-Chloronapthalene	PCB-1242
ORGANIC COMPOUNDS	Hexachlorobenzene	PCB-1254
Phenols/Substituted Phenols	Hexachlorobutadiene	PCB-1221
2-Chlorophenol	Hexachlorocyclopentadiene	PCB-1232
2,4-Dichlorophenol	Hexachloroethane	PCB-1248
2,4-Dimethylphenol	1,2,4-Trichlorobenzene	PCB-1260
4,6-Dinitro-o-Cresol [2 methyl 4,6-		PCB-1016
dinitrophenol	Phthalate Esters	
2,4-Dinitrophenol	Bis(2-ethylhexyl) phthalate	Organonitrogen Compounds
2-Nitrophenol	Butyl benzyl phthalate	Benzidine
4-Nitrophenol	Diethyl Phthalate Dimethyl	3,3'-Dichlorobenzidine
p-Chloro-m-Cresol [4 chloro-3-	Phthalate	2,4-Dinitrotoluene
methylphenol]	Di-n-Butyl Phthalate	2,6-Dinitrotoluene
Pentachlorophenol	Di-n-octyl Phthalate	1,2-Diphenylhydrazine
Phenol		Nitrobenzene
2,4,6-Trichlorophenol	Halogenated Ethers	N-nitrosodimethylamine
	Bis(2-chloroethoxy) methane	N-nitrosodi-n-propylamine
MISCELLANEOUS	Bis(2-chloroethyl) ether	N-nitrosodiphenylamine
Isophorone	Bis(2-chloroisopropyl) ether	
	4-Bromophenyl phenyl ether	
	4-Chlorophenyl phenyl ether	*Optional to analyze
Source: U.S. EPA and USACE (2003).		

4.5.2 Breton Sound Basin

As part of a comprehensive review of sediment quality data in the Northern Gulf of Mexico and adjacent national estuaries, Kennicutt (2017) reviewed sediment quality data collected throughout the northern Gulf of Mexico. The NOAA National Status and Trends (NS&T) Program analyzes sediments from coastal and estuarine sites throughout the United

States, including the Gulf of Mexico. Sediments were analyzed for concentrations of PAHs, pesticides, PCBs, and metals from 13 Louisiana sites, including two locations (Bay Gardene and Sable Island) within Breton Sound (NOAA 1991). As defined in the NOAA report, high concentrations of those COCs were those values that were greater than the mean plus one standard deviation of all locations in the United States; the values according to the report identify sediments affected by human activity but don't imply biological significance. Using this definition, high concentrations of sediment contaminants were not observed at sites sampled in Louisiana from 1986 to 1989 (NOAA 1991; Kenicutt 2017).

Kenicutt (2017) also reviewed sediment contamination data from 2001 to 2002 from the seven National Estuary Program (NEP)-designated estuaries of national significance located in the northern Gulf of Mexico, including data used in the EPA National Coastal Condition Report assessments. The purpose of this analysis was to rate Gulf and estuarine sediments using a sediment quality index. The index is a composite indicator based on sediment toxicity, contaminants, and TOC content. Sediment contaminant index ratings were defined as "good" if no sampled contaminants at any sample sites exceeded ERM values and fewer than five ERL values were exceeded; "fair" if five or more ERL values were exceeded and no ERM values were exceeded; and "poor" if one or more ERM values were exceeded.

The closest evaluated estuary to the proposed diversion structure was the Barataria-Terrebonne Estuarine Complex (BTEC), which includes the western portion of the Mississippi River Delta Basin. Using the sediment quality index, the BTEC was rated good with 8% of the estuarine area rated poor. The BTEC was rated good for the sediment contaminants with 4% of the area rated poor. Two locations were rated poor mostly because of localized, elevated TOC concentrations (Kenicutt 2017).

5.0 WETLAND RESOURCES AND WATERS OF THE UNITED STATES

5.1 INTRODUCTION

The Breton Sound Basin consists primarily of wetland and shallow open water habitats. These habitats are crucial for storm protection, and a variety of other functions (e.g., nursery habitat for aquatic resources and carbon sequestration). However, as described in Section 3.0 (Surface Water, Coastal Processes, and Groundwater Resources), coastal erosion, subsidence, sea-level rise, flood protection levees, among other factors, have resulted in the loss of wetlands in coastal Louisiana. This section provides an overview of the federal wetland protection laws and regulations, wetland functions, and wetland types and a description of existing wetland types within the project area, immediate outfall area, and project construction footprint, as well as wetland loss throughout the Breton Sound Basin.

5.2 REGULATORY SETTING

Under Section 404 of the Clean Water Act (CWA), the USACE is responsible for regulating the discharge of dredged or fill material into waters of the U.S., including wetlands. Waters of the U.S. (WOTUS) include, but are not limited to, waters that are currently used, were used in the past, or may be susceptible for use in interstate or foreign commerce, including all tidal, interstate, and other waters such as lakes, rivers, streams, and wetlands that could affect interstate or foreign commerce.

The USACE and EPA jointly define wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (USACE 1987). The USACE uses three characteristics to determine if an area is a jurisdictional wetland: appropriate hydrology, hydric soils, and dominance of hydrophytic vegetation (USACE 1987). When an area meets all three criteria, it is considered a wetland.

5.3 WETLAND FUNCTIONS

Wetlands provide a diverse set of functions and provide ecological, economic, and social benefits. The ability to perform a function is influenced by the characteristics of the wetland and the physical, chemical, and biological processes in it (USACE 2017). Louisiana's coastal wetlands provide habitat for the largest concentration of over-wintering waterfowl in the U.S., as well as habitat for wildlife, finfish, shellfish, and other aquatic organisms, including threatened or endangered species. Further, they support the largest commercial fishery in the contiguous U.S., by volume (NMFS 2017). Wetlands improve water quality by removing organic and inorganic toxic materials, suspended sediments, and nutrients via plant uptake and sedimentation. Primary productivity, decomposition, and other chemical processes also contribute to the removal of certain chemicals from the water (Mitsch and Gosselink 2000). Wetlands also provide a level of flood control; wetland vegetation can attenuate waves and storm surges, and communities sheltered by wetlands may sustain less damage from storm surges (Day et al. 2007). Further, due to their anoxic, wet conditions, wetlands provide a natural environment for sequestration and storage of carbon from the atmosphere. Most wetlands are net carbon sinks when methane emissions and carbon sequestration are balanced (Mitsch et al. 2013). Louisiana's wetlands are also an area of significant oil and gas production, as approximately 11 percent of oil and gas production in the U.S. originates from Louisiana's offshore and coastal waters (Boesch et al. 1994). Finally, the various wetland types of Louisiana provide aesthetic and recreational value for human uses.

5.4 WETLAND TYPES IN THE PROJECT AREA

Breton Sound Basin is an estuary located approximately 16 miles southeast of New Orleans, Louisiana. The water bodies within the Breton Sound Basin are typically shallow, well mixed, and turbid (Wissel et al. 2005). The estuary is microtidal with meteorological events overriding these predictable tides, such as sustained, high winds (Rozas 1995). Wetlands in the Mississippi River Delta are typically classified as fresh water, intermediate, brackish, or saline based on salinities and the corresponding plant communities present (Chabreck 1972; CPRA 2017). The Breton Sound Basin mimics this general classification with its inclusion of fresh, intermediate, brackish, and saline marsh types, with a general gradient of fresh to saline wetlands from northwest to southeast (CRMS 2013). These wetlands are interspersed with open water areas and SAV.

Wetland types within the overall project area include forested, scrub/shrub, and emergent marsh wetlands, which are further classified by their salinity regimes and tidal influence. Wetland systems are generally described on the basis of the Cowardin et al. (1979) classification system and vegetation cover classifications commonly used in the entire project area (for example, Chabreck 1972, Visser and Duke-Sylvester 2017). Table 5.4-1 provides a detailed list of the vegetation species that occur in each wetland type within the Breton Sound Basin, including invasive wetland plant species (ELOS Environmental 2018b).

5.4.1 Palustrine Wetlands

As defined by the Cowardin et al. (1979) classification system, palustrine wetlands are all nontidal wetlands; they may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. This system was developed to group vegetated wetlands such as marsh, swamp, bog, fen, and prairie.

5.4.1.1 Palustrine Forested Wetlands

Forested wetlands are dominated by woody vegetation greater than 20 feet tall. In the Breton Sound Basin palustrine forested wetlands may include live oak natural levee forest, batture forest, live oak-hackberry forest, bottomland hardwood forests and swamp forests. A detailed list of vegetation species that occur in these forest types is provided in Table 5.4-1. Live oak natural levee forest and batture forest are associated typically with natural or man-made levees. Bottomland hardwood forests and swamp forests are found throughout Louisiana and are the predominant natural community type. These wetland types all provide important stopover and migration habitat for migratory birds, as well as species of greatest conservation need (Mehlman et al. 2005; Holocomb et al. 2015; ELOS environmental 2018b).

5.4.1.2 Palustrine Scrub/Shrub Wetlands

Palustrine scrub/shrub wetlands are dominated by woody vegetation less than 20-feet tall including shrub species, as well as some tree species (Cowardin et al. 1979). Scrub/shrub wetlands generally occur along the higher elevations within the basin between the marshes and bottomland hardwood forests or upland forests. These communities are often considered a regeneration stage following some type of tree canopy disturbance (LDWF 2009). However, some areas represent stable communities of shrubs and trees stunted by frequent or permanent inundation or other environmental conditions (LDWF 2009).

5.4.1.3 Palustrine Emergent Wetlands

This vegetation type occurs along the Louisiana coast in bands that roughly parallel the shoreline, with their abundance regulated primarily by the conditions in the area (ELOS Environmental 2018b). Distribution of plant species is usually related to the frequency and duration of flooding. Fresh water marshes typically have a higher species diversity compared to salt marshes (Chabreck 1972). Typical freshwater emergent species can be found in Table 5.4-1. Similar to forested and scrub/shrub wetlands, emergent marshes also support wildlife populations, providing habitat for migratory birds and nursery areas for commercially and recreationally important aquatic species, such as Atlantic croaker (*Micropogonia undulates*) (Holcomb et al. 2015; ELOS environmental 2018b).

5.4.2 Estuarine Wetlands

Cowardin et al. (1979) defines estuarine wetlands as deepwater tidal habitats and adjacent tidal wetlands that have open, partly opened, or sporadic access to the open ocean. This system includes those habitats estuaries and lagoons that may be subtidal (continuously submerged) or intertidal (exposed and flooded by tides).

5.4.2.1 Estuarine Emergent Wetlands

Emergent wetlands include fresh, intermediate, brackish, and salt marshes. Salinity regimes determine extent of these marsh types. Fresh marsh is generally found in the portion of the estuary furthest from tidal influence and where there is generally an input of fresh water.

Intermediate marshes lie between fresh and brackish marshes in estuaries, with a salinity of 0.5–5 ppt (ELOS Environmental 2018b). Brackish marshes are between intermediate and salt marshes, typically dominated by salt-tolerant vegetation with average salinity at about 8 ppt. Salt marshes are typically found closest to the Gulf of Mexico and are regularly tidally flooded with a salinity of about 16 ppt. In coastal Louisiana, salt marsh is dominated by salt-tolerant grass with few other species (ELOS Environmental 2018b). See Table 5.4-1 for typical species found in each of these estuarine emergent wetland types.

5.4.2.2 Vegetated Shallows

Vegetated shallows are permanently inundated areas that contain rooted, submerged aquatic vegetation (SAV). SAV species composition and location depend mainly on salinity, light availability, and wave action (DeMarco et al. 2018; ELOS Environmental 2018b). Throughout coastal Louisiana, small scattered beds occur that provide valuable ecosystem services. These beds support aquatic populations and serve as habitat and nursery grounds for fish and shellfish. SAV communities are typically absent from the more exposed, down-estuary regions in coastal Louisiana (DeMarco 2018). See Section 8.0 for more information on SAV and aquatic resources.

5.4.3 Open Water

Open water in the project area includes natural and dredged/excavated channels and open water ponds, lakes, or bays that are designated as deepwater habitats by Cowardin et al. (1979). These open water habitats are further classified as either lacustrine or riverine for freshwater systems and estuarine or marine for saltwater systems. Open water in the Project area may be characterized as having unconsolidated bottom, aquatic bed, or unconsolidated shore substrates (Cowardin et al. 1979).

Table 5.4-1
Common Plant Species Occurring within the Project Area by Wetland Type

Wetland Type	Scientific Name	Common Name	Scientific Name	Common Name
Batture Forest	*Acer negundo*	boxelder	*Amorpha fruticose*	Lead plant
	Platanus occidentalis	American sycamore	*Populus deltoids*	Eastern cottonwood
	Salix interior	Sandbar willow	*Baccharis halimifolia*	Eastern baccharis
	Salix nigra	Black willow		
Bottomland Hardwood Forest	*Planera aquatica*	water elm	*Acer negundo*	boxelder
	Carya aquatica	water hickory	*Acer rubrum*	red maple
	Celtis laevigata	hackberry	*Crataegus spp.*	hawthorn
	Forestiera acuminata	swamp privet	*Platanus occidentalis*	American sycamore
	Quercus texana	nuttall oak	*Arundinaria gigantea*	switchcane
	Quercus nigra	water oak	*Quercus pagoda*	cherrybark oak
	Liquidambar styraciflua	sweetgum	*Sabal minor*	dwarf palmetto
	Ulmus alata	winged elm	*Crataegus viridis*	green hawthorn
Coastal Live Oak-Hackberry Forest	*Celtis jaevigata*	hackberry	*Quercus virginiana*	Live oak
	Fraxinus pennsylvanica	Green ash	*Sabal minor*	Palmetto
	Scutellaria ovata	Heartleaf skullcap		
Cypress-Tupelo-Blackgym Swamp	*Taxodium distichum*	Baldcypress	*Acer rubrum* var. *drummondii*	Drummond red maple
	Ceplalanthus occidentalis	Buttonbush	*Fraxinus caroliniana*	Carolina ash
	Itea virginica	Virginia-willow	*Nyssa aquatica*	Typelo gum
	Nyssia biflora	Swamp blackgum	*Phanopyrum gymnocarpon*	Savannah-panicgrass
	Saururus cernuus	Lizard's tail		

Freshwater marsh	*Panicum hermitomon*	Maidencane	*Sagittaria lancifolia*	Bull tongue
	Eleocharis baldwinii	Baldwin's spikerush	*Cladium jamaicense*	Sawgrass
	Boehmeria cylindrica	False nettle	*Colocasia esculenta*	Elephant ear
	Decodon verticillatus	Swamp loosestrife	*Eleocharis quadrangulate*	Square-stem spike sedge
	Leersia hexandra	Southern cutgrass	*Nymphaea odorata*	American white water-lilly
	Sagittaria lattifolia	Broadleaf arrowhead	*Sagittaria platyphylla*	Delta arrowhead
	Schoenoplectus deltarum	Delta bulrush	*Triadenum virginicum*	Virginia marsh St. Johnswort
	Typha latifolia	Broadleaf cattail		
Freshwater submerged aquatic vegetation	*Heteranthera dubia*	Water star-grass	*Myriophyllum spicatum*	Eurasian water milfoil
	Najas guadalupensis	Southern naiad	*Potamogeton crispus*	Crisped pondweed
	Potamogeton nodosus	Longleaf pondweed	*Stuckenia pectinate*	Sago pondweed
Intermediate marsh	*Leptochloa fusca*	Sprangletop	*Panicum virgatum*	Switchgrass
	Paspalum vaginatum	Seashore paspalum	*Phragmites australis*	Common reed
	Schoenoplectus americanus	Chairmaker's bulrush	*Spartina patens*	Marshhay cordgrass
Brackish Marsh	*Sparina patens*	Marshhay cordgrass	*Sparina cynosuroides*	Big cordgrass
	Spartina spartinae	Gulf cordgrass	*Bolboschoenus robustus*	Sturdy bulrush
Brackish SAV	*Ruppia maritima*	Widgeon-grass	*Vallisneria Americana*	Eelgrass
	Zannichellia palustris	Horned pondweed	*Myriophyllum spicatum*	Eurasian water milfoil
	Najas guadalupensis	Southern naiad		
Salt marsh	*Spartina alterniflora*	Smooth cordgrass	*Distichlis spicate*	Saltgrass
	Juncus roemerianus	Black rush	*Avicennia germinans*	Black mangrove
	Borrichia frutescens	Sea ox-eye	*Batis maritima*	Saltwort
Source: ELOS Environmental 2018b.				

5.5 WETLAND TYPES IN THE PROPOSED OUTFALL AREA AND CONSTRUCTION FOOTPRINT

Wetland types within the immediate vicinity of the proposed outfall area (26,985 acres of outfall area in the Breton Sound Basin), as determined in a desktop analysis by ELOS Environmental (2018b), are composed of jurisdictional fresh water forest and shrub, fresh water marsh, intermediate marsh, and open water habitat. Table 5.5-1 below summarizes the acreage and percentage of each wetland type within the vicinity of the proposed outfall area based on various publicly available data, such as the U.S. Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) maps and Louisiana's Coastwide Reference Monitoring System (CRMS); the data are also depicted in Figure 5.5-1 (ELOS Environmental 2018b).

Table 5.5-1
Wetland Habitat Types Occurring within the Proposed Outfall Area

Wetland Type	Total Acres	Approximate Percent of the Outfall Area
Open Water	13,790.9	51%
Palustrine Wetlands		
Freshwater Forested/Shrub	6,621.8	25%
Freshwater Marsh	5,770.8	21%
Estuarine Wetlands		
Intermediate Marsh	801.4	3%
TOTAL	**26,985**	**100%**
Source: ELOS Environmental 2018b.		

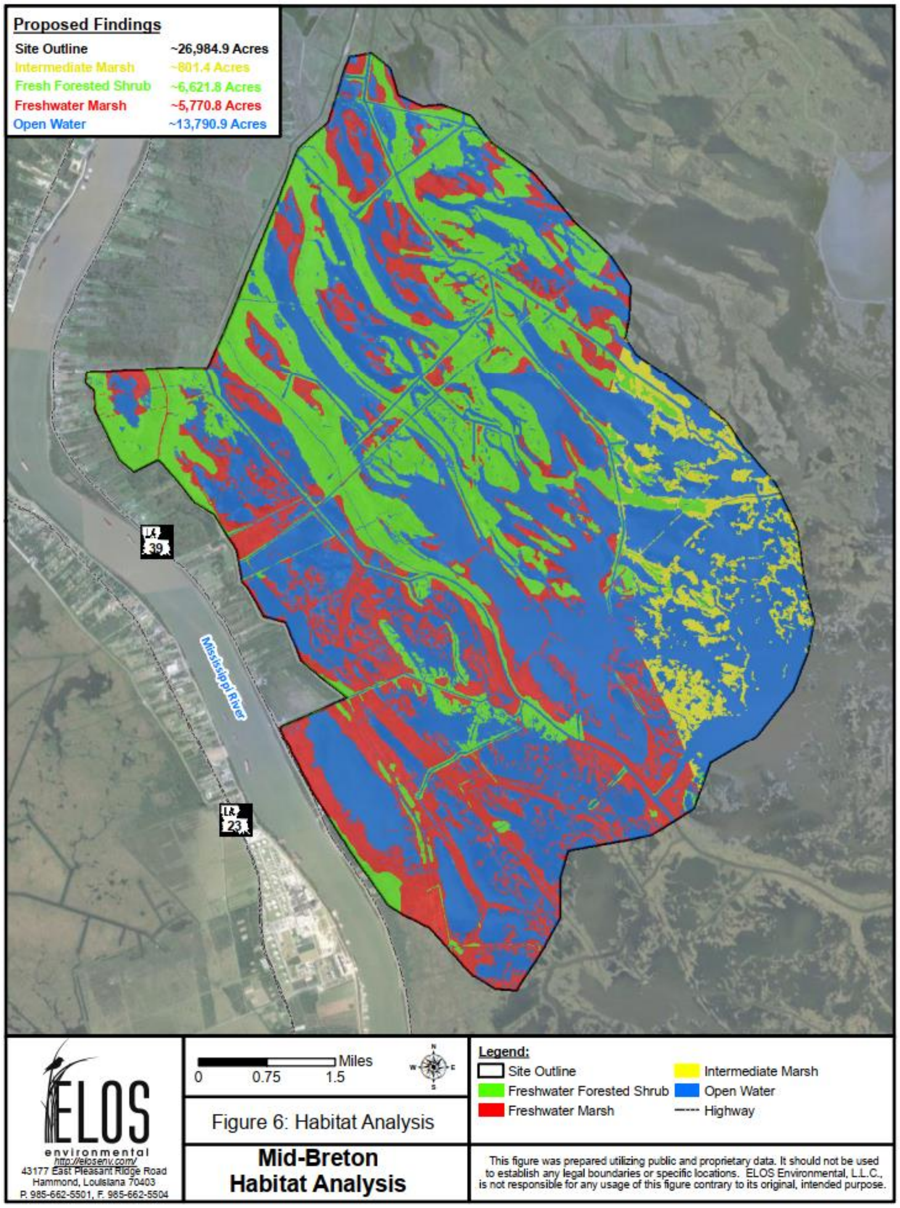


Figure 5.5-1. Wetland Types within the Proposed Outfall Area of the Breton Sound Basin.
Source: ELOS Environmental 2018b.

Wetland types within the proposed project construction footprint (approximately 530.07 acres) consist primarily of jurisdictional WOTUS and forested and scrub/shrub wetland types (see previous Section 5.4 for explanation) with upland areas typically determined by lack of hydrological indicators (ELOS Environmental 2018a). Figure 5.5-2 depicts the WOTUS and wetland types occurring within the proposed project construction footprint (ELOS Environmental 2018b).

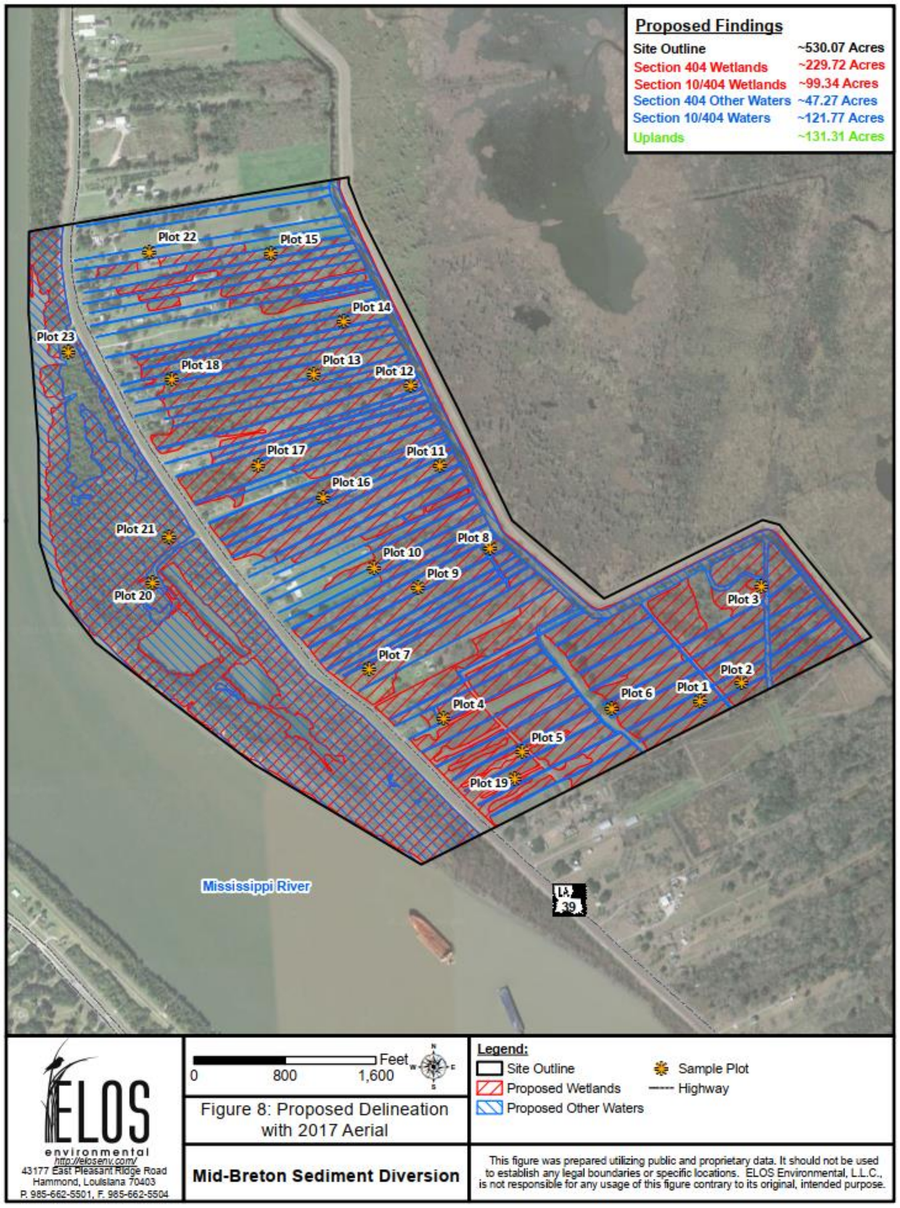


Figure 5.5-2. WOTUS and Wetland Types within the Proposed Project Construction Footprint.
Source: ELOS environmental 2018b.

5.6 WETLAND LOSS

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous U.S.; however, coastal erosion, subsidence, sea-level rise, flood protection levees and other factors have resulted in the loss of greater than 1 million acres in coastal Louisiana since the late 19th century (CPRA, 2019). Based on an analysis of aerial and satellite imagery between 1932 and 2016, approximately 4,833 square kilometers (1,866 square miles) of land have been lost in Louisiana (Figure 5.6-1). This amounts to a decrease of approximately 25 percent of the 1932 land area (Couvillion et al. 2017). Across coastal Louisiana, wetland loss rates increased to a peak in the late 1970s and have decreased since then. Where wetland loss rates have decreased in coastal Louisiana, these changes could be related to lower rates of oil and gas extraction (which peaked in 1969) and restoration activities (Couvillion et al. 2017).

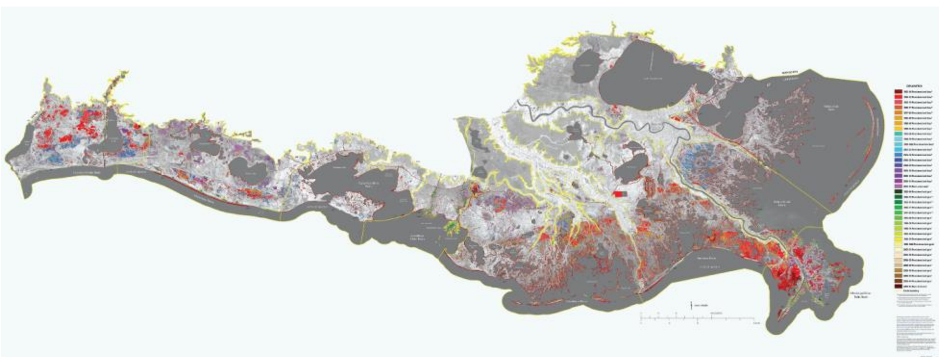


Figure 5.6-1. Land Loss (including wetland habitat) in Coastal Louisiana since 1932.
Source: Couvillion et al. 2017.

The Breton Sound Basin has lost about 38 percent of total land area between 1932 and 2016 (Figure 5.6-1, Couvillion et al. 2017). As shown in Figure 5.6-2, wetland loss has occurred in the interior of the Breton Sound Basin primarily within the estuarine wetland habitats (intermediate, brackish, and saline). Wetland loss has also resulted from wave generated erosion of exposed shorelines throughout the Breton Sound Basin. The Mississippi River Delta Basin has experienced a net loss of wetlands since the 1930s; however, since the 1960s, wetland loss rates in the Mississippi River Delta Basin declined, and a period of wetland gain occurred in the 1980s and 1990s before loss rates increased following Hurricane Katrina in 2005 (Couvillion et al. 2017).

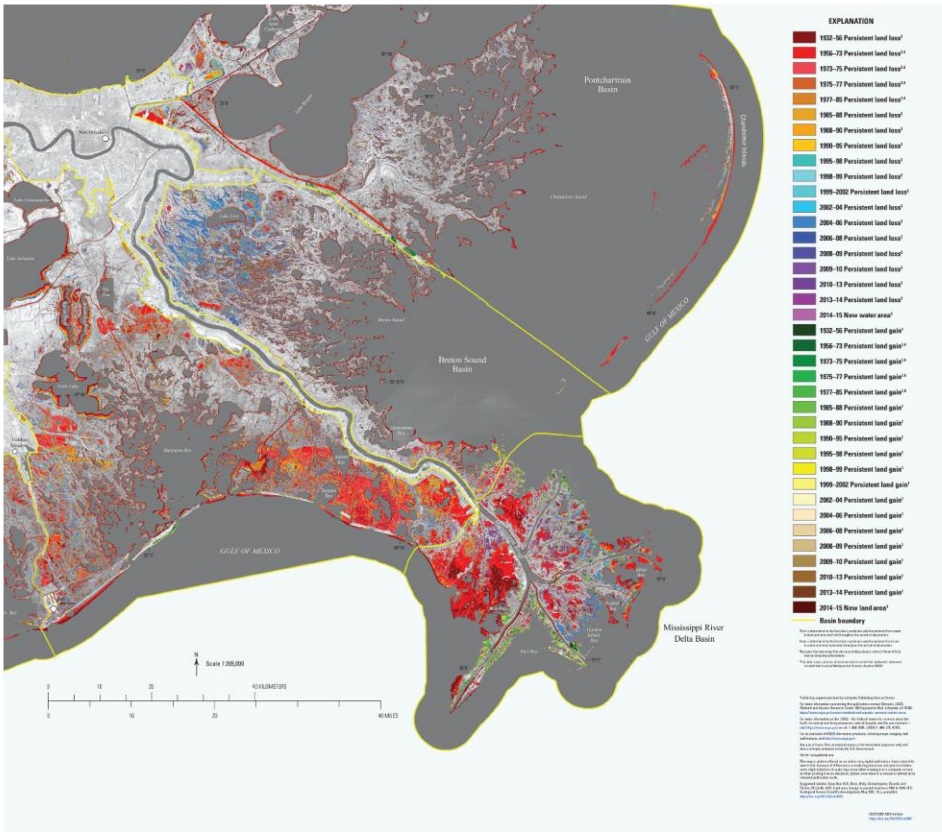


Figure 5.6-2. Land Loss (including wetland habitat) within and Surrounding the Project Area.
Source: Couvillion et al. 2017.

5.6.1 Patterns of Wetland Loss

There are two general patterns of wetland loss: (1) lateral loss and (2) interior marsh loss. Lateral loss is caused by wave generated shoreline erosion and the physical removal of marsh soils rich in organic matter. Recent studies within similar nearby wetland systems have shown that interior marsh loss is caused by numerous factors including: (1) land-surface subsidence which leads to soil waterlogging, erosion, and loss; and (2) saltwater intrusion which can cause the death of the vegetation holding the marsh soils in place (Gosselink et al. 1977; Mendelssohn and McKee 1988; Morton et al. 2003). DeLaune and Pezeshki (2003) demonstrated the importance of plant biomass production in maintaining marshes within the sediment-deficient environment of Breton Sound Basin. Interior marsh loss accounts for approximately 43 percent of the loss in coastal Louisiana (Leibowitz and Hill 1987 from Morton et al. 2003). Lateral loss of the shorelines of bay, lake, and Gulf environments is estimated to account for 25 percent of overall wetland loss in Louisiana between 1932 and 1990 (Penland et al. 2000; Wilson and Allison 2008). Wilson and Allison (2008) found that lateral loss from wave erosion accounted for 63 percent of the marsh loss and differential subsidence (interior loss) accounted for the remaining 37 percent. Marsh shorelines in coastal Louisiana are erosion-dominated and unstable, yielding significant material into the adjacent bays with their rapid retreat (approximately 1 m per year) (Wilson and Allison 2008).

5.6.2 Causes of Wetland Loss

Louisiana's wetland losses have been attributed to a variety of natural and anthropogenic causes, including sea-level rise, saltwater intrusion, fluid withdrawal (e.g., groundwater, oil, etc.), levee construction resulting in subsidence and compaction, canal dredging for irrigation and commerce, major storm events, herbivory, failed farming practices, and development (Salinas et al. 1986; Boesch et al. 1994; Bass and Turner 1997; Day et al. 2000; Coverdale et al. 2013). Some of these causes of wetland loss (e.g., saltwater intrusion, levee construction, herbivory) can sometimes be addressed through traditional restoration projects such as marsh creation, shoreline protection, vegetative plantings, and hydrologic restoration. These natural and anthropogenic causes be accounted for in any restoration or protection effort. These causes are complex, interacting, and may have differing effects across the coast. This complexity is reflected by the highly variable regional land loss rates in coastal Louisiana. Some of the key contributors to wetland loss are discussed below.

5.6.2.1 Subsidence and Relative Sea Level Rise

Subsidence is the sinking of land and can result from natural and anthropogenic processes. See Section 3.6.2 for information regarding causes and estimated subsidence rates for the project area and a discussion of relative sea-level rise.

Studies of very similar nearby marsh systems have shown that subsidence and relative sea-level rise result in increased flooding frequency and duration, which stresses marsh vegetation, resulting in mortality, marsh break-up, and erosion (DeLaune et al. 2003). For wetlands to remain healthy, the accumulation of sediment and above- and below-ground organic matter must occur at a rate sufficient to keep pace with rapid subsidence and relative sea-level rise (Boesch et al. 1994).

The natural process of organic matter accumulation in wetland soils contributes to the increase in carbon sequestration and soil accretion rates (Baustian et al. 2017; Snedden et al. 2015). In addition, marsh vegetation traps sediment and organic matter which encourages soil accumulation. Changes in salinity or inundation levels within wetland habitat, such as those resulting from saltwater intrusion and sea-level rise, can reduce the productivity of wetland vegetation, thereby reducing organic matter and sediment accumulation and eventually resulting in wetland loss (DeLaune et al. 1994). Erosion that occurs where wetlands are exposed to the energy of waves, wind, and tidal currents may be exacerbated where vegetation loss exposes the substrate directly to erosional forces (Boesch et al. 1994).

5.6.2.2 Risk Reduction Levees

The Breton Sound Basin is largely hydrologically isolated from the Mississippi River in the upper parts of the Breton Sound Basin. This is due to the creation of the Mississippi River and the NOV-NFL levee systems. These levee systems prevent fresh water inputs from the Mississippi River, thus, contributing to changes in the Basin's salinity gradient. The levee system also prevents the natural overbank sediment deposition process. Sediment inputs from rivers are important for coastal wetlands because they provide nutrients for plant growth and increase soil accretion and bulk density (Day et al. 2007). However, by preventing overbank flooding and flows from the Mississippi River and its distributing tributaries (or “distributaries”), levees have reduced the sediment load that enters the basin (Boesch et al. 1994).

The Breton Sound Basin has more connections to the Mississippi River than does the Barataria Basin. In the Barataria Basin, the MRL and the New Orleans and Vicinity Non-Federal Levee (NOV-NFL) extend southward to Venice (RM 10 AHP). On the Breton Sound side of the river, both the MRL and the NOV-NFL extend southward only to Pointe a la Hache (RM 44 AHP). Consequently, the lower Breton Sound Basin does receive some riverine inputs. These inputs occur through various openings such as Mardi Gras Pass, Bohemia Spillway, and Fort St. Philip and via overbank flooding when Mississippi River levels are high.

5.6.2.3 Storms

Major storm events such as hurricanes are a significant source of large-scale disturbances in coastal emergent marsh habitats. Unlike hurricane impacts in forested systems, where the primary disturbance is the creation of canopy gaps, hurricanes in coastal emergent marshes result in multiple disturbances including: compression of the marsh surface, deposition of sediment and vegetative debris scouring, and salt burn (Visser et al. 1999). Bianchette et al. (2015) analyzed the spatial and temporal patterns of sediment accretion across coastal Louisiana during the period around the landfall of Hurricane Isaac in 2012 and found that the highest rates of accretion were associated with the period of the storm and were at sites about 43 miles from the storm track, near the Mississippi River and adjacent distributaries.

Although storms deposit suspended sediments on wetland surfaces and bring freshwater inflows, they can also convert wetlands to open water from erosion when large storm surges bring salt water inland (Day et al. 2007). Major storms, including hurricanes, can cause erosion that creates or alters inlets and moves sediment. Retreating storm surge can damage root mats in floating marsh and damage rooted marsh vegetation. Salt water transported inland can result in mortality and changes to vegetation communities (LCWCRT 1999). After hurricanes Rita and Katrina, the brackish and saline marshes in the Breton Sound Basin appeared to be more resilient than fresh or intermediate marsh communities that experience detectable shearing from the passage of the storms (Barras 2005).

5.6.2.4 Canals and Spoil Banks

It is estimated that canal construction (including the dredging of canals for oil and gas development) directly resulted in the loss of nearly 29,000 acres of marsh in Louisiana between 1955 and 1978 (Boesch et al. 1994). In addition to direct wetland loss, canals have markedly altered the natural hydrology of the Louisiana marsh and have been linked to significant indirect wetland loss in some areas (Bass and Turner 1997). North-south canals provide a conduit for salt water to enter salt-intolerant freshwater marshes and swamps, particularly during storm events. Furthermore, increased tidal activity and boat wakes cause shoreline erosion along the canals. The hydrologic pumping caused by tides and boat passages can also remove fluid and semi-fluid soils from the interior of the marsh (Boesch et al. 1994).

The largest canal in the project area is the MRGO. The MRGO is a 76-mile navigation canal that forms the northeast boundary of the Breton Sound Basin. This canal was created to provide a shorter route between the Gulf of Mexico and the Port of New Orleans. The creation and operation of the MRGO is linked to the direct and indirect loss of thousands of acres of wetlands in the Breton Sound and Pontchartrain Basins. It provided a direct conduit for the salt water of the Gulf of Mexico into the fresh and intermediate wetland habitats in these basins. It also created a major boundary to the natural hydrologic regime in the area. In 2008, the United States Congress authorized the closure of the MRGO which was accomplished in 2009 with the construction of a rock dike across its width south of the intersection of the MRGO and Bayou La Loutre. The construction of the surge barrier in St. Bernard and Orleans Parishes further reduced the effectiveness of the MRGO as a conduit for hydrologic movement and storm surge through the MRGO.

Canal construction has also impacted the natural hydrology of marshes. Spoil banks are continuous piles of dredged material placed adjacent to canals during their construction. Spoil banks can obstruct the sheet flow of water across the marsh and subsurface flow of water through the marsh. These barriers can result in prolonged flooding events, especially following storms. Impoundments or semi-impoundments created by the configuration of several spoil banks have been shown to reduce the frequency and increase the duration of flooding during tidal events (Day et al. 2000; Swenson and Turner 1987). Prolonged flooding of a marsh can lead to waterlogged soils and stressed vegetation (Bass and Turner 1997).

5.6.2.5 Herbivory

Herbivory is the consumption of plant material by animals. Nutria (*Myocaster coypus*) were introduced to Louisiana in the 1930s from South America, and herbivory by nutria and muskrat is responsible for wetland loss across coastal Louisiana (Boesch et al. 1994, Jordan and Mouton 2010). Nutria are capable of denuding large areas of marsh of all vegetation and create “eat-outs” that turn to mudflats and eventually to open water. By the late 1950s, there were an estimated 20 million nutria in Louisiana (USGS 2000). While the number of nutria damage sites declined annually between 2001 and 2010, an estimated 26,273 acres of marsh were converted to open water due to herbivory during that timeframe (Jordan and Mouton 2010). Efforts by the state have shown success in curbing damage by nutria. Since the development of the Coastwide Nutria Control Program in 2002, nutria damage along survey transects in coastal Louisiana has been reduced from 82,080 acres in 2002 to 16,424 acres in 2018 (Normand and Manuel 2018). During 2017, the second most number of tails were harvested from wetlands located in Plaquemines Parish, at 29,474 tails (Normand and Manuel 2018). While the extent of muskrat impacts on wetland loss in Louisiana wetlands is less well quantified, sites exposed to muskrat herbivory have been documented as having moderate to severe vegetation damage (Kinler et al. 1998).

The roseau cane scale (*Nipponaclerda biwakoensis*), an insect native to China and Japan, has also contributed to widespread die-off of roseau cane (*Phragmites australis*) in the Bird’s Foot Delta, leaving large areas of former roseau cane stands either converted to mud flat or colonized by other plant species. Research is currently underway to determine the role of other contributing factors such as salinity and subsidence and to identify short- and long-term management options. This species is further discussed in Section 8.5.2.

Salt marshes may be converted to mudflats due to herbivory, for example, via marsh periwinkle grazing (Silliman et al. 2005). While herbivory is a greater influence in fresh water marshes, fauna such as fiddler crabs, mollusks, and polychaetes (marine worms) can affect salt marsh plant distributions via burrowing and subsequent soil mixing by increasing availability of oxygen to plant roots (Schultz et al. 2016, Gittman and Keller 2013). Soil oxidation via fiddler crab burrowing facilitates smooth cordgrass growth, “balancing” the detrimental effects of the periwinkles (Gittman and Keller 2013).

5.6.2.6 ***Deepwater Horizon* Oil Spill**

The 2010 DWH oil spill was the direct cause of a minimum of 850 miles of shoreline oiling in coastal Louisiana (Table 4.6-2 in DWH NRDA Trustees 2016a). The consequences of the spill included adverse impacts on aquatic resources, including marsh vegetation, intertidal biota (for example, fiddler crabs), and shoreline erosion (Zengel et al. 2015). Mortality of the two, dominant salt marsh plant species, smooth cordgrass and black needlerush, was nearly 100 percent following heavy oiling, while moderate oiling had little effect on smooth cordgrass but significantly impacted biomass and density of black needlerush (Mendelssohn et al. 2012, Lin et al. 2016). Beland et al. 2017 used remote sensing techniques to map changes in wetland cover and open water before and after the oil spill. In areas mapped, they found significant increases in land losses in heavily oiled marshes and concluded that oiling increased land loss rates by over 50 percent, but that the background land loss rates returned within three–six years after the spill.

5.6.3 Wetland Invasive Plants

Wetland and aquatic habitats in coastal Louisiana are adversely impacted by numerous invasive species, defined by the USFWS, as “species not native to the target habitat,” also referred to as nonnative species, per Executive Order (EO) 13112. An invasive species is likely to cause environmental or economic harm or harm to human health. Invasive species can reduce the ability of streams to convey water, displace native plant communities, and degrade aquatic habitats. Waterways and water diversions also provide a mechanism for establishment and expansion of invasive plant species outside their native habitats (Zhan et al. 2015). Fish and wildlife, without the native vegetation to which they are adapted, may move into other areas in search of food or habitat or both, in turn potentially modifying the newly occupied habitat.

Invasive plants play a large part in the loss of wetland and coastal habitats due to their ability to rapidly expand into the habitat to which they are introduced, which is often free of insects and diseases that would otherwise constrain the invasive species in their native habitats (USGS 2018). Louisiana has the largest port system in terms of imported goods (in tons) in the world, providing ample opportunity for invasive species introduction for both aquatic and terrestrial species (LA WAP 2015). At the local level, wildlife can further disperse plant species.

In Louisiana, organizations such as USGS and the Louisiana Sea Grant maintain databases of information on invasive species. Louisiana’s “State Management Plan for Aquatic Invasive Species” identifies nonnative plant species that “cause extensive economic or ecological harm…” (Kravitz et al. 2005). Data for nonindigenous wetland plant species potentially present in the Barataria Basin are listed in Table 5.6-1. The most prominent species are described below (Kravitz et al. 2005). Aquatic invasive species are presented in Section 9.7.

- Water hyacinth (*Eichhornia crassipes*) clogs bayous and canals, impedes boat traffic, slows water currents, and blocks light to native SAV, all of which degrades water quality and harms wildlife; it is found in almost every drainage basin in Louisiana.

- Water lettuce (*Pistia stratiotes*) is a perennial floating plant that impedes boat traffic, swimming, fishing, and other recreational activities; degrades water quality for native vegetation; and adversely affects fish and bird populations.

- Common Salvinia (*Salvinia minima*) is a floating fern that prefers slow-moving fresh waters and forms thick mats on the water surface up to 10-inches deep that can shade out native plants, degrading habitat for fish and birds and negatively affecting water quality.

- Giant Salvinia (*Salvinia molesta*) is a free-floating plant that does not attach to the soil; can form thick mats and impede boat traffic.

Table 5.6-1
Potential Invasive Wetland Plant Species and Habitat Type in Breton Sound Basin

Scientific Name	Common Name	Habitat Type (fresh/marine/brackish)
Acorus calamus	Single-vein sweetflag	Freshwater
Alternanthera philoxeroides	Alligatorweed	Freshwater
Amaranthus cannabinus	Tidal marsh amaranth	Brackish
Aeschynomene fluitans	Giant water sensitive plant	Freshwater
Ceratopteris richardii	Triangle water fern	Freshwater
Ceratopteris thalictroides	Watersprite	Freshwater
Cyperus difformis	Smallflower umbrella sedge	Freshwater
Egeria densa	Brazilian waterweed	Freshwater
Eichhornia crassipes	Water hyacinth	Freshwater
Hydrilla verticillata	Hydrilla	Freshwater
Iris pseudacorus	Yellow iris	Freshwater
Ludwigia grandiflora	Large-flower primrose-willow	Freshwater
Marsilea macropoda	Big-foot water-clover	Freshwater
Myriophyllum aquaticum	Parrot feather	Freshwater
Myriophyllum spicatum	Eurasian watermilfoil	Freshwater-Brackish
Oryza sativa	Rice	Freshwater
Pistia stratiotes	Water lettuce	Freshwater
Potamogeton crispus	Curly-leaf pondweed	Freshwater
Salvinia minima	Common salvinia	Freshwater
Salvinia molesta	Giant salvinia	Freshwater
Selaginella uncinata	Peacock spikemoss	Freshwater
Sources: Kravitz et al. 2005; USGS 2018.		

6.0 AIR QUALITY

6.1 INTRODUCTION

Air quality impacts have the potential to affect both the local area as well as having a regional impact. Areas outside of the immediate vicinity of the project site could be negatively affected by the project, due to the nature of air pollutants and climatology. The project study area for air quality is represented by Plaquemines Parish to consider both the local and regional impacts.

Air quality in a given location is described as the concentration of various pollutants in the atmosphere. Air quality is determined by several factors; including the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. This section describes existing air quality condition in Plaquemines Parish.

6.2 REGULATORY SETTING

Air quality in Louisiana is regulated by the LDEQ Air Quality Assessment Division and EPA Region 6. The Clean Air Act (42 USC 7401-7671q), as amended, gives EPA the responsibility to establish the primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) that set acceptable concentration levels for six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrous oxides (NO_x), ozone (O_3), fine particulate matter ($PM_{2.5}$), respirable particulate matter (PM_{10}), and sulfur dioxide (SO_2). Primary standards are designated for the protection of public health, while secondary standards are designated to protect the public welfare. The NAAQS are summarized in Table 6.2-1. Each state has the authority to adopt standards that are more stringent than those established by EPA; however, Louisiana accepts the federal standards.

The project area is located in the Southern Louisiana – Southeast Texas Interstate Air Quality Control Region (AQCR). AQCRs are designated by EPA per Section 107 of the Clean Air Act for air quality planning purposes and within each AQCR, the EPA assigns an attainment status for specific geographic areas relative to the NAAQS. If air quality monitoring data of ambient pollutant concentrations are below the NAAQS thresholds, an area is designated as in attainment of the NAAQS. If air quality monitoring data of ambient pollutant concentrations exceed the NAAQS thresholds, an area is designated as non-attainment. Areas for which sufficient data are not available to determine attainment status are designated as unclassifiable and are managed as attainment areas.

The LDEQ monitors levels of criteria pollutants at representative sites throughout Louisiana. Ambient air concentrations of certain air contaminants within Plaquemines Parish have been measured at air monitoring stations, and the results are reported to the EPA. The EPA Green Book Nonattainment Areas for Criteria Pollutants (Green Book) provides detailed information about NAAQS designations, classifications and nonattainment status. Plaquemines Parish, where the Project would be located, is designated as “unclassifiable/in attainment” for all criteria pollutants (EPA 2019).

Presented below is a description of each of the criteria air pollutants for which an NAAQS has been established, and their known health effects. In addition, diesel particulate matter (DPM) is described, which is a Hazardous Air Pollutant (HAP).

Ozone (O_3) is one of a number of substances called photochemical oxidants that are formed when volatile organic compounds (VOCs) and NO_X, react with sunlight and are by-products of the internal combustion engine. The damaging effects of photochemical smog are generally related to the concentrations of ozone. Ozone may pose a health threat to those who already suffer from respiratory diseases as well as to healthy individuals. Breathing ozone can trigger a variety of health problems, including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma. Additionally, ozone has been tied to crop damage, typically in the form of stunted growth and premature death. Ozone can also act as a corrosive, resulting in property damage such as the embitterment of rubber products (EPA 2015a).

Carbon monoxide (CO) is a colorless, odorless gas produced by the incomplete combustion of fuels. The primary adverse health effect associated with CO is the interference of normal oxygen transfer to the blood, which may result in tissue oxygen deprivation (EPA 2015b).

Respirable Particulate Matter (PM_{10}) and Fine Particulate Matter ($PM_{2.5}$) consist of extremely small, suspended particles or droplets 10 microns and 2.5 microns or smaller in diameter, respectively. Some sources of particulate matter, like pollen and windstorms, are naturally occurring; however, in populated areas, most particulate matter is caused by road dust, diesel soot, and combustion products, abrasion of tires and brakes, and construction activities. Both PM_{10} and $PM_{2.5}$ may adversely affect the human respiratory system, especially in those people who are naturally sensitive or susceptible to breathing problems (U.S. EPA 2015c).

Nitrogen dioxide (NO_2) is a by-product of fuel combustion. The principal form of NO_2 produced by combustion is nitrogen oxide (NO). NO reacts with oxygen in the air to form NO_2, creating the mixture of NO and NO_2 commonly called NO_X. Other oxides of nitrogen, including nitrous acid and nitric acid, are part of the nitrogen oxide family. While EPA's NAAQS covers this entire family, NO_2 is the component of greatest interest and the indicator for the larger group of nitrogen oxides. Current scientific evidence links short-term NO_2 exposures, ranging from 30 minutes to 24 hours, with adverse respiratory effects, including airway inflammation in healthy people and increased respiratory symptoms in people with asthma. Also, studies show a connection between breathing elevated short-term NO_2 concentrations and increased visits to emergency departments and hospital admissions for respiratory issues, especially asthma (U.S. EPA 2015d).

Sulfur dioxide (SO_2) is a colorless, pungent gas. At levels greater than 0.5 parts per million (ppm), the gas has a strong odor, similar to rotten eggs. It enters the atmosphere as a pollutant mainly as a result of burning high sulfur content fuel oils and coal, and from chemical processes occurring at chemical plants and refineries. Sulfuric acid is formed from SO_2, which is an aerosol particle component that may lead to acid deposition. Acid rain deposition into water, vegetation, soil, or other materials can harm natural resources and materials. Sulfur oxides (SO_X) include SO_2 and sulfur trioxide (SO_3). Although SO_2 concentrations have been reduced to levels well below national standards, further reductions are desirable because SO_2 is a precursor to sulfates. Sulfates are a particulate formed through the photochemical oxidation of SO_2. Long-term exposure to high levels of SO_2 can cause irritation of existing cardiovascular disease, respiratory illness, and changes in the defenses in the lungs. When people with asthma are exposed to high levels of SO_2 for short periods of time during moderate activity, effects may include wheezing, chest tightness, or shortness of breath (U.S. EPA 2015e).

Lead (Pb) occurs in the atmosphere as particulate matter. The major sources of lead emissions have historically been from the combustion of leaded gasoline in on-road motor vehicles and from industrial sources. The use of leaded gasoline is no longer permitted for on-road motor vehicles and airborne lead has significantly declined. Other sources of lead include the manufacturing and recycling of batteries, paint, ink, ceramics, ammunition, and secondary lead smelters. Lead accumulates in bones, soft tissue, and blood, and can affect the kidneys, liver, and nervous system. The more serious effects of lead poisoning include behavior disorders, mental retardation, and neurological impairment. Low levels of lead in fetuses and young children can result in nervous system damage, which can cause learning deficiencies and low intelligence quotients. Lead may also contribute to high blood pressure and heart disease (U.S. EPA 2015f).

Volatile organic compounds (VOCs) are defined as any compound of carbon, excluding CO, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions. Common sources of VOCs are on-road motor vehicles and solvent evaporation. Although health-based standards have not been established for VOCs, health effects can occur from exposures to high concentrations because of interference with oxygen uptake. In general, higher concentrations of VOCs are suspected to cause eye, nose, and throat irritation; headaches; loss of coordination; nausea; and damage to the liver, kidneys, and central nervous system (U.S. EPA 1999a). It should be noted that there are no NAAQS for VOCs because they are not classified as criteria pollutants. They are included in this analysis, however, because a reduction in VOC emissions reduces certain chemical reactions that contribute to the formulation of O_3.

Hazardous Air Pollutants, also known as toxic air pollutants or air toxics, are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. The EPA is required to control 187 hazardous air pollutants. Examples of HAPs include benzene, which is found in gasoline; perchlorethlyene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries (U.S. EPA 2015g).

Diesel particulate matter (DPM) is a mixture of particles that is a component of diesel exhaust (DE). The EPA lists DE as a mobile source air toxic, or HAP, due to the cancer and noncancer health effects associated with exposure to whole DE. Chronic inhalation exposure is likely to pose a lung cancer hazard, as well as damage the lung in other ways depending on exposure, and short-term exposures can cause irritation and inflammatory symptoms of a transient nature (U.S. EPA 2002). DPM (expressed as grams of DPM per cubic meter [m^3]) has historically been used as a surrogate measure of exposure for whole DE. Although uncertainty exists as to whether DPM is the most appropriate parameter to correlate with human health effects, it is considered a reasonable choice until more definitive information about the mechanisms of toxicity or mode(s) of action of DE becomes available (U.S. EPA 2015h).

Table 6.2-1
NAAQS

Pollutant		Primary / Secondary	Average Time	Level	Form
Carbon Monoxide (CO)		Primary	8 hours 1 hour	9 ppm 35 ppm	Not to be exceeded more than once per year
Lead (Pb)		Primary and Secondary	Rolling 3-month average	0.15 µg/m^{3} [a]	Not to be exceeded
Nitrogen Dioxide (NO_2)		Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	1 year	53 ppb[b]	Annual Mean
Ozone (O_3)		Primary and Secondary	8 hours	0.070 ppm[c)]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	Primary	1 year	12.0 µg/m[c]	annual mean, averaged over 3 years
		Secondary	1 year	15.0 µg/m[c]	annual mean, averaged over 3 years
		Primary and Secondary	24 hours	35 µg/m[c]	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24 hours	150 µg/m[c]	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		Primary	1 hour	75 ppb[d]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

a. In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m^3 as a calendar quarter average) also remain in effect.

b. The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

c. Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

d. The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards [40 CFR 50.4(3)]. A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Source: U.S. EPA 2016.

6.2.1 Conformity

A conformity determination is not required because the project area is in attainment of the NAAQS. The EPA established General Conformity Regulations in 1993 under 40 CFR Part 93, Subpart B to ensure that federal actions in nonattainment areas do not interfere with a state’s ability to attain or maintain compliance with the NAAQS through the development of a conformity determination, if required. The regulations are applicable to actions that would generate emissions from construction and operations that exceed General Conformity Thresholds.

6.3 CLIMATOLOGY

The project area is characterized by a subtropical marine climate with long, humid summers and short, moderate winters with year-round precipitation. The area is strongly influenced by the Gulf of Mexico, and precipitation is highest in the summer when prevailing southerly winds bring moist, semitropical weather conducive to thunderstorm development (Kunkel et al. 2013; National Climatic Data Center [NCDC] 2017).

In the winter, alternating subtropical and continental air masses result in occasional sudden drops in temperature (NCDC 2017). The area has an average annual high and low temperature of 77.7°F and 59.1°F, respectively. Average rainfall is 62.4 inches; the lowest average monthly precipitation is in October (3.5 inches) and the highest is in July (7.1 inches) (USCD 2017).

Coastal Louisiana is also subject to tropical storms and hurricanes; an annual average of 0.7 tropical cyclones of tropical storm strength (of which 0.3 are hurricanes) hit the Louisiana coast between 1851 and 2010. A hurricane is expected to make landfall in Louisiana every 2.8 years (Roth 2010). Tropical cyclones can cause loss of human life and substantial environmental and property damage. Between 1980 and 2013, the Southeast, which includes the project area, has experienced the most billion-dollar weather disasters of any region in the U.S. (Melillo et al. 2014).

Since 1895, the average temperature in the U.S. has increased by about 1.3 to 1.9°F; the majority of that change has occurred since 1970 (Melillo et al., 2014). However, the project area, and the rest of the southeastern U.S., has not shown an overall warming trend in the 20th century; instead, annual temperatures were highly variable during the first half of the century, followed by a relatively cool period between 1960s and 1970s during which the temperature in Louisiana dropped by almost 2°F, and a subsequent steady increase in temperature to the present (Kunkel et al. 2013; NOAA, 2019b). Recently (since the mid-1990s), the number of very hot days and warm nights has risen, and temperatures in Louisiana are projected to continue increasing, exceeding historical record levels by the mid-21st century (NOAA 2019b). Average annual temperatures in the project area are projected to increase by between 2.5 and 5.5°F by 2099 (Kunkel et al. 2013).

The risk of sea-level rise and increased flood risk is high in coastal Louisiana, particularly in low-lying areas. Flooding, particularly along the Mississippi River, is a potential hazard to the natural and human environment. Sea-level rise and subsidence has resulted in an increase in tidal floods, which can result in road closures and damage to infrastructure and storm drains; these events are expected to increase in frequency (Frankson and Kunkel 2017). In addition, rainfall and associated flooding from tropical cyclones are projected to increase (Frankson and Kunkel 2017). Regionally, Melillo et al. (2014) indicate that sea-level rise poses a widespread threat to natural and developed lands and the regional economy, and that increasing temperatures and the associated increases in extreme weather events, would affect natural and developed lands, public health, and the economy. Further, sea-level rise, storms and storm surges, and changes in surface and groundwater use patterns are expected to compromise the sustainability of coastal freshwater aquifers and distribution and function of wetland ecosystems. Climate change impacts add to the cumulative stresses currently faced by vulnerable populations including children, the elderly, the poor, some communities of color, and people with chronic illnesses. Climate-related threats to these populations include poor air quality, heat, drought, flooding, and mental health stress (Melillo et al. 2014).

6.4 CLIMATE CHANGE AND GREENHOUSE GASES

6.4.1 Climate Change

Climate Change refers to any significant change in the measures of climate lasting for an extended period of time. Climate Change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. Some gases, such as carbon dioxide and methane, trap heat in the atmosphere and transform the light of the sun into heat, similar to the glass walls of a greenhouse; these are known as greenhouse gases (GHG).

The increase of global mean surface temperature by the end of the 21st century (2081-2100) relative to 1986–2005 is likely to be 0.3°C to 4.8°C (IPCC 2014). Anthropogenic GHG emissions have increased since the pre-industrial era and are now the highest in history. This has led to atmospheric concentrations of GHG that are unprecedented in at least 800,000 years. Recent climate changes have had widespread impacts on human and natural systems. Observed changes in the climate system include the warming of the atmosphere and ocean, diminished snow and ice, changes in extreme weather and climate events, and rising sea levels (IPCC 2014). Therefore, while impacts may be seen locally, Climate Change has a global study area.

Federal agencies, states, and local communities address climate change by adopting policies intended to decrease GHG emissions. In addition, land management policies can reduce carbon dioxide in the atmosphere by expanding wetland and forest vegetation, which absorbs carbon from the atmosphere.

Gases that trap heat in the atmosphere are called GHG because they transform the light of the sun into heat, similar to the glass walls of a greenhouse. Common GHG included in the analysis are carbon dioxide, methane, and nitrous oxides.

Carbon dioxide (CO_2) is an odorless, colorless gas, which has both natural and anthropogenic sources. Natural sources include decomposition of dead organic matter; respiration of bacteria, plants, animals, and fungus; evaporation from oceans; and volcanic outgassing. Anthropogenic sources of carbon dioxide are from burning coal, oil, natural gas, and wood.

Methane (CH_4) is a flammable gas and is the main component of natural gas. A natural source of methane is the anaerobic decay of organic matter. Geological deposits, known as natural gas fields, also contain methane, which is extracted for fuel. Other sources include the exhaust from the combustion of fossil fuels, landfills, fermentation of manure, and cattle.

Nitrous oxide (N_2O), also known as laughing gas, is produced naturally by microbial processes in soil and water. Anthropogenic sources of nitrous oxide include agricultural sources, industrial processing, fossil fuel-fired power plants, and vehicle emissions. Nitrous oxide also is used as an aerosol spray propellant and has medical applications.

6.4.2 Existing Levels of Greenhouse Gases

6.4.2.1 Global

Total anthropogenic GHG emissions continued to increase over 1970 to 2010. Annual GHG emissions grew on average by 1.0 gigatonne carbon dioxide equivalent ($GtCO_2eq$) (2.2%) per year from 2000 to 2010 compared to 0.4 $GtCO_2eq$ (1.3%) per year from 1970 to 2000. Upon study of GHG emissions up to the year 2010, total anthropogenic GHG emissions were highest in human history from 2000 to 2010 and reached 49 (±4.5) $GtCO_2eq$/year in 2010 (IPCC 2014).

6.4.2.2 United States

The EPA publication, Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017, provides a comprehensive emissions inventory of the nation's primary anthropogenic sources and sinks of GHG. Emissions of GHG in 2017 in the United States totaled 6,472.3 million metric tons CO_2eq. Of the total, CO_2 accounted for 82 percent, CH_4 accounted for 10 percent, and N_2O accounted for 6 percent. Overall, U.S. emissions increased by 0.3 percent from 2016 to 2017. Recent trends can be attributed to multiple factors, including changes in general economic conditions, overall energy prices, the relative price of different fuels, weather, and the availability of non-fossil alternatives. Additionally, GHG emissions in 2017 were 12 percent below 2005 levels (U.S. EPA 2019b).

6.4.2.3 Louisiana

The CAIT 2.0 U.S. State GHG emissions collection applies a consistent methodology to create a six-gas, multi-sector, and comparable data set for all U.S. states. CAIT 2.0 enables data analysis by allowing users to quickly narrow down by year, gas, state, and sector. Total GHG emissions in Louisiana in 2011 were 237.9 $MtCO_2eq$. Of the total, CO_2 accounted for 93 percent, CH_4 accounted for 5 percent, and N_2O accounted for 1 percent (WRI 2014).

6.4.3 Predicted Effects of Climate Change

Changes in the climate system have already been observed, and continued emission of GHG will cause further warming and long-lasting changes in all components of the climate system. Continued GHG emissions increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems.

Anthropogenic GHG emissions are mainly driven by population size, economic activity, lifestyle, energy use, land use patterns, technology and climate policy. The IPCC uses Representative Concentration Pathways (RCPs) to make projections based on these factors. These RCPs demonstrate a range of climate change outcomes based on a range of future mitigation and GHG emission scenarios. A number of projected changes in the climate system are discussed below.

6.4.3.1 Sea Level

For the period 2081–2100 relative to 1986–2005, the global mean sea level rise will likely be in the ranges of 0.26 to 0.55 meters for the lower RCP, and of 0.45 to 0.82 meters for the higher RCP. While sea level rise will not be uniform across regions, about 70 percent of the coastlines worldwide are projected to experience a sea level change within ±20 percent of the global mean (IPCC 2014).

Increase in atmospheric temperature in turn increases ocean temperature. The warming of seawater causes it to increase its volume through a process called thermal expansion. Climate Change also causes ice to melt. Thus, sea levels rise due to thermal expansion and the input of more water from snow and ice melt. Sea level rise is classified into two categories: global and relative. Absolute sea level rise is the net increase in sea level averaged over the globe. Relative sea level rise is specific to locations and takes land changes into account, such as the subsidence and rising of land. From 1982 to 2017, the relative sea level trend in New Canal, LA, is 5.31 mm/year with a 95% confidence interval of ± 1.23 mm/year. From 1947 to 2017, the relative sea level trend in Grand Isle, LA is 9.08 mm/year with a 95% confidence interval of ± 0.43 mm/year (NOAA 2019b). NOAA documents the social vulnerability index, which shows the intersection of potential sea level rise and vulnerable 2010 Census tracts. The project area is designated as a Medium Vulnerability (NOAA 2019b).

6.4.3.2 Increased Frequency and Intensity of Storm Events

Changes in many extreme weather and climate events have been observed since about 1950 and are predicted to continue. These extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will very likely become more intense and more frequent. Increasing trends in extreme precipitation implies greater risks of flooding at regional scale (IPCC 2014).

6.4.3.3 Ecosystems and Biodiversity

Climate Change is expected to have effects on diverse types of ecosystems, from alpine to deep sea habitat. As temperatures and precipitation change, seasonal shifts in vegetation will occur; this could affect the distribution of associated flora and fauna species. As the range of species shifts, habitat fragmentation could occur, with acute impacts on the distribution of certain sensitive species.

A large fraction of terrestrial, freshwater and marine species faces increased extinction risk, especially as climate change interacts with other stressors. This is as a result of both the magnitude and rate of climate change. Climate-associated extinction drivers include warming, sea-ice loss, variations in precipitation, reduced river flows, ocean acidification and lowered ocean oxygen levels. Extinction is further driven by the interaction among climate-associated drivers and simultaneous habitat modification, over-exploitation of stocks, pollution, eutrophication and invasive species.

Global marine species redistribution and marine biodiversity reduction in sensitive regions, under climate change, will challenge the sustained provision of fisheries productivity and other ecosystem services. The progressive expansion of Oxygen Minimum Zones and anoxic "dead zones" in the oceans will further constrain fish habitats. Open-ocean net primary production is projected to redistribute and to decrease globally. Marine ecosystems, especially coral reefs and polar ecosystems, are at risk from ocean acidification. Further, coastal systems and low-lying areas will increasingly experience submergence, flooding and erosion throughout the 21st century and beyond, due to sea level rise (IPCC 2014).

7.0 NOISE

7.1 INTRODUCTION

According to research, noise can negatively affect the psychological and physiological well-being of individuals. These effects can range from annoyance to adverse physiological responses, including but not limited to permanent or temporary hearing loss, fatigue, and psychiatric disorders (Kryter 1994). Additionally, noise can be disruptive to animals, including disrupting colonial nesting birds. As a result, the public has concern for potential annoyance and adverse effects of noise on both wildlife as well as humans.

The following sections present information about noise fundamentals for both airborne and underwater sound, regulatory requirements and aspects in relation to noise, and the existing noise conditions in the vicinity of the proposed diversion structure.

7.2 NOISE FUNDAMENTALS

Noise is defined as unwanted or objectionable sound, including sound that interferes with communication, disturbs sleep, or is intense enough to damage hearing (FHWA 1995). Sound is defined as a physical disturbance in a medium (such as water or air) which is detected by the ear. Sound has two components: (1) a particle motion component, which is directional and the oscillatory displacement, velocity or acceleration of the “particles” of the medium, and (2) a pressure component (Southall et al. 2007).

The intensity of sound (i.e., sound pressure levels) is measured in units of decibels (dB). The pitch of sound (i.e., frequency) is measured in hertz (Hz). The human ear has a reduced sensitivity to low and high-frequency sounds in relation to mid-frequency sounds. Therefore, airborne noise is measured on the A-weighted scale (dBA) to account for this reduced sensitivity. By comparison, in water, noise is measured on a scale that is either weighted for a specific species of interest (e.g., marine mammals), or not weighted (Southall et al. 2007). In addition, noise measurements should be identified as a source level (SL) or a received level (RL). A RL measure the dB a receiver (e.g., a human, bird, or whale) receives (or is exposed to), whereas a SL typically references the pressure level 1 meter from the source.

Airborne sound behaves and is measured different than waterborne sound. Sound travels much slower through air than water (about 0.2 miles per second [mps] in air versus about 0.9 mps in water) (OSPAR Commission 2009). A given sound will produce a lower sound pressure level in air than in water, as airborne and waterborne sound have different reference levels. Waterborne sound is measured in dB relative to a reference pressure of 1 micro Pascals (µPa), whereas airborne sound has a reference pressure of 20 µPa.

There are two types of noise that are most relevant to the proposed project. These two types of noise are non-pulsed (i.e., continuous) and pulsed (impulsive) noises. Distinguishing between pulsed and non-pulsed noises is important, as pulsed noises have a larger capacity to create physical injury than non-pulsed noises. Pulsed noises are impulsive, have rapid rise times from ambient to maximum pressure followed by a decay period, typically cover a wide range of frequencies, and include noises such as those generated from explosives and impact pile driving. Non-pulsed noises do not have a rapid rise time, can be either single or multiple frequencies (or both), and include noises such as those generated from vibratory pile driving and drilling (Southall et al. 2007).

7.2.1 Airborne Sound

Human sensitivity to sound varies, depending on the time of day. For example, a noise (i.e., nuisance sound) which is generated during the night or evening hours may be perceived as a larger nuisance than the same sound which is generated during the daylight hours. Therefore, evaluation of noise and regulations that govern noise are often related to the time of day that the noise is generated. As a result, there are two measures which are used to evaluate noise exposure: 1) the Leq, or the 24-hour equivalent sound level which is the level of steady sound with the same total energy as the time-varying sound and averaged over a 24-hour period, and 2) the Ldn, or the day-night sound level which is the Leq weighted by time of day. The Ldn adds a 10 dBA increase to any noise generated between the hours of 10:00 p.m. and 7:00 a.m.

To put sound levels (dBA) in perspective, Table 7.2-1 lists common sounds in the environment and their respective approximate sound level. The human ear can perceive a change as little as 3 dBA, and a 10 dBA increase is perceived as a doubling of sound (FHWA 1995).

Table 7.2-1
Typical Noise Levels

Common Outdoor Activities	Sound Level (dBA)	Common Indoor Activities
	---110---	Rock Band
Jet Fly-over at 1000 ft		
	---100---	
Gas Lawn Mower at 3 ft		
	---90---	
Diesel Truck at 50 ft, at 50 mph		Food Blender at 1 m (3 ft)
	---80---	Garbage Disposal at 1 m (3 ft)
Noise Urban Area (Daytime)		
Gas Lawn Mower at 100 ft	---70---	Vacuum Cleaner at 10 ft
Commercial Area		Normal Speech at 3 ft
Heavy Traffic at 300 ft	---60---	
		Large Business Office
Quiet Urban Daytime	---50---	Dishwasher Next Room
Quiet Urban Nighttime	---40---	Theater, Large Conference Room
Quiet Suburban Nighttime		(Background)
	---30---	Library
Quiet Rural Nighttime		Bedroom at Night, Concert Hall
	---20---	(Background)
	---10---	
Lowest Threshold of Human Hearing	---0---	Lowest Threshold of Human Hearing

Source: California Department of Transportation Technical Noise Supplement, September 2013, p. 2-20.

7.2.2 Underwater Sound

Naturally occurring underwater sounds can include sounds from vocalizing marine animals, fish, waves (weather-dependent), storms, and tidal currents. Anthropogenic underwater noise sources which are relatable to the proposed project can include fishing and charter boats, recreational vessels, large shipping containers, dredging, pile-driving, and other sources.

Fish are thought to use sound in a number of ways that are important to their survival. For example, sound can be used by fish to understand their surrounding environment, detect predators and prey, orient themselves during migration, and for acoustic communication (USFWS 2015). Potential direct effects resulting from elevated underwater noise can result in instantaneous death, latent death soon after exposure, or death several days later. Indirect effects could potentially make fish susceptible to predation, disease, starvation, or affect an individual's ability to complete its life cycle. Behavioral changes resulting from underwater noise could cause fish to alter their movement and foraging patterns. If foraging shifts from food-rich to food-poor habitat patches or energy expenditures for foraging increase, overall fitness of the fish may decline (USFWS 2015).

Underwater noise associated with pile driving activities have the potential to produce high intensity sound pressure underwater, which could cause direct impacts to fish (Caltrans 2012; Hastings and Popper 2005; Popper and Hastings 2009). High pressure waves from underwater noise can cause the swim bladder to be rapidly squeezed and then rapidly expanded as the sound wave passes through the fish. Other impacts may include the rupture of capillaries in internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues (Caltrans 2012).

When a pile driving hammer strikes a pile, a pulse is generated that moves through the pile and radiates sound into the water, the ground, and the air. Sound pressure pulse as a function of time is classified as the waveform. These sounds are described by the peak pressure, the root-mean-square (RMS) pressure, and the sound exposure level (SEL). The Fisheries Hydroacoustic Working Group (FHWG), a multi-agency work group, developed criteria for the acoustic levels at which various physiological effects to fish could be expected (FHWG 2008). The criteria were developed primarily for species on the west coast of the United States; however, the NMFS and USFWS have relied on these criteria for assessing projects on the east coast and the Gulf of Mexico for sound effects analysis (USFWS 2015). The FHWG determined that peak sound pressure waves should be within a single strike threshold of 206 dB, and the cumulative sound exposure level (cSEL) associated with a series of pile strike events should be less than 187 dB cSEL for protected fish species that are larger than 2 grams, and less than 183 dB cSEL for protected fish species that are smaller than 2 grams (FHWG 2008).

7.3 REGULATORY OVERVIEW

Although there are no federal regulations which restrict overall environmental noise levels, several federal agencies have published guidelines and policies concerning noise levels, including the EPA and the Federal Highway Administration (FHWA). The EPA noise guidance states that a day-night sound level (Ldn) of 55 dBA protects the public from indoor and outdoor activity noise interference (U.S. EPA 1974). The FHWA has developed standards for roadway and construction noise (23 CFR 772) which state that highway agencies are required to assess land uses/activities which may be affected by highway or construction noise and to evaluate noise abatement measures to reduce noise impacts. The FHWA has developed noise abatement criteria as hourly A-weighted sound levels that provide a benchmark to assess the level at which sound levels become a source of annoyance at different land use types; these criteria are published in 23 CFR 7722 and summarized in Table 7.2-3. The FHWA's noise abatement criteria can be used for assessment of the impacts associated with construction.

Where proposed Project construction would occur in Plaquemines, parish noise ordinances have been established. Plaquemines Parish has defined permissible sound levels, by receiving land use category, under its noise ordinance (Plaquemines Parish Code of Ordinances, Chapter 17, Article IX:

Table 7.2-3
FHWA Noise Abatement Criteria Hourly A-weighted Sound Level Decibels

Activity Category	Hourly Leq (dBA)	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	Exterior	Residential (includes undeveloped lands permitted for residential).
C	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings. (Includes undeveloped lands permitted for these activities).
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A–D or F. (Includes undeveloped lands permitted for these activities).
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	--	--	Undeveloped lands that are not permitted.

Source: 23 CFR 772.

For residential areas, the maximum permissible sound level is not permitted to exceed the following levels by more than 15 dB: 60 dBA during the daytime (between 7:00 a.m. and 10:00 p.m.) and 55 dBA at night.

For waterborne noise impacts, the analysis will consider the National Marine Fisheries Service (NMFS) revision to their *Technical Guidance for Assessing Effects of Anthropogenic Sound on Marine Mammal Hearing* released in April 2018. In this guidance, thresholds are provided for the onset of noise-induced hearing loss, defined as, temporary threshold shifts

(TTS) and permanent threshold shifts (PTS) as well as the changes in the threshold of audibility. These thresholds are dependent upon the marine mammal hearing group as well as the noise type (i.e., continuous or impulsive). When either one of these two thresholds are exceeded, NMFS considers the onset of PTS or TTS to have occurred. Table 7.3-1 presents the acoustic thresholds for the marine mammal hearing group that is likely to be present within the Project area, which includes bottlenose and common dolphins. The thresholds for sirenians (which include manatees) are similar but have lower upper cutoff frequencies and sensitivities compared to the mid-frequency cetaceans. NMFS also recognizes that there is a research gap for fishes, invertebrates, and sea turtles. As more data become available, thresholds may be established for sea turtles and marine fishes (NMFS 2018).

Table 7.3-1
Marine Mammal PTS and TTS Onset Acoustic Thresholds for Impulsive and Continuous Sound for Mid-Frequency Cetaceans

Acoustic Thresholds	Impulsive Sound	Continuous Sound
PTS Onset Acoustic Thresholds	PK (flat) = 230 dB SEL_{cum} MF, 24 h = 185 dB	SEL_{cum} MD, 24 h = 198 dB
TTS Onset Acoustic Thresholds	PK (flat)= 224 dB SEL_{cum}, MF, 24 h = 170 dB	SEL_{cum}, MF, 24 h = 178 dB

Peak sound pressure has a reference value of 1 µPa.

Cumulative sound exposure level (SEL_{cum}) has a reference value of 1µPa2s.

Note: The script "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The script associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and the recommended accumulation period is 24 hours.

Source: National Marine Fisheries Service. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

7.4 EXISTING CONDITIONS

In general, noise is typically generated from human activities, including commercial and recreational boating activities, operation of machinery, human residential-related noise sources, such as air conditioners and lawn mowers, and other anthropogenic noise sources. However, the proposed project site is located in a semi-remote area, with wetlands, cultivated crops and grasslands and small areas of low-level development (Table 15.3-1). Typical urban noises have little to no impact on this area.

The dominant activity category, as defined by the FHWA's Noise Abatement Criteria (NAC), in close proximity of the proposed diversion structure is Activity Category B (residences). The FHWA Leq criteria for Activity Category B is 67 dBA.

7.4.1 Airborne Sound

The total sound of an environment, including natural and anthropogenic sources of sound, is known as the ambient sound level. The magnitude and frequency of airborne ambient sound levels can vary depending on weather conditions, vegetative cover/ground composition, seasonal changes, motor vehicle traffic patterns, and more. Furthermore, various types of land uses/land cover have different ambient sound levels.

Baseline ambient airborne noise levels for the proposed project construction footprint are not available at this time. However, the ambient sound levels which are present within 0.5 miles of the proposed diversion structure include typical local roadway traffic, aircraft noise, marine vessels including recreational and commercial vessels (e.g., airboats, fishing boats, large container ships, and smaller recreational boats), natural wildlife vocalizations, and typical anthropogenic noise sources such as air conditioners and lawn mowers. In the United States, the ambient sound levels for typical outdoor environments can range from 40 Ldn (associated with rural residential areas) to 90 Ldn (associated with a congested urban environment) (U.S. EPA 1974).

To examine noise levels, land uses are grouped into Noise Sensitive Areas (NSAs). These NSAs are locations which may be more susceptible to noise impacts because of their use by people. NSAs can include residential areas, churches, schools, libraries, and other noise-sensitive land uses. The NSAs that are nearest to the proposed diversion structure include residential areas along LA HWY 39 and the Mississippi that were identified using aerial photography and the Plaquemines Parish Assessor's Office.

7.4.2 Underwater Sound

Ambient underwater sound levels represent noise from naturally-occurring sources. When anthropogenic sources are added to ambient noises sources, underwater noise levels increase. The extent and duration of increase is variable in time and space and dependent upon the individual and cumulative anthropogenic source types. In the Breton Sound Basin, sources of anthropogenic underwater sound include commercial fishing and recreational vessels, dredging, pile-driving, and oil and gas production. In the Mississippi River, anthropogenic underwater sound may be generated by smaller fishing and recreational vessels, as well as larger commercial vessels (e.g., oil tankers and container ships), pile-driving, and dredging.

Breaking waves can produce underwater sound in the mid-frequency range of 500-10,000 Hz and can increase with wind speed. Marine mammals, fish, and invertebrates produce biological sounds which can generate noise in the frequency of 10 to 10,000 kHz. The sound of the random movement of water molecules due to temperature changes can generate higher frequency sounds. Lower frequency sound in the 20-500 Hz range is anthropogenic in nature, as vessel traffic generates low-frequency sound which can travel considerable distances (DOSITS 2017).

Measurements of baseline ambient underwater sound in the project area are not available. However, as discussed in Section 7.2.2, NMFS has established thresholds for physical and behavioral effects of underwater noise on sea turtles, fish, and marine mammals due to impulsive (e.g., impact pile-driving, seismic air guns) and non-impulsive (e.g., vibratory pile-driving, sonar) sound sources.

8.0 TERRESTRIAL WILDLIFE AND HABITAT

8.1 INTRODUCTION

The majority of the habitat in the Breton Sound Basin consists of wetlands and open water habitat, see Section 15.0 (Land Use and Land Cover). Less than 10,000 acres of various terrestrial habitats occur in the Breton Sound Basin, and less than 250 acres are located in the construction footprint (Table 15.3-1). However, numerous species rely on these terrestrial habitats. Although some species may use wetlands extensively, they are considered terrestrial species and are discussed below.

8.2 HISTORICAL CONTEXT

The Breton Sound Basin is characterized predominately by open water and wetlands, with natural and artificial levees, lakes, bayous, canals, barrier islands, and bays. The Project area is characterized primarily by historical agricultural, residential, and industrial land conversion and development within the natural levee ridges associated with the Mississippi River. Additional man-made levee systems located east of the Mississippi River batture and also west of the historical natural levee have been constructed to reduce area impacts due to storm surge and flooding as a result of major storms.

8.3 VEGETATION

The Breton Sound Basin includes the Mississippi River Alluvial Plain and the Deltaic Coastal Marshes and Barrier Islands ecoregions (levels III and IV respectively; U.S. EPA 2006). Land cover and land use, according to the EPA, associated with this ecoregion include marshland, wildlife habitat, oil and gas production, and hunting, trapping and fishing. Uplands between the Mississippi River mainline levee and the New Orleans to Venice/Non-Federal hurricane protection levee support citrus orchards and pasture (U.S. EPA 2006). In some areas, the levees themselves provide habitat for cattle grazing. According to LDWF, Breton Sound Basin is part of the Gulf Coast Prairies and Marshes ecoregion of Louisiana. Typical associated terrestrial communities include coastal marsh areas, cypress-tupelo-blackgum swamps, coastal live oak-hackberry forests, live oak natural levee forests, and bottomland hardwood forests. Upland habitat types in these ecoregions are agriculture/cropland/grassland, coastal dune grassland/shrub thicket, and live oak natural levee forest.

Terrestrial vegetation is limited to areas with nonhydric soils (i.e., without wetland soils) and therefore is limited to areas without extensive inundation. The distribution of terrestrial vegetation ends where wetlands begin. As such, upland habitats and vegetation in the project area are generally limited to the northern and western portions of the Breton Sound Basin and to ridges and coastal barrier islands (LDWF 2009).

The Louisiana Natural Heritage Program (LNHP) identifies coastal erosion and associated coastal disturbance factors, urban expansion, residential and commercial development, land disturbance operations, introduction of exotic species, and many other human and natural disturbance factors as threats to these upland habitats and the vegetation within them. In addition, as sea level rises and salt water reaches existing uplands, saltwater intrusion leads to erosion of uplands and conversion of upland vegetation to more salt tolerant species, such as those found in coastal marshes (LDWF 2009).

8.3.1 Agriculture/Crop/Grassland

The agriculture/crop/grassland vegetation category comprises 2,757 acres of the Breton Sound Basin with 31 acres expected to be within the construction footprint (Table 15.3-1). This category includes orchards (such as pecan and citrus orchards), vineyards, experimental plots, plant nurseries, roadway rights-of-way, cover crops (for example, grain, cotton, soybeans, rice and sugarcane), fields prepared or partially exposed, fallow (idle) fields, and grasslands (pastures and/or rangeland). Historically, agricultural land uses had higher diversity and provided habitat and forage for many species; however, monocultures have resulted in a decline in potential habitat quality. Vegetated stream sides and patches of forest or open rangeland, if present within these disturbed lands, can provide breeding, dispersal, and corridors for travel between fragmented habitats. The LDWF (2005) indicates that no species of conservation concern are dependent upon these habitats for survival, although many resident and migratory species may rely on them.

8.3.2 Coastal Dune Grassland/Shrub Thicket

Coastal dune grasslands and shrub thickets occur on beach dunes and elevated backshore ridges on barrier islands and on mainland shores. The dunes of Louisiana's barrier islands and mainland beaches are poorly developed because of the high frequency of overwash associated with hurricanes and storms and limited amounts of sand transported via wind and currents from other places. These habitats are normally well drained due to elevation above mean high water, but are exposed to the effects of salt spray, overwash with saltwater flooding, sand deposits, and storm floods, which can alter dunes and ridges in this community. Moderate or serious threats to coastal dune grasslands include human intrusion/disturbance, natural system modification (shoreline erosion), climate change, and severe weather. Although coastal dune shrub thickets are subject to similar threats, the severity of these threats to the habitat is low (LDWF 2015).

The vegetation of coastal dune grasslands is dominated by salt spray tolerant grasses, which may include wiregrass (*Spartina patens*) sea oats (*Uniola paniculata*), beach panicgrass (*Panicum amarum*), purple sandgrass (*Triplasis purpurea*), jointgrass (*Paspalum vaginatum*), seacoast bluestem (*Schizachyrium maritimum*), saltgrass (*Distichlis spicata*), sandspurs (*Cenchru*s spp.), finger grass (*Chloris petraea*), coast dropseed (*Sporobolus virginicus*), red lovegrass (*Eragrostis oxylepis*), and broomsedges (*Andropogon* spp.). Forbs are common, particularly on the gulfward side of the dune and may include salt wort (*Batis maritima*), beach morning-glory (*Ipomea stolonifera*), goat-foot morning-glory (*I. pes-caprae*), V goat-foot morning-glory (*Iva imbricate*), seaside goldenrod (*Solidago sempervirens*), sea rockets (*Cakile* spp.), large leaf pennywort (*Hydrocotyle bonariensis*), camphor weed (*Heterotheca subaxillaris*), sea purselane (*Sesuvium portulacastrum*), seastar rose-gentian (*Sabatia stellaris*), quelite (*Atriplex arenaria*), glassworts (*Salicornia* spp.), annual seepweed (*Sueda linearis*), butterfly pea (*Centrosema virginianum*), and common frog-fruit (*Lippia nodiflora*).

Coastal dune shrub thicket occurs on stable sand dunes and beach ridges on barrier islands and the mainland coast, but is very limited in extent and appears as a dense thicket of shrubs. Plant species may include wax myrtle *(Morella cerifera*), yaupon holly (*Ilex vomitoria*), marsh elder (*Iva* spp.), salt bush (*Baccharis halimifolia*), acacia (*Acacia smallii*), and toothache tree (*Zanthoxylum clava-herculis*). The shrubs are often covered with lichens and vines such as greenbriers (*Smilax* spp.) and wild grape (*Vitis mustangensis*). The thickets may be covered or eroded by dune migration and shift to coastal dune grassland (LDWF 2005).

8.3.3 Live Oak Natural Levee Forest

Live oak natural levee forest occurs principally in southeastern Louisiana on natural levees or front lands and on islands within marshes and swamps. This forest type occurs in the deltaic plain of southeastern parishes, including Orleans and St. Bernard Parishes. Since this forest type is found only on natural levees, which are higher and drier than the surrounding bottomlands and marshes, they were the first areas to be cleared for agriculture and residential development. Saltwater intrusion, fragmentation, overgrazing, coastal erosion, residential development, herbivory, recreational vehicle use, and roadway and utilities construction are identified as threats to live oak forests. Of the original 500,000 to 1,000,000 acres of this habitat in Louisiana, approximately 10,000 to 50,000 acres (one to five percent) remain in Louisiana. The forest is considered critically imperiled in Louisiana (LDWF 2005).

Live oak natural levee forest developed on natural ridges in the coastal zone and has greater species diversity than barrier island communities. In addition to live oak, canopy species include water oak (*Q. nigra*), American elm (*Ulmus americana*), hackberry, Drummond red maple, and green ash (*Fraxinus pennsylvanica*). In the understory, dwarf palmetto (*Sabal minor*) is often conspicuous, reaching up to 13 feet in height, but a number of other shrubs may be present, including deciduous holly (*Ilex decidua*), green hawthorn (*Crataegus viridis*), swamp dogwood (*Cornus foemina*), water elm (*Planera aquatica*), wax myrtle (*Morella cerifera*), elderberry (*Sambucus canadensis*), and red bay (*Persea borbonia*). The herbaceous layer is often poorly developed, but may contain such species as seaside goldenrod (*Solidago sempervirens*) and vines such as climbing hempvine (*Mikania scandens) and greenbriar (Smilax rotundifolia*). Epiphytes such as Spanish moss (*Tillandsia usneoides*) may also be conspicuous (LDWF 2005).

8.4 TERRESTRIAL WILDLIFE

Terrestrial wildlife species in the project area are numerous and diverse, including birds, reptiles, amphibians, and mammals. It is widely recognized that the public places a high priority on the value of wildlife for aesthetic, recreational, commercial, and conservation interests. Select game and non-game species found in the Breton Sound Basin are listed in Table 8.4-1, by habitat. Species designated as federally threatened or endangered are addressed in Section 11.0.

Numerous wildlife species are considered game species and are managed by the State as commercial, renewable natural resources. For example, whitetailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo silvestris*), bobwhite quail (*Colinus virginianus*), rabbit (such as *Sylivagus floridana*), gray squirrel (*Sciurus carolinensis*), alligator (*Alligator mississippiensis),* and migratory birds and waterfowl, which include designated species of doves, woodcock, teal, rails, gallinules, snipe, ducks, coots, mergansers, and geese, are all regulated species that occur in the project area (LDWF 2005). Feral hogs (*Sus scrofa*) are an important terrestrial species found primarily in terrestrial areas in the Breton Sound Basin. Feral hogs are treated a nuisance species by the LDWF and may be hunted year round.

Table 8.4-1
Select Terrestrial Wildlife Species Expected within the Project Area

Common Name	Scientific Name	Representative Habitats			
		Upland Forest (Live Oak Natural Levee)	Urban/ Agricultural	Wetlands/ Marsh/ Bottomland Hardwoods	Shoreline
Birds					
Swainson's thrush[a]	*Catharus ustulatus*	X		X	
Yellow-throated vireo[a]	*Vireo flavifrons*	X		X	
Painted bunting[a]	*Passerina ciris*	X			
Wild turkey[b]	*Meleagris gallopavo silvestris*	X	X	X	
Mourning dove[a, b]	*Zenaida macroura*		X		
Common ground dove	*Columbina passerina*	X	X	X	
European starling	*Sturnus vulgaris*		X		
Bald eagle[a,c]	*Haliaeetus leucocephalus*	X	X	X	X
Red-tailed hawk[a]	*Buteo jamaicensis*	X	X	X	X
Mottled duck[a, b]	*Anas fulvigula*			X	
Common gallinule[a, b]	*Gallinula chloropus*			X	
White-faced ibis[a]	*Plegadis chihi*			X	
Horned grebe[a]	*Podiceps auritus*				X
Black skimmer[a]	*Rynchops niger*				X
Pelicans[a]	*Pelecanus spp*				X
American oystercatcher[a]	*Haematopus palliatus*				X
Plovers[a]	*Charadrius spp.*				X
Sandpipers[a]	*Calidris spp*				X
Wilson's snipe[a, b]	*Gallinago delicata*			X	X
Northern bobwhite quail[b]	*Colinus virginianus*	X	X		
Gadwell[a]	*Anas Strepera*			X	
Reptiles					
Green anole	*Anolis carolinensis*	X	X		
Louisiana milksnake	*Lampropeltis triangulum*				X
Texas rat snake	*Elaphe obsoleta linsheimeri*	X	X		
Alligator[b]	*Alligator mississippiensis*			X	
Amphibians					
Tree frogs	*Hyla spp.*		X	X	
Smallmouth salamander	*Ambystoma texanum*	X			
Mammals					
Muskrat[b]	*Ondatra zibethicus*			X	
Nutria[b]	*Myocastor coypus*			X	
Bobcat[b]	*Lynx rufus*	X			
Gray squirrel[b]	*Sciurus carolinensis*	X		X	
Whitetail deer[b]	*Odocoileus virginianus*	X		X	

Table 8.4-1
Select Terrestrial Wildlife Species Expected within the Project Area

Common Name	Scientific Name	Representative Habitats			
		Upland Forest (Live Oak Natural Levee)	Urban/ Agricultural	Wetlands/ Marsh/ Bottomland Hardwoods	Shoreline
Feral hogs[b]	*Sus scrofa*	X	X		

a. Protected by the Migratory Bird Treaty Act.

b. Game species.

c. Protected by the Bald and Golden Eagle Protection Act.

Sources: DeMay et al. 2007, American Bird Conservancy (ABC) 2013, Conner and Day 1987, Anderson and Seigel 2003, The Cornell Lab of Ornithology 2018.

8.4.1 Birds

Louisiana’s coast is located within the Mississippi Flyway for migratory birds and is recognized by the National Audubon Society as a Globally Important Bird Area (IBA). It provides important wintering and stopover sites for migrant waterfowl, shorebirds, and passerines, with much of the Project area a state priority, with the southern end of the estuary a global priority (Audubon 2019). Migratory bird species nest in the U.S. and Canada during the summer months and then migrate south to the tropical regions of Mexico, Central and South America, and the Caribbean for the non-breeding season. Some species breed in the northern United States and migrate to the Gulf Coast for the non-breeding season. Over 1,000 species of migratory birds are protected under the Migratory Bird Treaty Act (MBTA) of 1918, which prohibits the take or killing of individual migratory birds, their eggs and chicks, and active nests.

Louisiana’s coastal wetlands and marshes provide winter habitat for more than 50 percent of the duck population of the Mississippi Flyway. Located on the north end of the Breton Sound Basin is Bayou Sauvage National Wildlife Refuge, which has observed at least 255 species of birds within the refuge (USFWS 2013). Two of the 23 designated IBAs in Louisiana comprise portions of the Project Area; the Active Delta IBA and the East Delta Plain IBA. A third IBA, comprising the Chandeleur Islands, lies outside but adjacent to the Studyt Area. The Audubon Society accounts for about 340 species that use these IBAs throughout the year and noted 400 breeding pairs of Brown Pelicans (Audubon 2019). In addition to the Bayou Sauvage National Wildlife Refuge, which actually lies just outside the Study Area, the Biloxi Willdife Management Area and Pass a Loutre Wildlife Management Area managed by the LDWF and the Delta National Wildlife Refuge and Breton National Wildlife Refuge managed by the Department of the Interior provide important bird habitat and lie within IBAs recognized by the Audubon Society. The open water areas are used for feeding, with numerous terrestrial habitats available to wildlife, including bayous, marshes, ridges, sloughs, spoil banks, bottomland hardwood forests, lagoons, canals, and borrow pits (Audubon 2019).

Louisiana is also a center for colonial wading bird and seabird nesting in the United States, particularly for those species that regularly nest on the Atlantic and Gulf Coasts (Fontenot et al. 2012). Colonial waterbirds, a subset of migratory birds, include a large variety of wading bird and seabird species that share common characteristics such as gathering in large assemblies (colonies/rookeries) during the nesting season, and primarily using the water resource for all or most of their food (USFWS 2002). Colonial wading birds that occur in the project area include herons, egrets, bitterns, spoonbills, ibis, gulls, pelicans, and storks. These birds are largely carnivorous and insectivorous, feeding in shallow water areas, especially marshes, flooded fields, fields, and along bayou banks.

Raptor species (e.g., osprey, bald eagle, red-tailed hawk) may also occur in the project area. These species predominantly use upland areas. However, some also hunt over marsh, coastal beaches, shorelines, and open water bays.

The direct loss of habitat due to the erosion of marshes, conversion of bottomland hardwoods to frequently flooded swamp forests as a result of sea-level rise, and habitat fragmentation due to land use changes in the basin have impacted the quality of habitat for numerous bird species in the basin. Other problems include agricultural runoff and subsequent declines in water quality. Erosion, subsidence, saltwater intrusion, exotic plants, development, and incompatible grazing practices threaten coastal migratory bird stopover habitat in the basin (DeMay et al. 2007). The Louisiana Wildlife Action Plan (LDWF 2015) reports that the bird habitats in most peril include barrier islands and coastal forests. The LDWF (2015) also attributes loss of bird habitat and habitat function to direct mortality from many other anthropogenic sources including ingestion of plastics, electrocutions from power lines, fisheries' bycatch, collisions with infrastructure (for example, communication towers, wind turbines, power lines, glass windows), vehicle strikes, and poisoning from toxic releases.

8.4.2 Reptiles and Amphibians

Approximately 140 species of amphibians and reptiles occur in Louisiana, however the lowest species richness is found in the coastal marsh and Mississippi River floodplain areas (Holcomb et al. 2015). Reptiles and amphibians associated with salt marshes include, but are not limited to, the salt marsh snake (*Nerodia fasciata clarki)*, the diamondback terrapin (*Malaclemys terrapin*), and the Gulf Coast toad (*Incilius valliceps*). Alligators (common in fresh to brackish marshes, bayous, and lakes) occasionally use saltwater habitats as well (Palmisano et al. 1973). Threats to amphibians and reptiles in the project area include land use changes (and corresponding loss and fragmentation of habitat), nonnative and invasive species, which may reduce availability of prey or habitat, and pets such as cats that prey on snakes. Hurricane impacts and sea-level rise are anticipated to reduce the extent of upland habitat available to some species (Holcomb et al. 2015).

8.4.3 Mammals

Approximately 70 mammal species are found in Louisiana and its adjacent waters (Holcomb et al. 2015). Common mammals found within State-managed Wildlife Management Areas and Department of Interior managed refuges in and adjacent to the Project Area and identified above include white-tailed deer, squirrels, otter, raccoon, feral hog, nutria and mink (USFWS 2009). Game species such as gray squirrel and fox squirrel occur in the higher regions of the swamps and bottomland hardwoods in the northern reaches of the project area, where mast producing trees provide adequate forage. Whitetail deer, cottontail rabbits, and swamp rabbit (*Sylvilagus aquaticus*) may be more plentiful in higher elevations and ridges of the northern extent of the project area. Small mammals such as the eastern mole (*Scalopus aquaticus*) and the southern flying squirrel (*Glaucomys volans*) occur most commonly on ridges and levees where higher ground allows for dens and nesting.

In addition to their economic value as game species, mammals in the basin have primary roles as both prey and predator, functioning at various levels of the food chain and food web. For example, primary consumers such as deer and rabbits feed on vegetation and may be prey to coyotes, as well as a food source for vultures once they are dead. Raccoons eat crayfish and fish as well as small mammals. Bats are critical to pollination and seed dispersal.

Land use changes, climate change, water pollution, and domestic and feral pets can adversely impact the quality of the environment for mammals. Conversion of native uplands to agriculture, industry, residential areas, or utilities and transportation results in a direct loss of habitat and reduces access to habitat by eliminating corridors between habitats. Climate change is considered a threat to native habitats along the Gulf Coast due to a corresponding loss of habitat. Feral cats are often cited as a significant threat to small mammals, such as shrews and moles (Holcomb et al. 2015).

8.5 TERRESTRIAL INVASIVE SPECIES

An invasive species is defined as one that is nonnative to an ecosystem which is likely to cause economic or environmental harm or harm to human health, pursuant to EO 13112 (1999) [U.S. Forest Service (USFS) 2013]. Terrestrial invasive animals and plants are listed by state and parish/county by the Electronic Early Detection and Distribution Mapping System (EEDDMapS 2018). The potential adverse impacts of invasive species on the quality of native habitats described in Section 9.7.1 for aquatic plant species apply to terrestrial habitats as well. While species and habitats vary, pathways of introduction and establishment can be similar.

8.5.1 Invasive Plants

A survey of Louisiana forests from 2001 to 2013 by the Forest Inventory and Analysis (FIA) unit of the USFS found invasive plants in 3,963 (46 percent) of 8,689 sample plots (Oswalt 2013), demonstrating the problem of invasive species in Louisiana's uplands. Some of the more common invasive plant species within the project area include bush killer (*Cayratia japonica*), European roseau cane (*Phragmites australis*), and Chinese tallow tree (*Triadica sebifera*). Chinese tallow tree grows and spreads rapidly and is especially invasive around upland habitat comprising natural ridges and spoil banks in the Project Area (USFWS 2009). The aquatic invasive plant species within the Breton Sound Basin [i.e., water hyacinth (*Eichhornia crassipes)* and giant salvinia (*Salvinia molesta)* are addressed further in Section 9.7.1].

8.5.2 Invasive Animals

Terrestrial invasive species can be found on the USGS non-indigenous species list. Based on the Breton Sound HUC code, species in this area include coastal plain toad (*Incilius nebulifer*), greenhouse frog (*Eluetherodactylus planirostris*), and the Cuban treefrog (*Osteopilus septentrionalis*). Many species are non-native, but have not become established and do not appear to adversely impact the quality of habitat for native species and are not considered a management issue in Louisiana. Of the invasive species identified, nutria and feral hogs are considered the most destructive and are discussed in additional detail below. Invasive fish and other aquatic invasive species are described in Section 9.7.2.

8.5.2.1 Nutria

Nutria graze on the base of plant stems and dig for roots and rhizomes in the winter, destabilizing and eroding the soil, converting marsh to mud flat and open water, and altering plant species and habitat. Heavy nutria foraging can convert susceptible marsh areas to open water called “eat-outs” and exacerbate land loss (USGS 2000). Historically, the fur industry helped control populations of this once highly sought pelt; however, with the decline in the fur trade, populations began to sky-rocket after 1990. In 2002, LDWF implemented the Coastwide Nutria Control Program (CNCP). Approved under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), the CNCP encourages nutria harvest via monetary incentives. With the exception of alligators, nutria have no natural predators in Louisiana, but they are prolific and can produce two litters a year. Nutria can displace native species such as beaver, muskrats, and mink. An estimated 80,000 acres of marsh in the state have been severely damaged or lost due to nutria (Normand and Manuel 2018).

8.5.2.2 Feral Hogs

Feral hogs in Louisiana originated as escaped or released livestock (Kravitz et al. 2005) but now occur throughout the state of Louisiana. They can disturb large areas of vegetation, habitat, and soils while foraging and traveling, providing areas for invasive plant species to become established. Native fauna are directly impacted by competition and predation. Extremely prolific, sows can have two litters per year averaging six piglets per litter. The hogs prefer wooded areas, flat coastal plains, swamps, marshes, and other habitats with plentiful water. Louisiana’s nutrient-rich soils and diverse ecosystems abundantly produce the hogs’ favorite foods: roots, leaves, nuts, tubers, snails, insects, frogs, snakes, and rats. Populations of hogs in areas near waterways can contribute to degradation of water quality when fecal material from hogs enters waterways via stormwater or agricultural runoff and are known to spread disease and parasites that can affect livestock, wildlife, and humans (Ashe 2009; Hartley et al. 2012).

8.5.2.3 Roseau Cane Scale

The Roseau cane scale (*Nipponaclerda biwakoensis*), native to China and Japan, is also referred to as Phragmites scale or Roseau cane mealy bug. This small insect is associated with the die-off of more than 100,000 acres of Roseau cane (*Phragmites australis*), mostly in the lower birdfoot delta. Phragmites is one of the most important aquatic plants at slowing coastal erosion in Louisiana. Its loss in the birdfoot delta has been followed by colonization of other plant species that have less robust root networks and which therefore may be less effective at holding together delta soils and stabilizing navigation channels. In some cases, the die-off of Phragmites has led to the conversion from marsh to unvegetated mud flats. The Roseau cane scale may also pose a threat to agricultural crops, although that has yet to be confirmed. The Louisiana Department of Agriculture and Forestry (LDAF) issued a quarantine on March 26, 2018 for most of south Louisiana in an effort to stop the spread of the invasive insect (LDAF 2018) through the cutting and transport of cane stems, largely by duck hunters.

9.0 AQUATIC RESOURCES

9.1 INTRODUCTION

Aquatic resources in the Breton Sound Basin presented here include: aquatic vegetation; benthic resources; fauna (fish, shellfish, and fisheries); marine mammals; and invasive species. The abundance of aquatic resources in the basin is influenced by salinity, inundation, and corresponding habitat gradients, as well as riverine water inputs of sediments and nutrients (Beck et al. 2017; Lopez et al. 2014; Piazza and La Peyre 2007, 2009, 2012; Rozas et al. 2005), wind and wave action, hurricanes, and other climate events (Day et al. 2013; Piazza et al 2010; Twilley and Rivera-Monroy 2009). Salinity (Section 4.3.2), hydrology

(Section 3.5), and wetland vegetation (Section 5.4) are presented in earlier sections but are referenced here as appropriate. Essential Fish Habitat (EFH) and threatened and endangered species in the Breton Sound Basin, regardless of habitat, are addressed in Sections 10.0 and 11.0, respectively. Fishes of the Mississippi River are also included in the Aquatic Resources section because the proposed project could, when operating, impinge, entrain, and potentially relocate some fish into the Breton Sound Basin.

9.2 HISTORICAL CONTEXT

The Mississippi River Delta, including the Breton Sound Basin, was formed from river sediments deposited during seasonal pulses of fresh water from the Mississippi River; coarse sediment depositions formed natural levees along the river, and finer sediments accumulated seaward of the levees, into the basin (Twilley and Rivera-Monroy 2009). As the delta grew, emergent marsh vegetation became established, which slowed water velocities and increased sediment deposition, resulting in the formation of expansive marsh systems that further stabilized the delta and provided habitat for a diversity of flora and fauna. Allochthonous nutrients helped increase and maintain high levels of primary production representative of deltaic wetlands hydraulically connected to the Mississippi River. The linkage between high levels of primary and secondary production and periodic flooding of the Mississippi River has been recognized for a long period of time (Viosca 1927).

Construction of flood control projects (for example, Mississippi River levees) in the early and mid-1900s disrupted the hydrologic connection between the Mississippi River and its adjacent wetlands, reducing or eliminating fresh water, nutrient and sediment inputs to the delta (Turner 1997, Day et al. 2000). The construction of oil and gas pipeline canals has resulted in increased flooding stemming from impoundment effects of dredged spoil deposition on canal banks and allowing tidal energy and resulting salinity further into the estuary (Cable et al. 2007). Historical alterations in salinity, sediments, nutrients, wave energy, and other environmental factors are reflected in the productivity, trophic level interactions, nutrient cycling, vertebrate food chains, and subsequent changes in assemblages of flora and fauna in the Breton Sound Basin (Beck et al. 1982). Further loss of benthic resources and coastal fish and shellfish populations is anticipated with additional loss of habitats that are critical to their growth and survival (Chesney et al. 2000, Beck et al. 2001).

There have been many suggestions and past attempts to divert Mississippi River water east into surrounding marshes. In 1906, the Oyster Commission of Louisiana recommended gaps in the east bank levee in Plaquemines Parish to reduce salinity in the oyster beds of Breton Sound Basin (Beck et al. 1982). Viosca (1927, 1928) described the dependence of the fisheries of Louisiana on the fresh water resources of the Mississippi River. He suggested that problems would occur with flood control projects and suggested siphons to add fresh water to the wetlands. The Bayou Lamoque Diversion Structure was completed in 1956 by the LDWF to maintain oysters in Breton Sound Basin and another structure was built in 1977 to increase the capacity of diverting fresh water to the Breton Sound Basin. The USACE MR&T Project (1964, in Beck et al. 1982) recommended diversions at Bohemia and Scarsdale on the east bank. The projects were not constructed due to lack of local funding. Beck et al. (1982) contained studies on the fresh water requirements to meet defined salinity goals for fish and wildlife (Gagliano et al. 1971) and relationships between fresh water inflow and salinity in the Breton Sound Basin (Light and Alawadt 1970).

Oiling exposure in Louisiana from the DWH oil spill was extensive, with over 1,100 km of marsh oiling state-wide. Marsh oiling in Louisiana represented approximately 95% of the total marsh oiling Gulf-wide (DWH NRDA Trustees 2016a, Nixon et al. 2015). Breton Sound Basin, however, received little oiling compared to Barataria Basin (Figure 9.2-1).

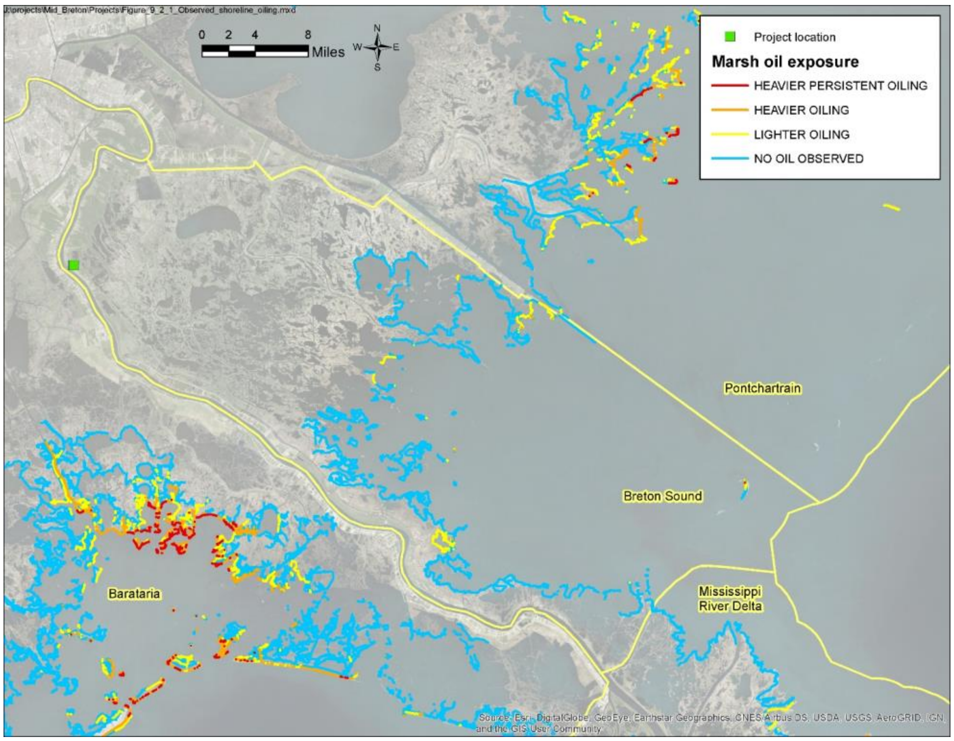


Figure 9.2-1. Observed Shoreline Oiling in and around the Project Area.
Source: Nixon et al. 2015.

9.3 AQUATIC VEGETATION

Aquatic vegetation in the Breton Sound Basin reflects salinity and inundation gradients, but is also influenced by sediment deposition, sediment type, nutrient and water clarity/light availability, seasonality, wave exposure, erosion, subsidence, sea-level rise, and storm surge (Paola et al. 2011, DeMarco 2018). Submerged aquatic vegetation (SAV) assemblages are generally grouped according to emergent marsh classification types. These distinctions are of marsh zones (fresh, intermediate, brackish, and saline) that reflect an extension of the marsh type into aquatic habitats without long-term emergent vegetation (Demarco 2018).

9.3.1 Submerged Aquatic Vegetation)

Breton Sound Basin exhibits an increasing salinity gradient, including fresh water wetlands in the uppermost basin and in the location of existing breaches along the east bank of the Mississippi River (e.g., Mardi Gras Pass and Fort St. Philip), intermediate marsh, followed by brackish habitats, and then saline marshes towards the Gulf of Mexico. SAV supports a diverse epiphytic biota, exports organic matter and nutrients into the water column, oxygenates the water column, and stabilizes bottom sediments by reducing current velocity and wave energy. In turn, these processes affect species composition, biomass, and distribution of the SAV, as well as the fauna that rely on SAV for food and habitat (Koch 2001). SAV in lakes, ponds, and open water also respond to sedimentation and agricultural water and nutrient runoff from the upper basin passing through the existing fresh water diversions, siphons, and splays.

SAV species distributions and biomass are influenced by winter salinity, water depth, and turbidity, as well as other variables. Chabreck (1972) documented a total of 30 SAV species on pond and lake bottoms in coastal Louisiana, and indicated widgeon grass (*Ruppia maritima*) was the most commonly identified species. Hillman et al. (2016) reported SAV biomass was lower in the saline zones in 2014 (compared to 2013) but did not vary significantly by salinity zone in 2013, demonstrating a salinity by year interaction effect on SAV. Consequently, SAV coverage is predicted as a group rather than by species (Visser et al. 2013, 2017). Changes in salinity, water depth, and light transmission can result in changes in biomass, productivity, species composition, and distribution of SAV (Hillman et al. 2017).

In their study of the reintroduction of Mississippi River water into Breton Sound through the Caernarvon Freshwater Diversion, Day et al. (2009) found that SAV percent cover was higher in the area most affected by the diversion. SAV had significantly ($p < 0.01$) elevated coverage in the inflow versus the reference area (unaffected by the diversion) in the Breton Sound Basin. The relative frequency of SAV increased across the total diversion area. Rozas et al. (2005) found that fresh water releases through the Caernarvon Freshwater Diversion increased the amount of SAV coverage. All 34 open-water sites sampled by Rozas et al. (2005) contained SAV (rooted vascular plants or macroalgae); whereas only 59% of the open-water sites in their reference area contained SAV. Percent cover was approximately 66% in the diversion inflow area and 18% in the reference area. The post-construction report for the Caernarvon Freshwater Diversion (USACE-LDWF 1998) reported that the three most common SAV species observed near the diversion were Eurasian watermilfoil, widgeon grass, and southern waternymph. The 2010 annual report for the Caernarvon Freshwater Diversion (CPRA 2010) indicated a reduction in SAV from salinity caused by storm surge after hurricanes in 2002, 2005, and 2008.

SAV is the most significant form of complex cover for aquatic animals in the Breton Sound Basin. Diverse SAV communities are often scattered throughout the marshes and provide important food and cover to a wide variety of fish and wildlife species, including juvenile and overwintering shrimp and crabs; coastal fishes such as red drum, Atlantic croaker, sand and spotted seatrout, and southern flounder; and habitat and foraging areas for invertebrates and fish (Hillman et al. 2017; LDWF 2005; Fonseca and Bell 1998). SAV in intermediate and brackish areas provide nursery grounds and shelter for many species of fish and shellfish (Rozas and Odum 1988; LWDF 2005).

9.4 BENTHIC RESOURCES

Coastal regions are among the most productive ecosystems in the world, and links between benthic and open water environments are significant in the transfer of energy between these habitats (Valiela 1995; Marcus and Boero 1998). For example, marsh epifauna such as periwinkles graze on algae and fungi that grow on the stems of marsh vegetation and soils, support the production of organic matter and nutrient cycling within the marshes, and are prey for salt marsh predators such as blue and mud crabs, turtles, large fishes, and wading birds (Montague et al. 1981; Kemp et al. 1990; Sillman and Bertness 2002). Benthic resources of the Breton Sound Basin described in this section include benthic algae, infauna (live in the sediment), and epifauna (live on top of the sediment). These benthic producer species and lower trophic level consumer species can also live on the shoots of marsh grasses and SAV, as well as oyster reefs. The penaeid shrimps (brown shrimp, white shrimp) and blue crab are presented in detail in Section 13.0, because they support valuable commercial fisheries and are key ecological species for coastal Louisiana. Likewise, oysters are sessile bivalves often addressed under benthic resources in assessment reports and EISs (for example, DWH NRDA Trustees 2016a). Eastern oysters are presented in Section 13.0, because they also support a valuable commercial fishery and provide important ecological functions in Louisiana estuaries.

Within the Breton Sound Basin, these lower trophic level benthic groups include benthic algae (i.e., chlorophytes, cyanophytes, and diatoms), infauna (i.e., amphipods, polychaetes, nematodes, and oligochaetes), and epifauna (i.e., small clams, snails, and marsh periwinkles). Changes in the distribution and composition of benthic resources have been linked to shifts in food web structure, increases in invasive species, and declines in the abundance of historical fish populations in other major U.S. estuaries (Kimmerer 2002 and 2004; Tango and Batiuk 2013; Kimmerer and Thompson 2014; Adamack et al. 2017). However, no specific benthic monitoring program exists for Breton Sound Basin and there are not many available ecological field studies evaluating how habitat and environmental conditions affect benthic resources in coastal Louisiana.

The major benthic groups and the predominant taxa for the Breton Sound Basin are listed in Table 9.4-1, including any known differences in benthic abundance, density, or biomass (per area or volume) by salinity zones, water quality conditions, or habitat type. Growth of benthic algal taxa depends on temperature, light, and nutrients. Like most aquatic organisms, benthic taxa have lower and upper threshold values for these conditions, outside of which they cannot grow. Cold temperatures generally reduce growth of benthic algae, infauna, and epifauna. Increased turbidity reduces light availability and generally reduces algal growth. Benthic taxa exhibit increasing growth with increasing temperature, light availability, and nutrient concentrations to some optimum growth based on these conditions (Thomann and Mueller 1987; Thornton and Lessem 1978); however, growth can become limited or even reduced if these functions get too high.

Table 9.4-1
Benthic Lower Trophic Level Taxa and Habitat Associations in Breton Sound Basin

Benthic Group	Predominant Taxa	Habitat Associations/Environmental Requirements
Benthic algae	Chlorophytes, Cyanophytes, Diatoms	Growth depends on temperature, available light, and nutrients. Tidal range and winds determine benthic diatom suspension and affect production (Shaffer 1988, Shaffer and Sullivan 1988). Chlorophytes prefer low salinity, high-nutrient, fast-flowing (short residence time) waters (Reynolds 2006). Low flow waters with high salinity and low nutrients favor cyanobacterial assemblages (Pinckney et al. 1999).

Table 9.4-1
Benthic Lower Trophic Level Taxa and Habitat Associations in Breton Sound Basin

Infauna	Amphipods, polychaetes, nematodes, oligochaetes	Mean infaunal density highest in vegetated marsh edge and non-vegetated bottom 3.3 feet (1 meter) from edge; density decreases with distance from marsh edge onto marsh surface and into deeper water (Rozas and Minello 2011, 2015, Whaley and Minello 2002) Benthic macrofauna communities responded to inflow events with increased abundances, biomass, and diversity but decreased during hypersaline conditions. Benthic meiofauna community abundance also increased with increasing inflow (Montagna et al. 2002). Species richness higher in shallower vegetated sites due to predator exclusion (Sikora and Sklar 1987 and reference therein). Mean number of infauna per sample were 10.5 in fresh, 7.5 in mesohaline, and 7.1 in polyhaline (Philomena 1983); Rozas and Minello (2015) demonstrate slight dip in spring infauna density for salinities at 4-7 ppt compared to fresh (1-2 ppt) and two higher salinity zones (≥ 13 ppt), but increasing density with salinity in fall samples by salinity zones. Benthic infaunal diversity decreased with salinity (Brown et al. 2000 and Gaston 1999) and density was reduced with contaminated sediments (Brown et al. 2000)
Epifauna	Mollusks such as small clams, marsh periwinkles, ribbed mussels	Epifauna attached to marsh stems within the estuary. Marsh periwinkles highest in salt marsh (*Spartina alterniflora*) and can graze Spartina down without predation regulation by blue crabs, turtles, birds (Siliman and Bertness 2002) Ribbed mussel density highest with lowest mortality rates at mid-estuary (salinity ~8 ppt) on *Juncus roemerianus* and higher at marsh edge than interior sites (Honig et al. 2015)

9.5 FAUNA

Fauna described here include key shellfish populations (shrimp, crabs, and oysters) and fish in the Breton Sound Basin, although some of these species also can inhabit the inland fresh water lakes and bayous or the nearby coastal and shelf waters of the northern Gulf of Mexico at different times during the year. Fresh water, estuarine, and marine waters and vegetation are used during different life stages by some these species, making impacts to any of these habitats relevant to the species. The most common fish species found in the lower reaches of the Mississippi River below New Orleans are also briefly described.

Fauna of the Breton Sound Basin are important for two main reasons: (1) they support valuable fisheries, and (2) they serve important ecological roles in the estuarine food web by transferring primary production up the estuarine food web and to coastal fish predators, marine mammals, sea turtles, and seabirds in the northern Gulf of Mexico.

The life history and population dynamics of key fish and shellfish species in Breton Sound Basin are presented first since their abundance and use of the Breton Sound Basin differs. The mean and median catch per unit effort (CPUE; total individuals caught per unit sample) for the key harvested and/or ecologically-important species are reported from the LDWF fisheries-independent monitoring data and briefly discussed as an indication of population trends in the Breton Sound Basin over time. Recent major events (i.e.,the 2019 opening of the Bonne Carre' spillway)[6] and the opening of the Caernarvon Freshwater Diversion Project are discussed to provide greater understanding of events affecting the Breton Sound Basin. These basin-wide annual time series plots are frequently used for annual reporting or for initializing and calibrating ecological models.

In Section 9.5.1 below, an overview of the key species of the Breton Sound Basin is provided, then a brief description of the common species in the Lower Mississippi River near the proposed diversion location is provided. In Section 9.5.2, the species and life stage-specific habitat preferences and environmental requirements related to hydrodynamics, bottom type, turbidity and sedimentation, and DO in Breton Sound Basin are provided, with salinity and temperature requirements listed in Table 9.5-1. Finally, the generalized food web and ecological interactions among the fauna in Breton Sound Basin are presented in Section 9.5.3. The species and life stages are grouped by feeding guilds or similar trophic positions (same prey, same predators) for the generalized estuarine food web in the Breton Sound Basin.

9.5.1 Key Fish and Shellfish Species in the Breton Sound Basin

Brown Shrimp

Brown shrimp, *Farfantepenaeus aztecus*, are benthic omnivores distributed from Massachusetts to southern Florida, and throughout the Gulf Coast to the northwestern Yucatan Peninsula (Patillo et al. 1997). The highest abundance of brown shrimp occurs along the Louisiana, Texas, and Mississippi coasts and the shelf waters in the northern Gulf Coast (Allen et al. 1980, Southeast Fisheries Center 1985, Williams 1984). Brown shrimp have an average life span of 24 to 28 months in the Gulf. Brown shrimp are an estuarine-dependent species meaning they spend some part to all of their life cycle in the estuary. O'Connell et al. (2017a) detailed the brown shrimp life cycle and the seasonal timing of peak abundances and movement of shrimp life stages on the shelf and in and out of Louisiana estuaries. The information is condensed here. At 10 to 15 mm total length (TL), brown shrimp post-larvae are carried into Breton Sound Basin by shelf currents and tides with peak migration in Breton Sound Basin occurring from January through June (Zein-Eldin and Renaud 1986). Metamorphosis to juveniles and settlement occurs around 25 mm TL in the estuaries, with peak months of early juveniles in Breton Sound Basin from mid-March through early June. The early juveniles prefer flooded marsh and edge habitats in the mid- to lower basin where they prey on benthic algae, infauna, and epifauna and can avoid larger aquatic predators including their own species (Zimmerman et al. 2000, Rozas et al. 2007, Minello et al. 2008). Rozas and Minello (2011)

[6] In September 2019 the U.S. Department of Commerce declared federal fishery disasters for the states of Louisiana, Mississippi and Alabama due to the impacts of extreme flooding events on fishery production in those states. Detailed scientific information is not yet available on the extent of the impacts to 2019 harvests of various species.

found that brown shrimp grew more slowly in low salinity habitats than high salinity habitats concluding that the slower growth was likely due to increased metabolic costs and less food resources in lower salinity. This would indicate that they are mainly found in higher salinity habitats in the lower basin. Juveniles remain in the shallow vegetated nursery habitats of Breton Sound Basin for about three months until they grow to approximately 60 mm TL (Minello et al. 1989). The larger juveniles move into deeper channels and open bays of the estuary in summer. They begin migrating as subadults (80 to 100 mm TL) out of the estuary towards the shelf in late summer and fall (Minello et al. 1989). Primary water quality factors known to affect brown shrimp abundance and distribution in the estuary include water temperature and salinity. According to de Mutsert et al. (2017) the optimum water temperature for brown shrimp is between 10 and 25 degrees centigrade; optimum salinity is 8 to 30 ppt.

Brown shrimp juveniles and subadults are highly abundant in Louisiana estuaries, and the migrating subadults support valuable commercial inshore and offshore fisheries in the early spring through late summer. Louisiana has the second highest brown shrimp landings after Texas, with Louisiana accounting for an annual average contribution of 30% of the total U.S. landings by weight (from 2000 to 2016, NMFS 2018). The GMFMC manages the penaeid shrimp fishery (including brown, white, and pink shrimp) in federal waters (offshore from 3 nautical miles to 200 nautical miles). LDWF manages the state's inshore fishery (state waters from shore to 3 nautical miles). An annual average of nearly 70% of Louisiana's reported shrimp landings from 2000 to 2013 are from state waters. The Breton Sound Basin which is included in the Pontchartrain Basin reporting area, contributes an average annual proportion of 6% of the inshore landings in Louisiana (Barnes et al. 2016).

Piazza et al. (2010) found a connection between winter El Niño Southern Oscillation (ENSO) conditions and juvenile brown shrimp abundance in Breton Sound Basin the following spring. The physical connection results from the impact of ENSO on winter weather conditions (air pressure, temperature, and precipitation). Juvenile brown shrimp abundance effects were found to lag ENSO by 3 months, with lower than average abundance of juvenile brown shrimp caught in the spring following winter El Niño events, and higher than average abundance of brown shrimp caught in the spring following La Niña winters. Salinity was the dominant environmental condition associated with juvenile brown shrimp. Spring salinity was forced by winter river discharge, winter wind forcing, and spring precipitation. Piazza et al. (2010) found that predicting brown shrimp abundance requires incorporating climate variability into models.

Sable and Villarrubia (2011) evaluated LDWF biological monitoring program data from 1988–2010 to determine if there have been any changes in the abundance patterns and distributions of the species in Breton Sound Basin before construction of the Caernarvon Freshwater Diversion was completed and after the diversion has been in operation. They found brown shrimp in trawls decreased, then increased with patterns not commensurate with the diversion operation periods, and distributions were rarely related to salinity at the stations. In the operation, maintenance and monitoring report for Caernarvon Freshwater Diversion for 2015–2016 (Plitsch 2017), brown shrimp were found to be well distributed throughout Breton Sound Basin and catches increased in both seines and trawls.

The effect of the Caernarvon Freshwater Diversion on brown shrimp has been studied and summarized (Rozas et al. 2005, GEC 2011, Plitsch 2017). In general, while there appears to be some displacement of juvenile brown shrimp downbasin while the diversion is in operation, there is no clear data indicating the Caernarvon Freshwater Diversion was resulting in decreases in abundance basin-wide. Brown shrimp did not appear to be negatively affected by the current flow regime of Caernarvon in a Before/After and Control/Impact (BACI) analysis. The biomass was apparently declining before the diversion became operational and appears to be increasing in the inflow area since 1996 (de Mutsert 2010, de Mutsert and Cowan 2012).

In a study of the abundance and size of shrimp before and after the DWH oil spill, van der Ham and de Mutsert (2014) found no significant changes in either abundance or size of brown shrimp in Breton Sound Basin before and after the spill. In 2011, brown shrimp abundances were higher than pre-spill in Breton Sound Basin; this pattern continued in 2012. The size of brown shrimp did not significantly differ after the spill compared with before the spill, in either the 2010, 2011, or 2012 year-classes.

White Shrimp

White shrimp, *Litopenaeus setiferus*, are benthic omnivores distributed from Fire Island, New York to St. Lucie, Florida on the Atlantic Coast, and from Apalachee Bay, Florida to Campeche Bay, Mexico in the Gulf Coast (Patillo et al. 1997). The highest abundance of white shrimp occurs along the Louisiana coast (Klima et al. 1982). White shrimp typically live for a year in the Gulf; however, some studies have also shown them to live up to 2 to 4 years in the Gulf (Christmas and Etzold 1977, Klima et al. 1982). White shrimp are an estuarine-dependent species with a similar life cycle and estuarine use by juveniles and subadults as the brown shrimp, although the seasonal timing of white shrimp juveniles in the estuaries lags behind the brown shrimp by a few months. O'Connell et al. (2017b) presents details of the white shrimp life cycle and the seasonal timing of peak abundances and movement of shrimp life stages on the shelf and in and out of Louisiana estuaries. The description from O'Connell et al. (2017b) is condensed here for Breton Sound Basin. White shrimp post-larval stages are carried from the shelf into the estuaries by currents and tides from May through November (Zein-Eldin and Renaud 1986).. One peak is in June and a second peak occurs in September (Baxter and Renfro 1968, Klima et al. 1982). Metamorphosis to juveniles occurs at 25 mm TL (Cook and Lindner 1970, Muncy 1984). Juveniles from 25 to 120 mm TL move to less saline waters (salinities usually below 5 and 10 ppt) and farther up into the estuary compared to brown shrimp. As with brown shrimp, Rozas and Minello (2011) found that white shrimp grew more slowly in low salinity habitats than high salinity habitats with the same conclusion as with brown shrimp. This would indicate that they are mainly found in higher salinity habitats in the lower basin. Juveniles leave the shallow habitats of the estuary after about three months and move into deeper, more saline regions in the lower estuary as they reach maturity and migrate back to the shelf to spawn (Cook and Lindner 1970).

Subadult and adult white shrimp are abundant in Breton Sound Basin and support a valuable commercial inshore and offshore fishery in Louisiana. The Louisiana white shrimp fishery has supported more than 60% of the U.S. annual landings from 2000 to 2016 (http://www.st.nmfs.noaa.gov). An annual average of 64% of Louisiana's reported white shrimp landings from 2000 to 2013 are from the state waters (LDWF Shrimp Management Plan 2015). the Breton Sound Basin which is in the Pontchartrain Basin contributes an average annual proportion of 8% of the inshore landings in Louisiana (LDWF Shrimp Management Plan 2015).

Sable and Villarrubia (2011) found that catches of white shrimp in trawls increased during the time of Caernarvon Freshwater Diversion operation. Plitsch (2017) found that white shrimp were present throughout Breton Sound Basin and catches increased in 2015 and 2016 in seines and 16 ft trawl samples, but decreased in 2014 in 6-foot trawl samples.

The effect of the Caernarvon Freshwater Diversion on white shrimp has been studied and is summarized (Rozas et al. 2005, GEC 2011, Pilsch 2017). White shrimp total catch in seines did not change from pre- to post-operation (USACE-LDWF 1998). However, Day et al.

(2009) reported small increases in white shrimp abundance after the initiation of Caernarvon operations. White shrimp biomass in seines was significantly higher post-operation in the impact versus the control area since the opening of Caernarvon Freshwater Diversion (de Mutsert 2010, de Mutsert and Cowan 2012).

In the study before and after the DWH oil spill, van der Ham and de Mutsert (2014) found no significant changes in either abundance or size of white shrimp in Breton Sound Basin before and after the spill. In 2011, white shrimp abundances were higher than pre-spill in Breton Sound Basin; this pattern continued in 2012. The size of white shrimp was significantly larger after the spill compared with before the spill in both 2011 and 2012.

Blue Crab

Blue crabs, *Callinectes sapidus,* are found in coastal bays and estuaries around the world, ranging from Nova Scotia to northern Argentina, Bermuda, and the Caribbean, and have been introduced to coastal waters of Europe and Japan. They are abundant throughout estuaries in the Gulf Coast (Patillo et al. 1997, Millikin and Williams 1984), where they typically live for one to three years, spending most of their life in the estuary.

O'Connell et al. (2017c) present details of the blue crab life cycle and the seasonal timing of peak abundances and movement of blue crab life stages in and out of Louisiana estuaries. Eggs are carried externally by the female for approximately two weeks. They hatch near the mouths of estuaries and the zoeal larvae are carried offshore. Zoeae are planktonic and remain in offshore waters for up to a month. The larvae can be transported >300 km or more in the northeastern Gulf of Mexico (Oesterling and Evink 1977) which suggests that larvae produced in one estuary could recruit into others. Re-entry to the estuaries occurs during the megalopal stage after which they molt to the first crab stage and settle in nursery habitats within the estuaries (Thomas et al. 1990, Perry et al. 1995). Juveniles (2.0 to 150 mm carapace width [CW]) and adults tend to remain in the estuary. Small juveniles prefer shallow (< 0.5- to 1-m deep) vegetated habitats while larger juveniles and adults prefer muddy or sandy substrates in deeper (≥ 1 m deep) channels and bays. Adult males spend most of their time in low salinity waters (≤ 15 ppt) of estuaries; females move to these lower salinities as they approach their terminal molt to mate with the males (during the spring in the Gulf of Mexico). After mating, females move in June and July to higher salinity (typically 15 ppt and above) regions in the lower estuary and near barrier islands (Williams 1984, Patillo et al. 1997).

Adult blue crabs (≥ 125 mm carapace width) support important commercial and recreational fisheries in the Gulf and Atlantic Coasts. The Louisiana commercial fishery has supported 20 to 25% of the average annual U.S. landings from 2000 to 2016 (NMFS 2018). A general decline in adult blue crab abundance has been observed in trawl data (West et al. 2016, 2018); however, observed landings for Louisiana have remained high since the late 1980s (Figure 9.5-1). West et al. (2016, 2018) determined that the Louisiana blue crab stock is currently overfished and that the annual fishing mortality rates are extremely close to overfishing limits.

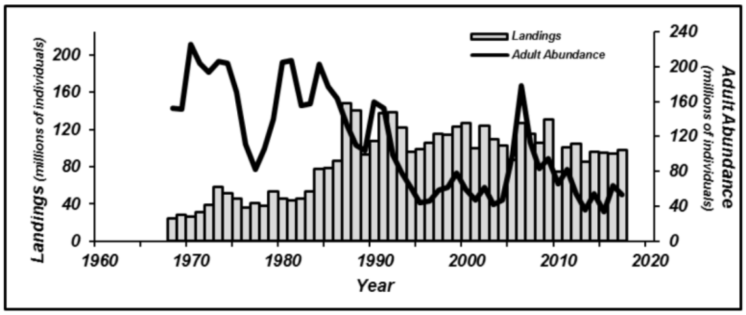


Figure 9.5-1. Estimated Adult Abundance from the LDWF Stock Assessment Model and Observed Landings of Louisiana Blue Crab. Commercial crab landings are expanded by 5% to approximate for the recreational harvest. Units are in millions of individuals.
Source: West et al. 2018.

In their study of the evolution of Mardi Gras Pass from March 2012 to December 2013, Lopez et al. (2014) reported capturing blue crab within the pass using trot-line, crab traps, and minnow traps. The effect of the Caernarvon Freshwater Diversion on blue crab has been studied and is summarized in the lessons-learned report (GEC 2011). Post-operation catch of blue crab was almost double the pre-construction catch in seines and slightly changed in trawls. Seines primarily caught juvenile crabs, whereas trawls caught crabs of all sizes. CPUE increased by 88% post-operation, was highest in 1991 (a year of low salinities, although the river water was not introduced through Caernarvon), and catches increased at the most interior stations

Bay Anchovy

Bay anchovy, *Anchoa mitchilli*, range from Maine to Tampico, Mexico and likely have the greatest biomass of any fish in estuarine waters of both the southeastern U.S. and the Gulf of Mexico (Morton 1989, Pattillo et al. 1997). All life stages of bay anchovy are abundant in Louisiana estuaries. LDWF does not target the fish or actively monitor their abundances, though their early life history and population dynamics are well studied in the northern Gulf of Mexico (i.e., Chesney 2008). Bay anchovy reach maturity within three months and have a maximum lifespan of about three years (Houde and Zastrow 1991). Because of their high biomass and importance within estuarine food webs, bay anchovy is often used as an indicator species of estuarine health (Sable et al. 2017a). Bay anchovies prey exclusively upon zooplankton and are a dominant prey item for many predatory coastal bird and fish species (Shipp 1986). Their abundance and distribution in estuaries appear to be primarily influenced by zooplankton distribution (Houde and Zastrow 1991). Life history reports and species accounts regard bay anchovy as a true euryhaline and eurythermal species tolerant of a wide range of salinities and temperatures (Houde and Zastrow 1991, Pattillo et al. 1997, Sable et al. 2017a).

Abundance data for other coastal anchovy species exhibit multi-decadal cycles with large-scale climatic changes (Chavez et al. 2003). It is unknown whether bay anchovy populations in Louisiana's estuaries exhibit such cycles; however, the CPUE trend for trawls appears to preliminarily indicate these multi-decadal patterns. In a BACI study of the Caernarvon Freshwater Diversion, de Mutsert (2010) and de Mutsert and Cowan (2012) found bay anchovy abundance was significantly higher in seines after the diversion opened. In their study of the evolution of Mardi Gras Pass from March 2012 to December 2013, Lopez et al.

(2014) reported capturing bay anchovy along Transect A near the opening of the pass off the Mississippi River using electrofishing.

Gulf Menhaden

Gulf menhaden, *Brevoortia patronus*, form large schools and feed on plankton in the water column. They are found primarily in the Gulf of Mexico, with peak abundances from Apalachicola, Florida to Matagorda Bay, Texas (Pattillo et al. 1997). Gulf menhaden are abundant in coastal Louisiana and have constituted a high proportion of the total abundance of species caught by multiple LDWF fishery-independent gears (Watkins et al. 2014). Adult menhaden rarely live beyond four years (Patillo et al. 1997).

Sable et al. (2017b) presents a conceptual life history diagram adapted from Christmas et al. (1982) and describes the details of the gulf menhaden life cycle in and out of the Louisiana estuaries. Spawning occurs in the fall through early spring on the shelf. Yolk-sac larvae are carried inshore and to the estuaries by currents. The larval stage begins around 2.6 mm standard length and lasts three to five weeks (Christmas et al. 1982). Feeding larvae move further up the estuary into shallow bays and river tributaries. Metamorphosis to the juvenile stage occurs around 19 mm standard length in the low salinity upper estuary. They move farther down the estuary (≥ 10 ppt) and into deeper waters as they grow from 40 mm to about 85 mm standard length. Maturation occurs after two growing seasons. Adults typically live two to three years (Deegan 1990). Adults move inshore and up in the estuary and rivers during spring and summer (Deegan 1990) and then onto the shelf to spawn during the fall and winter (Shaw et al. 1985).

Gulf menhaden have a critical ecosystem role as a primary consumer and generalist filter feeder (Ahrenholz 1991, Deegan 1986) and as prey to a wide variety of predators (Vaughan et al. 2007). There is an extensive Gulf menhaden fishery dating back to the late 19th century (Nicholson 1978). The fishery for Gulf menhaden is one of the largest by volume in the United States and has been managed under a regional Fishery Management Plan (FMP) since 1978 (SEDAR 2013). The average annual landings from 2000 through 2016 for the northern Gulf of Mexico is 516,821 million tons, with Louisiana landings making up an average of 80% of the reported commercial landings (NMFS 2018). The majority of the Gulf of Mexico landings occur in Louisiana in large part because purse seining is still legal, unlike in Florida and Alabama (Vanderkooy and Smith 2002).

The effect of the Caernarvon Freshwater Diversion on Gulf menhaden has been studied and is summarized in the lessons-learned report (GEC 2011). Catches of Gulf menhaden in seines increased in the post-construction period by 503% and the greatest catch was at the station nearest the diversion; however, the catch was very patchy because menhaden is a schooling species resulting in patchy catches of large numbers. Seines and trawls tend to catch juveniles, whereas gill nets and trammel nets tend to catch larger fish. Trawl catches of menhaden increased by 325% (6-foot) and 85% (16-foot). The large decrease in catch at the station closest to the diversion post-operation may have been due to the preference of larger menhaden for higher salinities (USACE-LDWF 1998). Gulf menhaden abundance was significantly higher post-operation in the impact versus the control area since the opening of the Caernarvon Freshwater Diversion (de Mutsert 2010, de Mutsert and Cowan 2012). In their study of the evolution of Mardi Gras Pass from March 2012 to December 2013, Lopez et al. (2014) reported capturing Gulf menhaden along Transect A near the opening of the pass off the Mississippi River using electrofishing.

Red Drum

Red drum, *Sciaenops ocellatus*, occur throughout the Gulf Coast and along the Atlantic Coast to Massachusetts (Murphy and Taylor 1990). They are an estuarine-dependent species with juveniles and subadults remaining in their natal estuaries until they reach maturity and begin to aggregate to shelf regions for spawning. Red drum reach maturity at about 660 to 700 mm TL at age four, with a maximum age of 37 years reported for the northern Gulf of Mexico (Powers et al. 2010; Wilson and Nieland 1994; Patillo et al. 1997).

Red drum spawn on the northern Gulf of Mexico shelf during a relatively brief period that generally begins in August and ends in the early part of October (Wilson and Neiland 1994). Feeding larvae are 8 to 15 mm TL with metamorphosis to the juvenile stage occurring at 15 mm TL (Patillo et al. 1997). The larvae and early juveniles are carried by tides and currents in late fall to the shallow estuaries with peak ingress occurring in October. Larvae are carried through barrier island passes in the surface waters and juveniles move from the bay up the estuary to quiet backwater nursery areas to grow (Perret et al. 1980; Peters and Michael 1987). Early juvenile red drum less than 100 mm TL use the marsh edge and shallow vegetated habitats of the estuaries extensively. Early juvenile drum leave the shallow nursery habitats when they reach about 40 to 120 mm TL to move into bays and deeper channel waters. As juveniles approach 200 mm TL in their first spring, they may remain in deep water bays or congregate in tidal passes (Simmons and Hoese 1959; Peters and Michael 1987). Large juvenile and adult red drum make long-range movements throughout the estuaries and into backwaters with increasing temperature and foraging opportunities. Young red drum are euryhaline and eurythermal. Sub-adults appear to remain in the bays throughout the year while older fish (>3 years) move to the shelf in early fall and winter to spawn (Perret et al. 1980; Hein and Shepard 1986; Wilson and Nieland 1994).

Red drum support an important recreational fishery in the south Atlantic and Gulf state waters, where landings have averaged 14,500,944 pounds annually from 2000 through 2013 (Louisiana has not reported recreational landings since 2013), with the annual proportion of recreational landings from Louisiana constituting more than 70% of the total (NMFS 2018). Recreational fisheries for juvenile and subadult red drum that live within the estuarine waters (ages 1 to 4) are strictly managed within each of the Gulf of Mexico state waters. Red drum were commercially overfished in the Gulf of Mexico during the late 1980s, and a commercial harvest moratorium has been in place since 1987 (Powers et al. 2013).

In their study of the evolution of Mardi Gras Pass from March 2012 to December 2013, Lopez et al. (2014) reported capturing red drum within the pass using gill nets and electrofishing. In the 2015-2017 operations, maintenance and monitoring report for Caernarvon Freshwater Diversion (Plitsch 2017), red drum were reported as being throughout the Breton Sound Basin. They showed an increased in capture between 2015 and 2016 using trammel nets and remained steady in gill net capture between the years. They have been relatively steady in both trammel and gill net capture through the years except 1994 which showed a sharp increase possibly demonstrating the schooling behavior of the species.

The effect of the Caernarvon Freshwater Diversion on red drum has been studied and is summarized in the lessons-learned report (GEC 2011). Red drum were generally more abundant in the post-operation period and were caught in the greatest numbers in trammel nets, gill nets, and seines. Catch numbers for all gear types increased post-operation as compared to pre-operation. In the CPRA (2010) report red drum catch in the seine data was 29% higher during the post-operational period and were caught below and above the 5 psu isohaline. Red drum biomass was significantly higher post-operation in the impact versus the control area since the opening of the Caernarvon Freshwater Diversion (de Mutsert 2010; de Mutsert and Cowan

2012). The authors of those reports suggested greater individual biomass was a result of greater prey availability resulting from operation of the Caernarvon Freshwater Diversion.

Spotted Seatrout

Spotted seatrout, *Cynoscion nebulosu*s, are found in coastal waters from Cape Cod, Massachusetts to the Bay of Campeche, Mexico. Spotted seatrout are non-migratory and estuarine-dependent, with tagging and telemetry studies showing adults usually remain in and very near to their natal estuaries (Callihan 2011; Callihan et al. 2013; Murphy et al. 2011). Spotted seatrout reach maturity by age 2 and have an average life span of 5 to 9 years (Murphy and Taylor 1994). The average size of age-2 and age-3 seatrout in the Louisiana recreational harvest data are typically 300 to 380 mm in TL (West et al. 2014). A maximum reported length of a single age-6+ fish exceeded 580 mm TL (West et al. 2014).

Spotted seatrout generally spend their entire life cycle in and near their natal estuary, showing very little to less than 30% of the adult population moving between estuaries (Wagner 1973; Saucier and Baltz 1993; Ditty and Shaw 1994; Killam et al. 1992; Callihan 2011). The life stages of spotted seatrout are found within different regions or salinity zones of the estuary (Helser et al. 1993, Shepard 1986). Sable et al. (2017c) provides a conceptual life cycle diagram to describe the seatrout life stages within the estuarine habitats. Eggs are spawned in sea grasses or around barrier island passes in the late spring and summer in the lower estuary and hatch within a day. After larvae absorb their yolk-sac and begin feeding, they move along the deep channels towards shallower channels up the estuary into intermediate and brackish salinity zones (typically around ≤ 15 ppt). Metamorphosis of larvae to juveniles occurs after about 23 days and around 12 mm TL. Early young-of-year juvenile seatrout settle and remain in shallow marsh edge or submerged aquatic vegetated habitats for 120 to 150 days until they grow to around 180 to 200 mm TL (Nieland et al. 2002). Late juvenile and adult spotted seatrout move throughout the estuary, likely in response to temperature and food supply, moving to warmer shallow waters along shorelines and the mid-and upper estuary in the winter and deeper cooler waters of the bays and barrier island passes in the summer. Male seatrout mature around 220 mm TL while female seatrout typically mature around 300 mm TL. Adult seatrout move to the deep channels and the barrier island passes to spawn in the summer

Spotted seatrout support an important recreational fishery in the South Atlantic and Gulf of Mexico state waters. The Louisiana seatrout catch has steadily increased since the 1980s, supporting the highest annual recreational catch of 8 to 12 million pounds in the U.S. since the mid-1990s (NMFS 2018). Louisiana harvest constitutes 62% of the total U.S. landings for the Atlantic and Gulf Coasts. The states manage their own fishery stocks that are evaluated under a regional FMP (Blanchet et al. 2001).

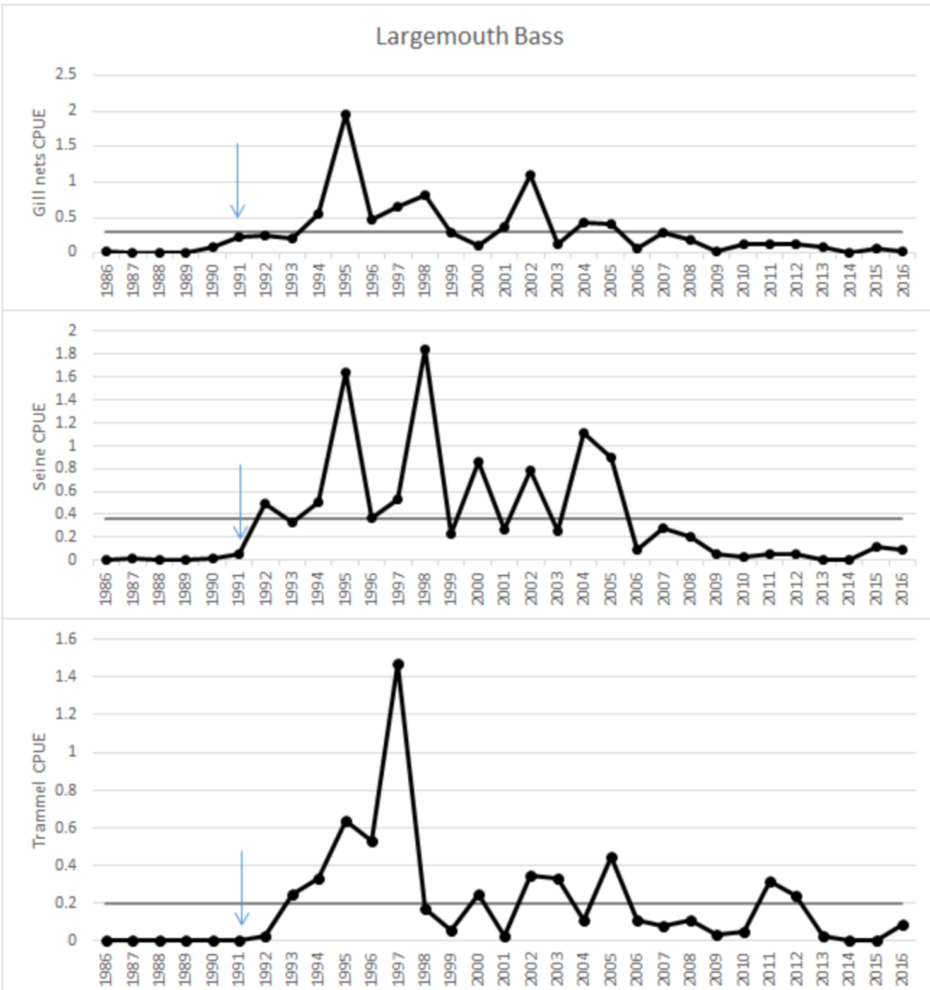
In their study of the evolution of Mardi Gras Pass from March 2012 to December 2013, Lopez et al. (2014) reported capturing spotted seatrout within the pass using gill nets. The effect of the Caernarvon Freshwater Diversion on spotted seatrout been studied and is summarized in the lessons-learned report (GEC 2011). Trawl catches increased post-operation and seine catches of primarily small juvenile spotted seatrout decreased by 33% post-operation. Harvest was greatest at stations located an intermediate distance from the diversion. Gill net catch decreased by 22% post-operation. A report by deMutsert and Cowan (2012) showed operation of the Caernarvon Freshwater Diversion increased spotted seatrout biomass per individual and did not result in reductions in the abundance of spotted seatrout. The authors suggested sufficient higher salinity areas remained in the Breton Sound estuary during operation of the Caernarvon Freshwater Diversion to support spotted seatrout populations and suggested increases in primary productivity supported increases in growth and biomass.

Largemouth Bass

Largemouth bass, *Micropterus salmoides*, are piscivores native to North America. They range from North Carolina to Texas and northeast Mexico, through the Mississippi River System, Great Lakes, and southern Ontario. There are two genetic strains of the largemouth bass in the U.S., the northern strain and the Florida strain (Philipp et al. 1983). Largemouth bass reach maturity by age 2 and have an average life span of about 7 years (Murphy and Taylor 1994) in southern Louisiana.

Largemouth bass are the most popular sportfish in the U.S. and are often stocked in lakes and reservoirs. Beginning in 1996 LDWF has stocked largemouth bass, generally fingerlings, in the Caernarvon Freshwater Diversion Area (Kaintz 2010). An analysis of the genetics of largemouth bass captured in the vicinity of the Caernarvon Freshwater Diversion revealed that over 80% consisted of the northern strain of largemouth bass. Hijuelos et al. (2017) summarizes the life cycle and habitat requirements of largemouth bass in coastal Louisiana. The information is further summarized for Breton Sound Basin. Largemouth bass tend to prefer lower salinity (less than 5 psu) and less turbid waters since they are visual predators; however, adult largemouth bass are highly adapted to variable salinities and temperatures, and bass younger than 3 years old have shown higher growth in brackish salinities compared to fresh water habitats due to the availability of energy- (or calorie-) rich estuarine and marine prey (Glover et al. 2013). Spawning typically occurs in February and early March in Breton Sound Basin when temperatures climb above 16° C. Males build nests in sandy substrate or soft mud close to vegetative cover (Brown et al. 2009; Davis & Lock 1997), and the spawned eggs hatch after three to five days (Scott and Crossman 1973). As largemouth bass grow from fry in the first two to four weeks into juveniles, their diet switches from insects and larvae to on small shrimps, crabs, and fish (Brown et al. 2009). Both fry and early juvenile bass tend to remain in shallow shoreline or SAV habitats. Large juveniles nearing the end of their first year and adults prefer slow moving waters near the shoreline or in SAV. In Louisiana, adult largemouth bass have a diverse diet with a large portion made up of invertebrates, shrimp and fish in addition to crawfish and crabs (Boudreaux 2013). Generally largemouth bass prefer areas around submerged or flooded emergent aquatic vegetation (Maceina 1996; Miranda and Pugh 1997).

In their study of the evolution of Mardi Gras Pass from March 2012 to December 2013, Lopez et al. (2014) reported capturing largemouth bass using electrofishing along both transects within the pass. In the 2015–2017 operations, maintenance and monitoring report for Caernarvon Freshwater Diversion (Plitsch 2017), largemouth bass were captured in the highest of numbers immediately after the opening of the Caernarvon Freshwater Diversion, but CPUE generally dropped in all sampling gear after 2006 except for a slight rise in 2011 and 2012 using trammel nets (Figure 9.5-2).



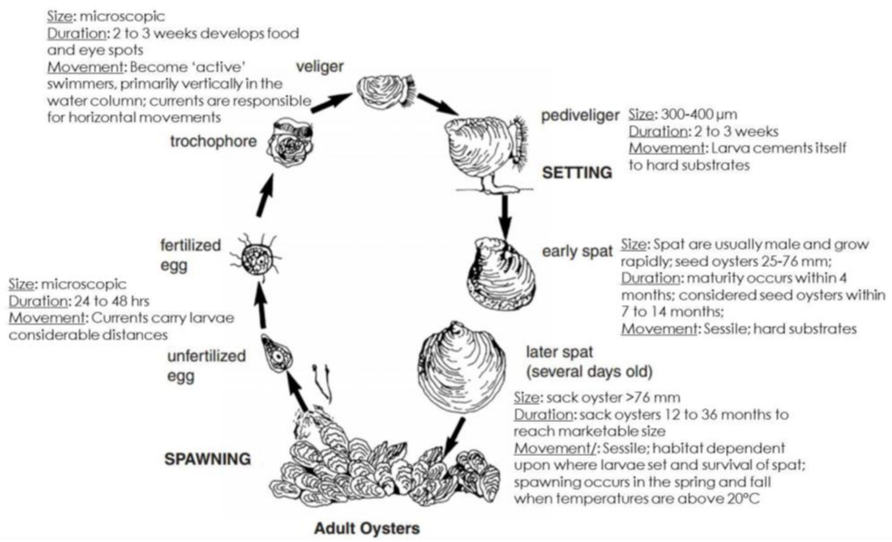
Source: Plitsch 2017.

Figure 9.5-2. Largemouth Bass Caught in Gill Net and Seine (CPUE). Blue arrows indicate the year of diversion opening, gray line indicates long-term average.

The effect of the Caernarvon Freshwater Diversion on largemouth bass has been studied and is summarized in the lessons-learned report (GEC 2011). The opening of Caernarvon has led to Delacroix becoming one of the state's premier bass fishing areas. Largemouth bass catches in seines were twice as high after the Caernarvon Freshwater Diversion was opened; nearly all bass were collected above the 5 psu isohaline (LDNR 2003). Bass were caught nearly year-round post-operation and on only a few occasions pre-operation. CPUE for bass was highest from about 1995 through 1998, fluctuated around the average until 2006 and, then, generally fell below average (Figure 9.5.2). Largemouth bass biomass was significantly higher post-operation in the impact versus the control area since the opening of the Caernarvon Freshwater Diversion (de Mutsert 2010; de Mutsert and Cowan 2012). As with red drum and spotted seatrout, the authors suggested such increases in biomass may result from greater prey availability post operation.

Eastern Oysters

Eastern oysters, *Crassostrea virginica,* are sessile filter feeders distributed from the Gulf of St. Lawrence to the Gulf of Mexico and have been introduced in other locations around the world. Genetic data suggest the Atlantic Coast populations are separate from those in the Gulf, with a transition zone occurring along Florida's eastern coast (Banks et al. 2007). Oysters are common in all of the Louisiana coastal basins and are most abundant in the southeastern and central regions, including the Breton and Chandeleur Sounds and the Atchafalaya and Vermilion Bays (Nelson et al. 1992). Sack oysters are mature adults larger than 75 mm and are considered of harvestable size in Louisiana; on average, it takes about 18 months in Louisiana to reach this size (Stanley and Sellers 1986). Adult oysters form clumps on existing reefs or bars within the estuaries; their distribution in the estuary depends upon larval settlement and spat survival. In the Gulf Coast, oysters spawn when salinities are higher than 10 psu and water temperatures exceed 20°C, with mass spawning initiated above 25°C, which typically results in a bimodal peak from May through June and from September through October (Banks et al 2007; Stanley and Sellers 1986). The basic oyster life history cycle starts with the adult stage (Figure 9.5-3). Spawning adult oysters release sperm and eggs into the water column, where fertilization occurs. The fertilized eggs quickly hatch into larvae–also called veliger. During this two week phase, the larvae float, feed on plankton, and rely on wind and currents (with some passive movement) to carry them until they find a place to settle—this action is also called setting or spatfall. A current strong enough to supply food but not re-suspend sediment is necessary for survival of eastern oysters (Sellers and Stanley, 1984; EOBRT, 2007). Oyster larvae choose settlement locations based on physical cues (e.g., presence of hard substrate or cultch) and chemical cues emitted from adult oyster shells (Brumbaugh et al., 2006; Zivkovik, 2010). Because the oyster will not have another chance to move, it is critical to find a location that will ensure it can survive and grow to adulthood.

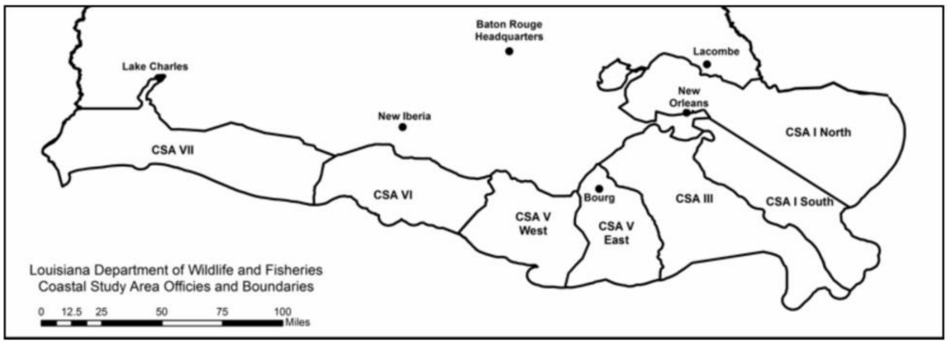


Source: Hijuelos et al., 20171

Figure 9.5-3. Eastern Oyster Life Stages Diagram.

Spatfall generally peaks when there is a rise in water temperature, which typically occurs from May through August (Kilgen et al., 1989), although there would also be additional spatfall in the fall after the second spawning event. Growth of eastern oysters generally increases in August and September after spawning, but temperature, salinity, intertidal exposure, turbidity, and availability of food (i.e., phytoplankton density) all play an important role in oyster growth rates (Hijuelos et al., 2017). According to Lowe et al. (2017), optimal growth conditions for commercial oysters include a temperature range of 20.0 to 26.3°C, and a salinity range of 10.7 to 16.1 psu. Reduced salinities below 5 psu for prolonged periods in the warm summer months cause excessive mortality from parasites and disease (Craig et al. 1989; LaPeyre et al. 2009), while salinities above 15 psu show higher predation mortality on the reefs by marine oyster drills and stone crabs (Miller et al. 2017). Hijuelos et al. (2017b) provides a summary of the life history of the eastern oyster.

Eastern oysters are of high value to Louisiana's economy. Louisiana regularly leads the U.S. in oyster production with an annual averaged contribution of 34% of the nation's total landings from 1997 through 2013 (LDWF 2015b). Louisiana accounts for nearly 60% of all oysters landed in the Gulf of Mexico for this time period. LDWF manages the statewide oyster fishery for the public oyster areas in the Coastal Study Areas (CSAs) (Figure 9.5-4). The public oyster grounds are monitored by the LDWF fisheries independent monitoring program and are primarily used as seed grounds for private leases located in the same CSAs. Figure 9.5-6 illustrates the extensive public oyster seed grounds and seed reservations in the Breton Sound Basin (CSA 1 south).



Source: LDWF 2015 Oyster Stock Assessment Report.

Figure 9.5-4. Map of Public Oyster Areas for Louisiana. CSA 1 south is labeled to reference the Breton Sound public oyster seed grounds and the Bay Gardene public seed reservation.

Most oyster landings are produced from private leases within the coastal basins (LDWF 2015b). Total oyster landings in Louisiana have met or surpassed 10 million pounds of meat every year since 1994, with the exception of 2010, which fell under 7 million pounds due to the oil spill and depressed salinities from flooding the basin. The annual total number of seed and sack oysters estimated from the CSA 1 public oyster grounds has generally declined since the peak in the 1990s through 2001(Figure 9.5-5) (LDWF 2015b, 2018). The public oyster seed grounds in the Breton Sound Basin (CSA 1 south) consist of approximately 300,000 water bottom acres located from the MRGO southward to South Pass in the Mississippi River Basin Delta, and eastward from the eastern extent of private leases east of the Mississippi River to the Breton National Wildlife Refuge. These seed grounds include Bay Gardene Public Oyster Seed Reservation, as well as areas designated as “sack harvest only” in Lake Fortuna, Lake Machias, and Bay Long. Hydrology in the area is influenced at high Mississippi River stages by discharge through gaps in the Mississippi River levee south of Pointe a la Hache, such as the Bohemia Spillway and the crevasse in the spillway called “Mardi Gras Pass”; discharge from the Caernarvon and Bayou Lamoque fresh water diversion structures; and mainstem river distributaries in the southern portion of the Breton Sound Basin (e.g., Fort St. Philip). The LDWF continually expands and enhances the public oyster reefs through the placement of cultch material (i.e., shell, limestone, crushed concrete) on suitable water bottoms.

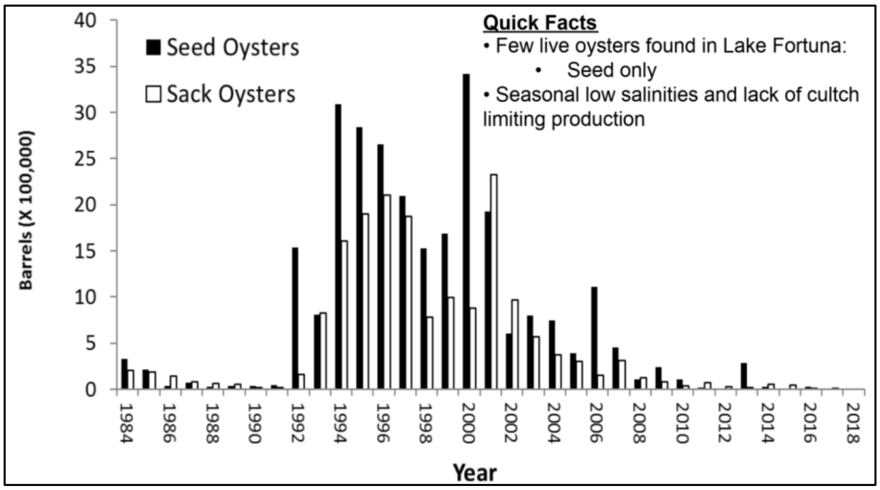


Figure 9.5-5. Oyster Seed and Sack Production within CSA 1 South through 2018.

Oyster reefs filter large volumes of water and can affect water quality and plankton abundance (La Peyre et al. 2014; zu Ermuggason et al. 2012). Oyster filtration affects energy cycling and carbon transfer within the estuarine food web (La Peyre et al. 2013; Fulton et al. 2010). Oyster reefs and bars also provide hard-structure habitat that estuarine fish and invertebrates can use for feeding and as predation refuge (i.e., La Peyre et al. 2014; Stunz et al. 2012; Humphries et al. 2011; Grabowski et al. 2005).

Beck et al. (2017) provides a summary of the impact of the Mardi Gras Pass breach in the Bohemia Spillway on the oyster populations and landings from Breton Sound Basin. During the years 2000-2009, Breton Sound Basin produced approximately 47% of the statewide commercial oyster landings. Oyster populations substantially decreased after 2009. The study, however, finds it unclear whether the repair and closure of Mardi Gras Pass would increase oyster production because of the amount of water flowing through openings in the vicinity of Fort St. Philip. Banks et al (2011) studied the effect of the depressed salinities during the spring and summer of 2010 on the oyster population in Breton Sound Basin. They found that sampling at 21 locations yielded a total of 827 live oysters. They recorded an 81% mortality in seed oysters and a 56% mortality of sack oysters within the Breton Sound Basin.

The effect of the Caernarvon Freshwater Diversion on eastern oysters has been studied and is summarized in the lessons-learned report (GEC 2011). Since the opening of the diversion, seed and sack oysters available on the public oyster seed grounds in the Caernarvon outfall area have increased substantially (CPRA 2010). The preconstruction period had low seed availability. The pre-operation (1982–1991) stock assessment seed oyster average was 74,741 barrels and the post-operation (1992–1994) average was 1,641,439 barrels (USACE-LDWF 1998). Seed and sack oysters increased over 1,000% during the post-operation period (CPRA 2010). Numbers of dead oysters increased by 96%; however, during pre-operation dead oysters were a much higher percentage of the total than post-operation. Mortality peaked in 1991 (56%) and was lowest in 2003 (2%). Oyster productivity has been dropping since 2003 generally due to increased harvesting on the public seed grounds.

The overall survival, measured over one year periods using nestier trays post-operation was 32% and 64% pre-operation (CPRA 2010). If stations above the 5 psu isohaline are excluded, the overall survival is 64% pre-operation and 45% post-operation (CPRA 2010). Survival of oysters varied among years. Analysis of variance performed on the interaction between station, time, and pre-versus-post-operation was significant ($p < 0.01$). The Caernarvon Freshwater Diversion did not affect all stations equally; stations closer to the diversion structure were impacted the most. During the pre-construction period, these stations that were close to the diversion had low mortality, suggesting the cause of the mortality was extremely low salinity caused by operation of the Caernarvon Freshwater Diversion (USACE-LDWF 1998). Hurricane Katrina destroyed all the nestier trays in August 2005. Nestier trays were not reestablished until July of 2006, so survival was relatively high in 2006 (CPRA 2010).

Freshwater Fishes in the Lower Mississippi River below New Orleans

Blue catfish and flathead catfish are the most common species caught by fishers in the main channels and along the banks of the Mississippi River. Freshwater drum, spotted gar, smallmouth buffalo, bighead carp, and silver carp are also caught in the river (Lower Mississippi River Conservation Committee 2013). Skipjack herring, gizzard, and threadfin shad are forage fishes that form large schools and will move up the Mississippi River from the Gulf of Mexico. The study of the fish and wildlife in Mardi Gras Pass by Lopez et al. (2014) provides insight in the species that would enter the proposed Breton Diversion. Fourteen different species of fresh water fish were captured in Mardi Gras Pass, including channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), spotted gar (*Lepisosteus oculatus*), longnose gar (*Lepisosteus osseus*), channel catfish (*Ictalurus punctatus*), blue catfish (*Ictalurus furcatus*), redear sunfish (*Lepomis microlophus*), American eel (*Anguilla rostrata*), bluegill (*Lepomis macrochirus*), spotted sunfish (*Lepomis punctatus*), longear sunfish (*Lepomis megalotis*), inland silverside (*Menidia beryllina*), river carpsucker (*Carpiodes carpio*), and black crappie (*Pomoxis nigromaculatis*).

9.5.2 Habitat Preferences and Environmental Requirements

All fauna within the Breton Sound Basin spend at least some part to all of their life cycle within the estuary (see Section 9.2). Habitat preferences and environmental requirements vary by species and life stage. Life cycle diagrams and space-time plots of life stage use within the estuaries are helpful to determine when species are in the estuary and where their life stages occur. Defining how habitat or environmental conditions such as temperature, salinity, DO, and contaminants affect individual fish vital rates (that is, survival, growth, movement, reproduction) is difficult and physiological or individual-based models are often used to scale individual-level effects up to observable population results (Rose 2000; Rose and Sable 2013). The species catch (CPUE) data from the LDWF fisheries independent monitoring program, as well as data available from several independent field studies (i.e., Baltz et al. 1998; Minello and Rozas 2002; Soniat et al. 2013), and expert opinions were used to define the effects of temperature, salinity, and the proportion of vegetation to open water on species habitat suitability and/or biomass distribution. This approach was used within the Breton Sound Basin and surrounding regions for the ecological modeling efforts for the Mississippi River Delta Management Study in 2014 and 2015 supported by the CPRA (de Mutsert 2010; de Mutsert and Cowan 2012; de Mutsert et al. 2017). Other factors that can affect habitat preferences and conditions are briefly summarized below for estuarine fish and shellfish populations.

9.5.2.1 Water Flow and Tidal Transport

The migration of larvae and movement of early juveniles into suitable nursery habitat can be affected by current flow in and out of the estuary, and hydrologic connectivity among the estuarine channels (Rozas et al. 2012). Piazza (2009), Piazza and La Peyre (2007, 2009, 2010, 2012), and Piazza et al. (2010) examined the effect of climate variability on the estuarine nekton composition in Breton Sound Basin and found that weather events and river flow affected nekton community dynamics and estuarine productivity. Their findings indicated that pulsed river flow resulted in higher nekton abundance and biomass as well as higher fish growth. Northerly cold fronts can push water out of the estuaries to affect juvenile shrimp and blue crab recruitment in the estuary (Rogers et al. 1993; Guillory et al. 2001). Water elevations and fine-scale differences in marsh morphology can affect species access and movement patterns among the estuarine habitats. Species that frequently use marsh edge habitat as feeding and nursery areas generally benefit from increased levels of flooding of the marsh surface. (Piazza 2009; Rozas et al. 2012; Roth et al. 2008; Minello and Rozas 2002; Rozas and Reed 1995).

9.5.2.2 Hard and Soft Bottom and Submerged Aquatic Vegetation

The presence of hard substrate, such as oyster shell, or the presence of SAV in open waters, can affect the perceived habitat suitability and relative abundance of juvenile fish and shellfish in comparison to soft bottom or unvegetated bottom habitats. SAV (see Section 9.3) can provide increased food availability and cover from predation, in a similar way to that defined for marsh edge habitat in the estuary (Minello et al. 2003; Rozas and Minello 2010; Rozas et al. 2013). Oyster reefs and bars also provide hard-structure habitat that a unique faunal community of estuarine fish and invertebrates can use for feeding and as predation refuge (Grabowski et al. 2005; Humphries et al. 2011; Stunz et al. 2012; La Peyre et al. 2014).

9.5.2.3 Turbidity and Sedimentation

Visual predators such as largemouth bass, spotted seatrout, southern flounder, alligator gar, and red drum prefer low turbidity and slower moving waters to better detect and catch their prey (Patillo et al. 1997). However, the abundance of other key estuarine species, such as Atlantic croaker, shrimp, and crabs, tend to be higher in higher turbidity waters likely due to increased benthic prey availability and less detection by visual predators (i.e., Minello et al. 1989; Lassuy et al. 1983). Forage fish, such as bay anchovy and Gulf menhaden, also tend to be attracted to higher turbidity waters where plankton concentrations can be higher. Turbidity from high concentrations of suspended sediment and dissolved organic matter may limit phytoplankton production during the short-term, thus lowering food availability for planktivorous organisms. Filtration by eastern oysters can reduce turbidity and phytoplankton blooms, but high turbidity due to sediments and particulates in the water column, and sedimentation of silts, can reduce settlement of oyster spat and clog or cover filter-feeding adult oysters (Killam et al. 1992; Stanley and Sellers 1986). Beck et al. (2017) attributed fresh water from Mardi Gras Pass possibly leading to increased sedimentation on oyster reefs and bio-fouling reef material.

9.5.2.4 Dissolved Oxygen

Faunal species will move away from low or anoxic DO levels if they can. Blue crab have been observed to leave the water to escape anoxic conditions (Killam et al. 1992). Prolonged low DO events in deeper bays can cause mass mortality events such as in Mobile Bay, Alabama, where they are referred to as jubilees (Patillo et al. 1997). The Breton Sound Basin is a shallow estuary [mean depth of 3.3 feet (1 meter)] and is generally well-mixed by the wind. However, localized low DO and hypoxia events (LDWF 2014; Beck et al. 2017) can occur in shallow eutrophic waters such as marsh ponds when connectivity is reduced and temperatures rise in the summer.

9.5.2.5 Salinity and Temperature

Salinity and water temperature are critical factors affecting the distribution, growth and feeding activity, and survival of estuarine-dependent fishery species. Each species and life stage has their optimal salinity and temperature ranges (summarized in Table 9.5-1) where growth is maximized and activities such as spawning occur most frequently. Spatial analysis of LDWF fishery distributions, based on fishery independent data, showed intermediate and brackish fringing marshes in Barataria Basin and surrounding regions to have the highest clusters of optimum juvenile habitat (Hijuelos et al. 2017). Very similar habitat suitability functions were defined by species and life stage for all fish and shellfish populations included within the EwE food web model of the Breton Sound Basin developed by de Mutsert (2010) and de Mutsert et al. (2012, 2017).

Table 9.5-1
Modeled Habitat and Environmental Requirements for Fauna in the Breton Sound Basin (from de Mutsert et al. 2017)

Species	Life Stage	Optimum Salinity (ppt)	Optimum Temperature (⁰C)
Grass shrimp	Single population	0.01–12.38	8–30
Oyster drill	Single population	15–30	8–30
Eastern oysters	Spat	8–15	25–30
	Seed,	8–15	20–30
	Sack	14–30	20–30
Blue crab	Juvenile	1–20	8–30
	Adult	7–20	8–30
Brown shrimp	Juvenile	10–25	8–30
	Adult	10–25	8–30
White shrimp	Juvenile	5–25	8–30
	Adult	5–25	8–30
Killifish	Single population	3.72–17.83	8–30
Silversides	Single population	3.13–17.29	8–30
Bay anchovy	Juvenile	1–17	8–30
	Adults	1–17	8–30
Sheepshead	Juvenile	15–33	8–30
	Adult	30–35	8–30
Gulf sturgeon	Juvenile	0–20	8–30
Gulf menhaden	Juvenile	1–10	8–30
	Adults	5–40	8–30
Sunfish	Juvenile	0–2	8–30
	Adult	0–2	8–30
Striped mullet	Juvenile	0–20	8–30
	Adult	0–15	8–30
Atlantic croaker	Juvenile	2.72–17.85	8–30
	Adult	2–35	8–30
Spotted seatrout	Juvenile	5–20	8–30
	Adult	7.5–20	8–30
Red drum	Juvenile	5–20	8–30
	Adult	1–15	5–30
Black drum	Juvenile	2–30	8–30
	Adult	3–30	8–30
Largemouth bass	Juvenile	0–2	8–30
	Adult	0–2	8–30
Spot	Juvenile	2–30	8–30
	Adult	4.23–22.25	8–30
Blue catfish	Juvenile	0–2	8–30
	Adult	0–2	8–30
Southern flounder	Juvenile	1.09–15.08	8–30
	Adult	2.33–16.31	8–30
Sand seatrout	Single population	5.42–13.21	8–30
Sea catfish	Juvenile	7.9–20.05	8–30
	Adult	3.76–16.84	8–30

9.5.2.6 Percent Vegetation Cover

Emergent marsh provides structure which helps reduce predation pressure on early life stages of many estuarine dependent fishery species, and on adults for many common smaller fishes and crustaceans, such as killifishes and grass shrimp. These wetlands also produce detritus, important components of the aquatic food web, and other important food items for a diverse array of crustaceans and finfishes (Minello and Rozas 2002). The HSIs and the EwE food web model (de Mutsert et al. 2017) use optimum ranges of wetland habitat availability within defined areas or sub-regions of Breton Sound Basin to define optimum wetland cover for some of the estuarine species. For example, the juvenile life stages of shrimp, crab, bay anchovy, menhaden, striped mullet, Atlantic croaker, southern flounder, spotted seatrout, black drum, and red drum had defined habitat optimums of 25 to 80% wetland cover in the estuaries (Minello and Rozas 2002). Largemouth bass and sunfish that typically prefer vegetated shoreline or SAV beds had optimum wetland cover defined as 30 to 50%.

9.5.3 Food Web and Ecological Interactions

The estuarine food web is comprised of a pelagic food chain driven by phytoplankton production and distribution, and a benthic food chain driven by detritus, benthic algal, and bacterial production. These two food chains are linked at the base of the food web due to phytoplankton sinking and benthic algal re-suspension from constant wind-mixing of the shallow estuary (Schaeffer et al. 1988).

The composition and characteristics of estuarien aquatic communities are regulated from the bottom-up by resource availability and from the top-down by herbivory and predation. For example, both bay anchovy and Gulf menhaden abundance patterns are likely driven by plankton prey production and distribution (Houde and Zastrow 1991). Likewise, oyster filtration of phytoplankton and bacterioplankton in the water column can locally reduce availability for zooplankton and forage fishes in the water column (La Peyre et al. 2014; Fulford et al. 2010). Oyster spat are a preferred prey for larger blue crab, black drum, and oyster drills. Juvenile and subadult brown and white shrimp, anchovies, and blue crab are prey to economically important fishery species, such as adult largemouth bass, red drum, larger blue crabs, Atlantic croaker, and spotted seatrout (Gandy et al. 2011; Shipp 1986; Overstreet and Heard 1978).

Examples of top-down controls include predation on young shrimp and blue crab, and potentially climate and weather related events, which are the primary factors that limit or reduce recruitment in the estuaries (Patillo et al. 1997; Minello et al. 1989; Heck and Coen 1995). Predation mortality on estuarine species varies by depth and habitat structure (that is, presence of vegetation or oyster shell), with shallower depths and vegetation or oyster reef providing cover and limiting the access of larger predators (Minello et al. 1989, 1990; Heck and Coen 1995; Minello et al. 2003; Rozas and Minello 2010; Humphries et al. 2011; Stunz et al. 2012; Baker et al. 2014).

9.6 MARINE MAMMALS

9.6.1 Introduction

The affected environment for marine mammals includes the Breton Sound Basin and the Mississippi River Delta Basin. This section includes a discussion of marine mammals inhabiting the shallow waters (less than 67 ft [20 m] deep) of the northern Gulf of Mexico and those within the general geographic area of the proposed project. Discussions focus primarily on the Mississippi River Delta (MRD) Stock of bottlenose dolphins (see Figure 9.6-1), and secondarily on bottlenose dolphins of the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, and Northern Coastal Stock (Hayes et al. 2018). The West Indian manatee is occasionally seen as far west as Texas (Fertl et al. 2005); however, as this species is further protected under the ESA, it is discussed in detail in Section 11.0.

9.6.2 Marine Mammals in the Northern Gulf of Mexico

Marine mammals, including dolphins and whales, are animals with complex social structures, behaviors, and life history patterns. In the northern Gulf of Mexico, marine mammals are found in estuarine, coastal, shelf, and oceanic waters. For marine mammals, a population stock is defined as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature. The northern Gulf of Mexico includes 21 cetacean species managed as 56 discrete stocks (that is, demographically independent populations, discussed below) and one sirenian species, the West Indian manatee (*Trichechus manatus*). Twenty of the cetacean species belong to oceanic stocks and are generally found in waters beyond the shelf break (greater than 656-foot [200-meter] isobath), while 34 stocks of common bottlenose dolphins (*Tursiops truncatus*), are found in shallower waters (Davis et al. 1996; Mullin and Hansen 1999; Fulling et al. 2003; Mullin and Fulling 2004; Waring et al. 2016). Bottlenose dolphins are currently managed as 36 distinct stocks within the Gulf of Mexico, most of which are only found in coastal waters (less than 67-foot [20-meter] isobath) (Hayes et al. 2018). Three of these stocks are designated as coastal stocks (Western Coastal, Northern Coastal, and Eastern Coastal), while 31 are designated as bay, sound, and estuary (BSE) stocks or areas of contiguous, enclosed, or semi-enclosed bodies of water adjacent to the Gulf of Mexico (Hayes et al. 2018). These BSE stocks show a strong year-round, multi-year fidelity to a geographic area, exhibiting low levels of immigration and emigration, and thus are generally unaffected by population fluctuations in other stocks.

While bottlenose dolphins are not listed under the ESA, all dolphin stocks are protected under the Marine Mammal Protection Act (MMPA), and several bottlenose dolphin stocks are listed as “strategic stocks.” Strategic stocks are those with declining populations for which the level of direct human-caused mortality exceeds the Potential Biological Removal (PBR) level. PBR level is defined as the maximum number of animals that may be removed from a stock, excluding natural mortality, which allows it to reach or maintain its optimum sustainable population. The MRD Stock is considered as strategic, because the stock size is unknown and the estimate of human-caused mortality and serious injury exceeds PBR (Hayes et al. 2017). Other Gulf of Mexico BSE stocks, such as the Mississippi Sound, Lake Borgne, Bay Boudreau Stock are also listed as strategic due to the impacts of unusual mortality events (UMEs; see Section 9.6.4.3), which have affected stocks along the coasts of Louisiana, Mississippi, Alabama, and western Florida (Hayes et al. 2018).

9.6.3 Marine Mammals in Breton Sound and Mississippi River Delta Basin

9.6.3.1 Bottlenose Dolphins

Bottlenose dolphins are found in tropical and temperate waters worldwide and are the most abundant coastal cetaceans from the U.S. Mid-Atlantic States to Texas. They are a slow maturating species with long life spans and low reproductive rates. Male bottlenose dolphins reach reproductive maturity between the ages of 9 and 14 years. Females reach maturity between 5 and 13 years of age, giving birth every 3 to 6 years (Wells and Scott 2009).

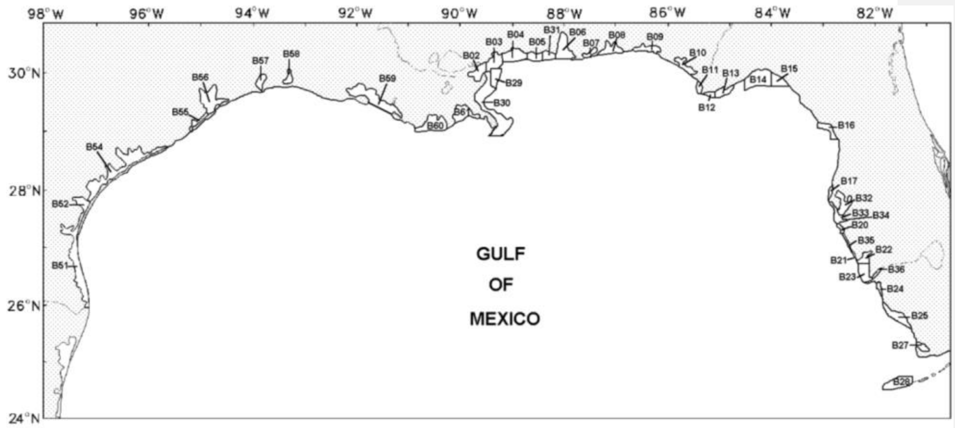


Figure 9.6-1. Northern Gulf of Mexico Bays, Sounds and Estuaries Stocks with the MRD Stock Represented by B30; and the Mississippi Sound, Lake Borgne, and Bay Boureau Stock Represented by B31, B02-05, and B29.

Mississippi River Delta Stock

Bottlenose dolphins associated with Breton Sound belong to the MRD Stock. This stock covers the eastern side of Mississippi River from the birdfoot delta through Breton Sound to the western side of Bay Boudreau (Figure 9.6-1) (Hayes et al. 2017). A recent (2017) aerial survey line-transect population size estimate is available for this stock which is estimated at a minimum 170 and maximum of 332 individuals (Garrison 2017). Given evidence from better studied popultions, this population may exhibit a high degree of site fidelity.

Although calving could occur year-round, the calving season usually ranges from January through July, with a peak in February-May, a time when pregnant females and young animals have an increased vulnerability to stressors (Lane et al. 2015; Colegrove et al. 2016). There is little information available for the MRD Stock, particularly for those dolphins that inhabit Breton Sound. Because the stock size is small and because even a relatively few mortalities and serious injuries would cause the PBR level to be exceeded, this stock is considered to be strategic (Hayes et al. 2018). Given the typical timing of high discharge coincides with peak calving season, and the number of connections between the Mississippi River and the Breton Sound Basin, stocks may already be impacted by increasing amounts of fresh water.

Mississippi Sound, Lake Borgne, and Bay Boudreau Stock

The Mississippi Sound, Lake Borgne, and Bay Boudreau Stock was delimited in the first stock assessment reports published in 1995 (Blaylock et al. 1995). The stock area (Figure 9.6-2) is complex extending from Mobile Bay to the east and Lake Bornge and Bay Boudreau to the west and extending 1 km from the Mississippi Sound barrier islands and passes into the Gulf of Mexico. It is important to note that this stock is outside of the project area for the proposed Breton Diversion but is adjacent to the northeastern boundary of the project area. The configuration of this stock is, in part, the result of the management of the live capture fishery for bottlenose dolphins. This area was once the site of the largest live-capture fishery of bottlenose dolphin in North America (Hayes et al. 2018).

The best available abundance estimate for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins is 3,046 individuals, based on a January 2012 vessel-based capture-recapture photo-ID survey (Mullin et al. 2017). This estimate is considered low because it does not include an estimate for most of Lake Borgne or any of Bay Boudreau. Pitchford et al. (2016) conducted seasonal surveys from late 2011 to 2013 in Lake Borgne and Mississippi Sound. The population estimates ranged from 3,236 in spring 2012 to 738 in spring 2013. According to Pitchford et al. (2016), changes in density estimates suggested animals use the westernmost portions of the Project Area during the warmer seasons of summer and fall, and also suggested the Mississippi Sound region is dynamic with respect to environmental variables that affect dolphin distribution and occurrence.

Because the estimate of human-caused mortality and serious injury exceeds the PBR level, this stock is considered to be strategic. Because an UME of unprecedented size and duration (March 2010 through July 2014) impacted the northern Gulf of Mexico, including this stock, there is cause for concern with this stock (Hayes et al. 2018). In addition, it was projected that there was up to a 62% decline in population size resulting from the DWH oil spill (Schwacke et al. 2017).

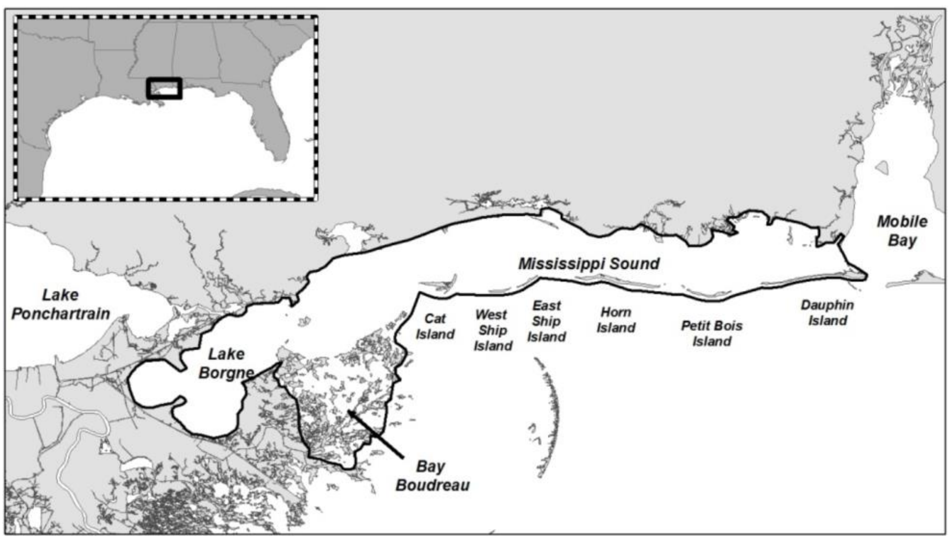


Figure 9.6-2. Geographic Extent of the Mississippi Sound, Lake Borgne, and Bay Boudreau Stock, Located on the Coasts of Alabama, Mississippi, and Louisiana.

Northern Coastal Stock

Bottlenose dolphins of the Northern Coastal Stock typically inhabit an area between the Mississippi River Delta and the 84°W longitude (Figure 9.6-3) (Hayes et al. 2017). This coastal stock is found in waters between the shore, barrier islands, or outer bay boundaries out to about 65-foot depths (the 20-meter isobath), and in areas influenced by freshwater inputs. Because of the spatial distribution of this coastal stock, it may have a common boundary with BSE stocks as discussed above and may occasionally overlap with the distribution of bottlenose dolphins in the two stocks also discussed above. However, there is no significant mixing or interbreeding between these stocks. In addition, individuals from the Northern Coastal Stock could be present in inshore waters, particularly during winter, and possibly in areas around the outer boundary of the proposed project area (Waring et al. 2016).

An occurrence of an UME of unprecedented size and duration (began February 2010 and is ongoing) continues to impact the Northern Coastal Stock and is a cause for concern (Hayes et al. 2017). However, there are insufficient data to determine the population trend of this stock.

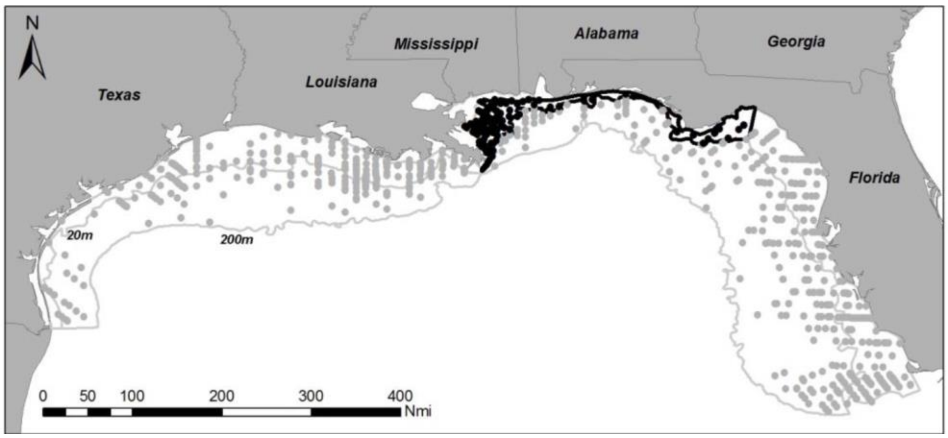


Figure 9.6-3. Range of Northern Coastal Stocks of Bottlenose Dolphins in Coastal and Continental Shelf Waters. Dark circles indicate groups within boundaries of the Northern Coastal Stocks. Map displays 66-foot (20-m) and 656-foot (200-m) isobaths.

9.6.4 Habitat Preferences and Environmental Requirements

Studies indicate that certain environmental factors that influence habitat use by bottlenose dolphins include salinity and temperature (Hornsby et al. 2017; Shane et al. 1986; Wells and Scott 1999), which also influence the distribution of their prey. Bottlenose dolphins are commonly associated with coastal characteristics, moving between rivers, open bay waters, and inlets, and within the lower portions of rivers, passes, and creeks (Miller 2003; Urian et al. 2009; Shippee 2014; Moreno and Matthews 2018). Miller et al. (2013) found fewer dolphins within Mississippi Sound in the winter than in summer and speculated that the lack of prey which migrate offshore in winter may be the cause. Within estuaries, bottlenose dolphins are frequently observed in locations with specific environmental and habitat characteristics and in areas influenced by tidal cycles where prey may concentrate (Würsig and Würsig 1979; Mendes et al. 2002). Prey may concentrate near the bottom of deeper channels where salinity and temperature are more stable. Tidal fronts concentrate nutrients and phytoplankton creating conditions to concentrate prey for feeding by dolphins. Zones of high turbidity offer protection for prey from visual predators but leave them susceptible to echolocating dolphins. Foraging dolphins also have been shown to have an affinity to areas of high turbulence. Group size of dolphins was also positively related to increased number of observations with forage concentrations (Moreno and Matthews 2018).

In addition to enhancing foraging success, bays, estuaries, and tidal marshes may provide bottlenose dolphins refuge from large predators such as pelagic sharks (Shane et al. 1986; Wells and Scott 1999). Miller et al. (2013) found higher dolphin density during the summer in coastal areas of Mississippi Sound and around barrier islands than in offshore waters. Higher dolphin density during the summer correlated with the presence of larger numbers of calves, suggesting that dolphins may use shallow coastal waters as nurseries.

One factor that defines habitat for dolphins and their distribution therein is salinity. A study looking at the effects of salinity on bottlenose dolphins in Barataria Bay found that dolphins used areas with salinities greater than 11 psu while avoiding areas with salinities below 5 psu (Hornsby et al. 2017). The study found that these dolphins generally remain in lower salinity areas (less than 8 psu) for less than 24 hours. However, more recent visual surveys and satellite telemetry suggests that salinity is not the only factor in habitat usage. Individuals were repeatedly recorded in salinities less than 2 ppt for days to weeks. This illustrates the complex interactions of biotic and abiotic factors determining habitat usage. It is recognized that prolonged exposures to low salinity conditions can result in biological and physiological responses including skin lesions, tissue necrosis, changes in blood chemistry parameters, physiological stress, and secondary infections (Ewing et al. 2017; Colbert et al. 1999; Holyoake et al. 2010; Mullin et al. 2015), although the timing of those responses is largely unknown. For example, in Lake Pontchartrain, most of the 30 to 40 dolphins entrapped for 2.5 years by Hurricane Katrina and exposed to an average salinity of 4.8 psu (range 1.4 to 9.2 psu), developed severe skin lesions from the detrimental effects of reduced salinity or the combined effect of salinity and low water temperatures (Mullin et al. 2015). Similarly, in a coastal bay in Texas, exposures to salinities of less than 10 psu may have contributed to dolphin deaths (Colbert et al. 1999)

In contrast, out-of-habitat dolphins in Louisiana impacted by Hurricane Rita survived exposures to low salinities (≤ 15 psu) for three weeks (Rosel and Watts 2008), with five of the seven animals exhibiting signs of emaciation and one showing evidence of skin lesions. Due to the logistics of the severe storm situations described above, in-depth diagnostics for physiological and pathological changes were not possible. Unlike bottlenose dolphins, the Atlantic spotted dolphin is found in areas not greatly influenced by fresh water discharges or regular changes in salinity, and thus may be less likely exposed to reduced salinity conditions.

9.6.4.1 Food Web and Ecological Interactions

Studies on the prey preferences of bottlenose dolphins in Breton Sound and surrounding areas are not available, but they are likely to be comparable to those of other BSE and coastal stocks like the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. Prey preferences of BSE stock dolphins are spatially and seasonally variable which may reflect differences in foraging opportunities and/or prey density (see foraging discussion above). Stomach contents of bottlenose dolphins have generally shown that less than ten prey species account for most of the entire prey, and have generally included Atlantic croaker, sand seatrout, silver perch, spot, brief squid, penaeid shrimp, and mullet, with drums and croakers being among the most common prey (Barros and Odell 1990; Barros and Wells 1998; Gannon and Waples 2004; Gannon et al. 2005; Berens et al. 2010; Bowen 2011). In Louisiana estuaries, 13 species were found to account for 90% of the total abundance of aquatic animals (de Mutsert 2010), many of which are known to be key dolphin prey.

9.6.4.2 The Deepwater Horizon Oil Spill and Current Health Status

The heaviest oiling in Louisiana from the DWH oil spill occurred on the tip of the Mississippi Delta, west of the Mississippi River in Barataria, Timbalier, and Terrebonne Bays, and east of the river on the Chandeleur Islands (Michel et al. 2013; DWH 2016; Hayes et al. 2018). A substantial number of beaches, barrier islands, and wetlands along the Louisiana, Mississippi, Alabama, and Florida coasts experienced oiling (Michel et al. 2013). Thus, even though Breton Sound proper did not receive significant oiling, it is likely that BSE stocks, including the MRD Stock received exposure to oil in the water. The suite of live animal studies (such as capture release health assessments and photo-identification) and investigations of strandings provided strong evidence of the severe adverse health effects from the DWH oil spill, resulting in compromised reproduction and survival persisting for at least four years (Schwacke et al. 2014; Lane et al. 2015; DWH 2016; Kellar et al. 2017; Mullin et al. 2017; Schwacke et al. 2017; Smith et al. 2017; Balmer et al. 2018). The effects of oil exposure on marine mammals depend on a number of factors including the type and mixture of chemicals involved, the amount, frequency and duration of exposure, the route of exposure (inhaled, ingested, absorbed, or external), and biomedical risk factors of the particular animal (Geraci 1990; Helm et al. 2015; Hayes et al. 2017). The effects of the oil spill were confounded by the UMEs that have been ongoing since 1999 acting as an additional stressor to the BSE stocks.

Various assessment studies have shown that the BSE dolphin stocks most exposed to DWH oiling exhibited substantially higher rates of mortality, disease, and reproductive failure. In the four years after the oil spill, dolphin dead stranding rates in certain regions of the BSE stock were 3.5 to 4 times greater than the 95% confidence levels (Litz et al. 2014; Venn-Watson et al. 2015; Keller et al. 2017). Mortality rates were 2.5 to 3.5 times higher in oiled areas compared to non-oiled areas as estimated from the boat-based follow-up surveys of animals examined during capture-release health assessments (Lane et al. 2015; DWH 2016; Keller et al. 2017). Keller et al. (2017) assessed reproductive success of the northern Gulf of Mexico (GoM) stocks for the four years after the oil spill and found that the GoM stocks had a reproductive success (19.4%) which was less than a third of areas not impacted by the spill (64.7%).

The reproductive failure rates were also consistent with findings of Colegrove et al. (2016) who examined perinate strandings in Louisiana, Mississippi, and Alabama from 2010 through 2013. That researcher reported nearly a quarter of all stranded common bottlenose dolphins were prone to late-term failed pregnancies (nearly a quarter of the strandings were aborted calves or calves that died shortly after birth). Colgrove et al. (2016) also reported increased occurrence of in utero infections, including pneumonia and brucellosis. The high prevalence of dolphins with adrenal gland disease, lung disease, moderate to severe bacterial pneumonia, and poor body weight (Schwacke et al. 2014; Venn-Watson et al. 2015a; DWH 2016; Smith et al. 2017) likely contributed to the high rate of failed pregnancies and to dolphin deaths. Other adverse health effects included anemia, excessive tooth loss, and liver injury (Schwacke et al. 2014; DWH 2016). The long-term consequences of compromised adverse health effects, increased reproductive failure, and adult mortality may have population-level implications.

In a study of carcass detection rates of cetacean species in the Gulf of Mexico, William et al. (2011) estimated a carcass recovery rate of 2% for cetacean species other than the bottlenose dolphin. They give an example that one sperm whale carcass was recovered, and a necropsy identified oiling as a contributing factor in the whale’s death. The carcass-detection rate for sperm whales is 3.4% (Williams et al. 2017), making it plausible that 29 sperm whale deaths could be attributed to the oil spill.

9.6.4.3 Unusual Mortality Events

The MMPA defines an unusual mortality event (UME) as a stranding event that is unexpected, involves a significant die-off of any marine mammal population, and demands an immediate response (16 USC 1421h). Historically, the MRD Stock has been affected by two bottlenose dolphin UMEs. The first reported UME occurred from January through May 1990 and included 344 bottlenose dolphin strandings in the northern Gulf of Mexico (Litz et al. 2014), with strandings reported from Texas to the Florida Panhandle. The cause of that event could not be determined (Hansen 1992); however, morbillivirus (a virus that can cause significant mortality in dolphin populations) may have contributed to the UME (Litz et al. 2014). The second UME (the northern Gulf of Mexico cetacean UME [NGUME]) was declared for cetaceans in the northern Gulf of Mexico beginning March 1, 2010 and ending July 31, 2014 (Litz et al. 2014). This UME included cetaceans that stranded prior to the DWH oil spill (see section above for impacts of the spill), during the spill, and post spill. Previous contributing factors for UMEs in the Gulf of Mexico (such as marine biotoxins, morbillivirus, and brucellosis) were not supported as the primary causes of this event (Litz et al. 2014; Venn-Watson et al. 2015).

Louisiana had higher than normal cetacean strandings between March and April 2010. After April 2010, Louisiana continued to have the highest level of strandings of the states affected by the UME. Exposure to the DWH oil spill was determined to be the primary underlying cause of the elevated stranding numbers in the northern Gulf of Mexico after the spill (Schwacke et al. 2014; Venn-Watson et al. 2015a; Colegrove et al. 2016) with high reporting partially attributed to the response effort (Litz et al. 2014). Most of the increase in NGUME strandings in 2010 prior to the DWH oil spill were concentrated in Lake Pontchartrain, Louisiana and the western Mississippi Sound, and were most likely a result of prolonged exposure to cold temperatures and low salinity, both known risk factors for dolphins (Litz et al. 2014; Mullin et al. 2015; Venn-Watson et al. 2015). Most cetaceans stranded during the NGUME were primarily common bottlenose dolphins (87%), with over half of the stranded animals clustered along the shorelines in Louisiana (Litz et al. 2014; Venn-Watson et al. 2015).

In 2019, NOAA's National Marine Fisheries Service declared a UME for the northern Gulf of Mexico in response to a large number of dead bottlenose dolphins found from the Florida Panhandle to Louisiana. From February 2019 through October 3, 2019, 317 bottlenose dolphins stranded; about three times the normal average. Most of those strandings occurred during the months of March through May (https://www.fisheries.noaa.gov/national/marine-life-distress/2019-bottlenose-dolphin-unusual-mortality-event-along-northern-gulf). The cause of the UME was unknown but under investigation. Additionally, the stocks primarily impacted by the UME was not reported.

9.6.5 Existing Threats

Several distinct threats have been identified to impact marine mammals in the Gulf of Mexico, in addition to those noted above from the DWH oil spill (Vollmer and Rosel 2013; Phillips and Rosel 2014). The magnitude and potential effects of these threats vary spatially and temporally, making assessments of their impacts challenging. Bottlenose dolphins, including individuals of the MRD Stock, are at risk from bycatch and entanglement in gear from commercial and recreational fisheries (for example, shrimp, menhaden purse seine, gillnets, blue crab and hook and line), as well as from illegal feeding and harassment, pollution, marine debris, habitat loss and degradation, vessel strikes, intentional harm/injury (gunshots), and underwater noise from increased boat traffic and industrial development (Soldevilla et al. 2012; Vollmer and Rosel 2013; Phillips and Rosel 2014; Waring et al. 2016). However, total human-caused mortality and serious injury is unknown for many stocks, such as the MRD Stock.

Although rare, natural events have also been reported to impact bottlenose dolphins. In coastal Louisiana, individuals have been reported in areas outside their preferred habitat (such as lakes and ditches), possibly often related to storm surge from hurricanes (Rosel and Watts 2008; Mullin et al. 2015). With regard to pollution, other than the DWH oil spill, there is little information on the link between the presence of contaminants in the environment and prey of bottlenose dolphins in Breton Sound and their health condition. Only one study has evaluated the presence of 69 persistent organic pollutants in blood and blubber of bottlenose dolphins within areas near Breton Sound (within Chandeleur Sound). That study reported concentrations that were lower or comparable to those from dolphin samples collected from other southeastern sites (Balmer et al. 2015).

9.7 AQUATIC INVASIVE SPECIES

Invasive species can alter biotic interactions (predation, competition, grazing) and indirectly affect habitat. For example, invasive species can foul ship hulls, damage infrastructure, alter water quality, and result in economic losses due to loss of recreation and cost of treatment and removal (Molnar et al. 2008; Hester 1994; U.S. EPA 2008).

Louisiana is home to one of the busiest port systems in the nation with respect to tons of cargo imported and exported, resulting in a high risk for species introductions (Kravitz et al. 2005). Ships entering U.S. waters from outside the Exclusive Economic Zones (EEZs) are required to exchange ballast water, retain ballast water onboard, or use an alternative U.S. Coast Guard (USCG)-approved method of ballast water treatment before entering U.S. waters (33 FR 14273) to reduce the threat of invasive species, with exceptions for oil tankers, military vessels, and passenger ships with ballast water treatment systems (66 FR 58381). While global shipping accounts for the greatest proportion of marine invasive species introductions, marine debris also has a role in introducing non-native species that may become invasive (NOAA 2017). Invasive aquatic species are also frequently introduced and established in Louisiana via recreational boating (transporting invasive species from one water body to another), ballast water, aquaculture, plant nurseries, and the aquarium industry (Kravitz et al. 2005; NOAA 2017).

9.7.1 Invasive Plants

Aquatic invasive plants include those that grow primarily below the water surface, such as hydrilla and those that float, such as giant salvinia (*Salvinia molesta*), common salvinia (*Salvinia minima*), and water hyacinth (*Eichhornia crassipes*). Common invasive aquatic species in the Breton Sound Basin can displace plant communities, reduce water conveyance and boat passage, and degrade native aquatic habitats (Kravitz et al. 2005). These species typically reproduce vegetatively, are introduced and spread via boats and boat trailers, prefer slower moving fresh waters, and may impede recreational access by boaters and swimmers. Floating species can form dense mats at the surface of the water, may outcompete native species, and reduce the habitat value to fish and wildlife.

Aquatic invasive plant species with the potential of occurring within Breton Sound Basin are listed in Table 9.7-1.

Table 9.7-1
Aquatic Invasive Plant Species and Habitat Type with the Potential of Occurring within the Breton Sound Basin

Scientific Name	Common Name	Habitat Type (fresh/ marine/brackish)
Alternanthera philoxeroides	Alligatorweed	Freshwater
Egeria densa	Brazilian waterweed[a]	Freshwater
Eichhornia crassipes	Water hyacinth[a]	Freshwater
Hydrilla verticillata	Hydrilla[a]	Freshwater
Landoltia punctata	Dotted duckweed	Freshwater
Limnophila x ludoviciana [indica x sessiliflora]	Marshweed	Freshwater
Myriophyllum aquaticum	Parrot feather[a]	Freshwater
Myriophyllum spicatum	Eurasian watermilfoil[a]	Freshwater-Brackish
Nymphoides peltata	Yellow floating-heart	Freshwater
Oryza sativa	Rice	Freshwater
Ottelia alismoides	Duck-lettuce	Freshwater
Pistia stratiotes	Water lettuce[a]	Freshwater
Salvinia minima	Common salvinia[a]	Freshwater
Salvinia molesta	Giant salvinia[a]	Freshwater

a. Species also included in the State Management Plan for Aquatic Invasive Species (Kravitz et al. 2005).

9.7.2 Invasive Animals

Of the 100 “worst invasive alien species in the world” (Lowe et al. 2010), Louisiana reports at least 13 of these in the state and portions of the Project Area, including Asian tiger mosquito, zebra mussel, nutria, and the feral hog. The zebra mussel, which can be found in larval, juvenile and adult stages in the lower Mississippi River, is included on the list of the 12 most destructive species in the U.S., as designated by The Nature Conservancy (Stein and Flack 1996). Like aquatic plants, the establishment and expansion of invasive animal populations occurs primarily via trade routes. At a more local level, establishment and expansion of non-native species is typically facilitated by disturbance, recreation and transportation, and animals. Water control structures provide another mechanism by which invasive species are distributed in Louisiana (Zahn et al. 2018). Invasive vegetatve species can be a problem for restoration and construction projects because of the newly cleared areas provide openings for invasive species establishment and distribution.

A list of invasive aquatic animals (Table 9.7-2) was compiled from: (1) the USGS NAS database, delineated by the eight-digit HUC 08090203 (Eastern Louisiana Coastal which includes the Breton, Pontchartrain and Mississippi Delta basins); (2) data from the LDWF (Kravitz et al. 2005) (3) the BTNEP; and(4) the Smithsonian Environmental Research Center (Fofonoff et al. 2018). Non-aquatic invasive species, such as mammals and amphibians, are presented with terrestrial wildlife in Section 8.5.

The network of natural and constructed channels provides a mechanism for distribution of mollusks in Louisiana and in the Breton Sound Basin. These organisms can foul industrial intake pipes and boats, alter benthic substrate, and compete with native mollusks for resources. Zebra mussels were found in the Bonnet Carré Spillway after the 2008 opening (Font 2009).

The Asian tiger prawn (*Penaeus monodon*) is a crustacean that is considered invasive and the import, sale, and possession of this species is prohibited under Louisiana statutes. This invasive shrimp species was introduced into the U.S. for mariculture and has been reported from Lake Borgne to Vermilion Bay (https://www.seagrantfish.lsu.edu/biological/invasive/tigerprawn.htm). This shrimp is a more aggressive predator on soft-bodied invertebrate benthic organisms than native shrimp, possibly outcompeting native shrimp species for food resources.

Invasive finfish have become established in Louisiana as a result of the extensive network of waterways (Kravitz et al. 2005). In Louisiana, it is illegal to, at any time, to possess, sell, or transport live carp (all species of carp, including diploid and triploid grass carp) without written permission from LDWF. The import, sale, and possession of the silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*Hypophthalmichthys nobilis*) are prohibited under Louisiana statutes. These carp occur in all tributaries and distributaries of the Mississippi River and directly compete with native paddlefish (spoonbill catfish), shad, and juveniles of recreational and commercial fish. Populations of silver carp, bighead carp, grass carp, and common carp have been shown to be introduced by diversions, such as the Davis Pond Freshwater Diversion and Bonnet Carré Spillway (GEC 2011; USGS 2011, 2018). In April 2009, large numbers of juvenile silver carp were collected from the pools of the Bonnet Carré Spillway (USACE 2009b).

Table 9.7-2
Aquatic Invasive Animal Species with the Potential of Occurring within the Breton Sound Basin

Scientific Name	Common Name	Fresh/Marine
Mollusks		
Corbicula fluminea[a]	Asian clam	Freshwater
Dreissena polymorpha[a]	Zebra mussel	Freshwater
Pomacea maculate	Giant apple snail	Freshwater
Crustaceans		
Penaeus monodon	Asian tiger prawn	Marine
Fishes		
Herichthys cyanoguttatus[a]	Rio Grande cichlid	Freshwater
Oreochromis sp.	Tilapia species (potential arrival)	Freshwater
Ctenopharyngodon idella[a]	Grass carp	Freshwater
Cyprinus carpio [a]	Common carp	Freshwater
*Hypophthalmichthys molitrix***	Silver carp	Freshwater
Hypophthalmichthys nobilis[a]	Bighead carp	Freshwater
Sander Canadensis	Sauger	Freshwater
Oncorhynchus mykiss	Rainbow trout	Freshwater-Marine

a. Species also included in the State Management Plan for Aquatic Invasive Species (Kravitz et al. 2005).
Source: USGS 2018.

10.0 ESSENTIAL FISH HABITAT

10.1 INTRODUCTION

Congress enacted amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (PL 94-265) in 1996 that established procedures for identifying Essential Fish Habitat (EFH) and required interagency coordination to further the conservation of federally managed fisheries. A provision of the Magnuson-Stevens Act requires that Fishery Management Councils (FMCs) identify and protect EFH for every species managed by a Fishery Management Plan (FMP) (U.S.C. 1853(a)(7)). The Gulf of Mexico Fishery Management Council (GMFMC) defines six FMPs for the Gulf of Mexico: shrimp, red drum, reef fish, coastal migratory pelagics, corals, and spiny lobster. In addition, National Marine Fisheries Service's Highly Migratory Species Division manages an FMP for highly migratory species (i.e., sharks, tuna, billfish, and swordfish) as they cross domestic and international boundaries. Managed species with the potential to occur in waters of the Breton Sound Basin are listed in Table 10.1-1 and included under the following FMPs:

- Shrimp Fishery of the Gulf of Mexico, U.S. Waters;
- Red Drum Fishery of the Gulf of Mexico;
- Reef Fish of the Gulf of Mexico;
- Coastal Migratory Pelagic Resources in the Gulf of Mexico and South Atlantic; and
- Atlantic Highly Migratory Species.

Per the Magnuson-Stevens Act, EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” The definition for EFH may include habitat for an individual species or a group of species, whichever is appropriate within each FMP. EFH is separated into estuarine and marine components. The estuarine component is defined as “all estuarine waters and substrates (mud, sand, shell, rock, and associated biological communities); sub-tidal vegetation (seagrasses and algae); and adjacent intertidal vegetation (marshes and mangroves).” The marine component is defined as “all marine waters and substrates (mud, sand, shell, rock, and associated biological communities) from the shoreline to the seaward limit of the Exclusive Economic Zone” (GMFMC 2004).

The area of analysis for the potential impacts of the Mid-Breton Sediment Diversion on EFH includes all tidally influenced wetlands and waters within the entire Breton Sound Basin and Mississippi River Delta Basin. For the purposes of EFH discussion, these two basins will be referred as the Study Area. EFH for specific species and life stages was identified within the project area based on the review of aerial photography, GIS, literature review, and previous field surveys. Federally managed species and their possible life history stages that may use the EFH within the project area are also discussed in this section.

Habitat Areas of Particular Concern (HAPCs) are localized areas of EFH that are ecologically important, sensitive, stressed, and/or rare areas. Although designated HAPCs have no regulatory protections above all other EFH, projects impacting HAPCs may be more scrutinized and may be subject to additional conservation measures (NOAA 2015). No HAPCs are located in the project area.

Table 10.1-1
EFH for Species Managed by the GMFMC that Occur in the Study Area[a]

Fishery	Species	Life Stage	Coastal Zone	Habitats
Coastal Migratory Pelagic fish	King mackerel	Juveniles, adults	Nearshore	Water column
	Spanish mackerel	Larvae, spawning adults	Nearshore	Water column
		Juveniles, adults	estuarine, nearshore	Water column
		Eggs, larvae	estuarine, nearshore	Water column
	Cobia	Juveniles	Nearshore	Water column
		Adults		Water column, hard bottom
		Spawning adults		Water column
Red drum	Red drum	Eggs	Nearshore	Water column

Table 10.1-1
EFH for Species Managed by the GMFMC that Occur in the Study Area[a]

Fishery	Species	Life Stage	Coastal Zone	Habitats
		Larvae	Estuarine	SAV, soft bottom, water column
		Juveniles	Estuarine, nearshore	Emergent marsh, SAV, hard bottom, soft bottom, sand/shell
		Adults		SAV, emergent marsh, soft bottom, hard bottom, sand/shell, water column
Reef fish	Almaco jack	Juveniles	Nearshore	water column
	Gag	Adults	Nearshore	Hard bottom
	Gray snapper	Adults	Estuarine, nearshore	Hard bottom, soft bottom, sand/shell, emergent marsh
		Spawning adults	Estuarine, nearshore	Reef, hard bottom
	Gray triggerfish	Larvae	Nearshore	Water column
		Juveniles		
		Adults		Hard bottom
	Lane snapper	Larvae	Estuarine, nearshore	Water column
		Juveniles		SAV, water column, sand/shell, soft bottom
		Adults	Nearshore	Sand/shell, hard bottom
	Red snapper	Juveniles	Nearshore	Hard bottom, soft bottom, sand/shell
		Adults		Hard bottom
	Vermilion snapper	Juveniles	Nearshore	Hard bottom
		Adults		Hard bottom
		Spawning adults		Hard bottom
Shrimp	Brown shrimp	Larvae	Estuarine, nearshore	Water column
		Juveniles	Estuarine	SAV, emergent marsh, oyster reef, soft bottom, sand/shell
		Subadults	Estuarine, nearshore	Soft bottom, sand/shell
		Adults	Nearshore	Soft bottom, sand/shell
	White shrimp	Eggs	Estuarine, nearshore	Water column
		Larvae		Water column
		Juveniles		SAV, emergent marsh, oyster reef, soft bottom
		Subadults		Soft bottom, sand/shell
		Adults		Soft bottom

Table 10.1-1
EFH for Species Managed by the GMFMC that Occur in the Study Area[a]

Fishery	Species	Life Stage	Coastal Zone	Habitats
		Spawning adults		Soft bottom
	Pink shrimp	Larvae	Nearshore	Sand, shell, water column
		Juveniles	Nearshore	SAV
		Adults	Nearshore	Sand, shell
		Spawning Adults	Nearshore	Sand, shell

a. As identified in April 19, 2019, letter from NMFS.

10.2 EFH CATEGORIES WITHIN THE STUDY AREA

Six of the 12 EFH classified habitats (those habitats identified as important to life stages of fish) within the Gulf of Mexico occur within the Study Area:

- Emergent marshes (tidal wetlands (including mangroves), tidal creeks, rivers/streams)
- Submerged Aquatic Vegetation [SAV] (seagrasses, benthic algae)
- Soft bottom (mud, clay, silt)
- Sand/shell bottom (sand, shell)
- Oyster reefs (i.e. hard bottom)
- Water Column Associated (pelagic, planktonic, coastal pelagic)

The following EFH habitats do not occur in the project area and will not be discussed further: mangroves, reefs (reef halos, patch reefs, deep reefs), hard bottoms (live bottom, low-relief bottoms, high-relief bottoms), banks/shoals, shelf edge/slope, and drifting algae.

10.2.1 Estuarine Emergent Marsh

Wetlands provide a diverse set of functions and provide ecological, economic, and social benefits. The ability to perform a function is influenced by the characteristics of the wetland and the physical, chemical, and biological processes in it (USACE 2017). Louisiana's coastal wetlands provide habitat for wildlife, finfish, shellfish, and other aquatic organisms, including threatened or endangered species. Further, they support, by volume, the largest commercial fishery in the contiguous United States (NMFS 2017). Wetlands improve water quality by removing organic and inorganic toxic materials, suspended sediments, and nutrients via plant uptake and sedimentation. Primary productivity, decomposition, and other chemical processes also contribute to the removal of certain chemicals from the water (Mitsch and Gosselink 2000). Wetlands also provide a level of flood control. Wetland vegetation can attenuate waves and storm surges, and communities sheltered by wetlands may sustain less damage from storm surges (Day et al. 2007). Further, due to their anoxic, wet conditions, wetlands provide a natural environment for sequestration and storage of carbon from the atmosphere. Most wetlands are net carbon sinks when methane emissions and carbon sequestration are balanced (Mitsch et al. 2012).

Wetland types that overlap with EFH within the project area include emergent wetlands, which are further classified by their salinity regimes and tidal influence. Fresh marsh is found in the very northern portion of the Breton Sound Basin and in portions of the Mississippi River Delta most influenced by freshwater input. Intermediate marshes lie between fresh and brackish marshes in estuaries at salinities 0.5-5 parts per thousand [ppt] (ELOS Environmental 2018b). Brackish marshes are between intermediate and salt marshes, typically dominated by salt-tolerant vegetation with average salinity at about 8 ppt. Salt marshes are typically found closest to the Gulf of Mexico and are regularly tidally flooded with an average salinity of about 16 ppt. In coastal Louisiana these salt marshes are dominated by salt-tolerant grass (*Spartina alterniflora*) with few other species (ELOS Environmental 2018b).

Wetland types in the Study Area are composed of jurisdictional fresh water forest and shrub, fresh water marsh, intermediate marsh, and open water habitat (refer to Figure 5.5-1). Wetland types within the proposed project construction footprint (approximately 530.07 acres) consist primarily of jurisdictional WOTUS and forested and scrub/shrub wetland types (refer to Section 5.5) (ELOS Environmental 2018a).

Many larval and juvenile marine species utilize marsh as their nursery habitat (Rozas 1995, LDWF 2017e). Plant diversity within the intermediate or oligohaline marsh (0 to 5 practical salinity unit [psu]) is the highest of the four estuarine marsh classifications and is dominated by narrow-leaved persistent species, such as marsh hay or saltmeadow cordgrass (also known as wiregrass; *Spartina patens*), bulltongue arrowhead (*Sagittaria lancifolia*), and Roseau cane (*Phragmites australis*).

10.2.2 Submerged Aquatic Vegetation

SAV within the Study Area supports a diverse epiphytic biota, exports organic matter and nutrients into the water column, oxygenates the water column, and stabilizes bottom sediments by reducing current velocity and wave energy. In turn, these processes affect species composition, biomass, and distribution of the SAV, as well as the fauna that rely on SAV for habitat or food (Koch 2001). SAV in lakes, ponds, and open water also respond to sedimentation and agricultural water and nutrient runoff from the upper basin passing through the existing fresh water diversion, siphons, and splays.

As discussed previously in Section 9.3.1, SAV species distributions and biomass are influenced by salinity, water depth, and turbidity, as well as other variables. Chabreck (1972) documented a total of 30 SAV species on pond and lake bottoms in coastal Louisiana, including widgeon grass (*Ruppia maritima*); (the most commonly identified species), Eurasian water milfoil (*Myriophyllum spicatum*), stonewort (*Chara vulgaris*; an algae), and coontail (*Ceratophyllum demersum*) (Chabreck 1972; Merino et al. 2009). Rozas et al. (2005) reported increasing cover of SAV in the Study Area as a result of the operation of the Caernarvon Freshwater Diversion.

In studies associated with the Caernarvon Freshwater Diversion, Rozas et al. (2005) found that fresh water releases through the Caernarvon Freshwater Diversion increased the amount of SAV coverage. All 34 open-water sites in the diversion inflow area sampled by Rozas et al. (2005) contained SAV (rooted vascular plants or macroalgae); whereas only 59% of the open-water sites in their reference area contained SAV. Percent cover was approximately 66%

in the diversion inflow area and 18% in the reference area. The 2010 annual report for the Caernarvon Freshwater Diversion (CPRA 2010) indicated a reduction in SAV from salinity caused by storm surge after hurricanes in 2002, 2005, and 2008.

SAV is the most significant form of complex cover for aquatic animals in the Breton Sound Basin. Diverse SAV communities are often scattered throughout the marshes and provide important food and cover to a wide variety of fish and wildlife species, including juvenile and overwintering shrimp and crabs; coastal fishes such as red drum, Atlantic croaker, sand and spotted seatrout, and southern flounder; and habitat and foraging areas for invertebrates and fish (Hillman et al. 2017; LDWF 2005; Fonseca and Bell 1998); and overwintering habitat for bird species, such as gadwalls. SAV in intermediate and brackish areas provide nursery grounds and shelter for many species of fish and shellfish (Rozas and Odum 1988; LWDF 2005).

10.2.3 Soft Bottoms

Soft bottoms consist of unconsolidated sediment, such as mud, clay, and silt substrates and unvegetated areas and provide essential habitat throughout many life stages of fish and shellfish. Many species utilize soft bottom habitats in early life stages as they move to deeper habitats or emigrate to shelf habitats in adulthood. Species use and abundance may be affected by characteristics including substrate grain size, salinity, turbidity, dissolved oxygen levels, and water circulation. Greater discussion of the organisms that live on or in soft bottoms is provided in Section 9.4. Soft bottoms are the primary benthic habitat found in the Study Area's lakes, canals and bays.

10.2.4 Sand/Shell

Sand and shell substrates include sandy material, shell, and a mix of shell hash or rubble. Such habitats are not commonly found in the Study Area but could generally be expected to be located in the vicinity of the barrier islands and in areas closest to the Mississippi River where bedload from the river is deposited. Organisms that typically can be found in such habitats include adult spotted seatrout, black drum, and gizzard and threadfin shad.

10.2.5 Open Water

Open water in the Study Area includes the open water of Breton Sound, natural and dredged/excavated channels, and open water ponds and bays that are designated as deepwater habitats by Cowardin et al. (1979). Open water in the project area may be characterized as having unconsolidated bottom, aquatic bed, or unconsolidated shore substrates (FGDC 2013).

10.2.6 Oyster Reefs

Oyster reefs provide important habitat for fish and other invertebrates, as well as microhabitat for smaller species. Oyster reefs filter large volumes of water and can affect water quality and plankton abundance (La Peyre et al. 2014; zu Ermuggason et al. 2012). Oyster filtration affects energy cycling and carbon transfer within the estuarine food web (La Peyre et al. 2013; Fulton et al. 2010). Oyster reefs and bars also provide hard-structure habitat that estuarine fish and invertebrates can use for feeding and as predation refuge (La Peyre et al. 2014; Stunz et al. 2012; Humphries et al. 2011; Grabowski et al. 2005).

The public oyster seed grounds in the Study Area (CSA 1 south) consist of approximately 300,000 water bottom acres located from the MRGO southward to South Pass in the Mississippi River Basin Delta, and eastward from the eastern extent of private leases east of the Mississippi River to the Breton National Wildlife Refuge. Based on a recently completed side-scan sonar study, there is more than 27,700 acres of reef acreage on the public oyster seed grounds in the Study Area (LDWF 2019).

10.3 FEDERALLY MANAGED SPECIES THAT MAY USE EFH WITHIN THE PROJECT AREA

NMFS and the GMFMC (2013, 2015, 2017, 2019, NOAA Mapper, GMFMC EFH Portal) identify EFH along the estuarine and nearshore coastal zones in the waters of the project area, including white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), red drum (*Sciaenops ocellatus*), lane snapper (*Lutjanus synagris*), and gray snapper (*Lutjanus griseus*). Although EFH for the dog snapper (*Lutjanus jocu*) was also previously identified within the project area, it was removed from the reef fish FMP in June 2016 and no longer has designated EFH (81 FR 32249). The managed species that may use EFH within the project area are listed in Table 10.1-1, including life stages and subcategories of EFH for each of the species.

This section briefly discusses the preferred habitat, life history stages, and relative abundance of each of these species based on information provided by the GMFMC, as well as the highly migratory species and other managed species (i.e., shark species and sailfish [*Istiophorus platypterus*]) with the potential for occurring in the project area.

10.3.1 Penaeid Shrimp

Penaeid shrimp that may associate with EFH in the project area include brown shrimp and white shrimp. Brown shrimp juveniles and subadults are highly abundant in Louisiana estuaries, and the migrating subadults support valuable commercial inshore and offshore fisheries in the early spring through late summer. Subadult and adult white shrimp are abundant in waters of the project area and support a valuable commercial inshore and offshore fishery in Louisiana.

10.3.1.1 Brown Shrimp

Brown shrimp (*Farfantepenaeus aztecus*) are benthic omnivores distributed from Massachusetts to southern Florida, and throughout the Gulf Coast to the northwestern Yucatan Peninsula (Patillo et al. 1997). They spawn in depths greater than 18 m during fall and spring, and year-round in depths greater than 64 m. Brown shrimp have an average life span of 24 to 28 months in the Gulf. Brown shrimp are an estuarine-dependent species meaning they spend some part to all of their life cycle in the estuary.

Brown shrimp post-larvae are carried into the Study Area by shelf currents and tides with peak immigration occurring from January through June (Zein-Eldin and Renaud 1986). Metamorphosis to juveniles and settlement occurs around 25 mm TL in the estuaries, with peak months of early juveniles in the Study Area from mid-March through early June. The early juveniles prefer flooded marsh and edge habitats where they prey on benthic algae, infauna, and epifauna and can avoid larger aquatic predators including their own species (Minello et al. 2008, Rozas et al. 2007, Zimmerman et al. 2000). Juveniles remain in the shallow vegetated nursery habitats of Breton Sound Basin for about three months until they grow to approximately 60 mm TL (Minello et al. 1989). The larger juveniles move into deeper channels and open bays of the estuary in summer. They begin migrating as subadults (80 to 100 mm TL) out of the estuary towards the shelf in late summer and fall (Minello et al. 1989). Brown shrimp juveniles and subadults are highly abundant in the more saline portions of the Breton Sound Basin, and the migrating subadults support valuable commercial inshore and offshore fisheries in the early spring through late summer. The Breton Sound Basin contributes an average annual proportion of 13% of the inshore landings in Louisiana (LDWF Shrimp Management Plan 2015).

10.3.1.2 White Shrimp

White shrimp (*Litopenaeus setiferus*) are benthic omnivores distributed from Fire Island, New York to St. Lucie, Florida on the Atlantic Coast, and from Apalachee Bay, Florida to Campeche Bay, Mexico in the Gulf Coast (Patillo et al. 1997). White shrimp spawn in depths between 9-34 m (but usually less than 27 m) from spring through fall. White shrimp are an estuarine-dependent species with a similar life cycle and estuarine use by juveniles and subadults as the brown shrimp, although the seasonal timing of white shrimp juveniles in the estuaries lags behind the brown shrimp by a few months.

Similar to brown shrimp, white shrimp post-larval stages are carried into the Breton Sound Basin from the shelf into the estuaries by currents and tides from May through November (Zein-Eldin and Renaud 1986). One peak is in June and a second peak occurs in September (Baxter and Renfro 1968, Klima et al. 1982). Metamorphosis to juveniles occurs at 25 mm TL (Cook and Lindner 1970; Muncy 1984). Juveniles from 25 to 120 mm TL move to less saline waters (salinities usually below 5 and 10 ppt) and farther up into the estuary compared to brown shrimp. Juveniles leave the shallow habitats of the estuary after about three months for deeper, more saline regions in the lower estuary as they reach maturity and migrate back to the shelf to spawn (Cook and Lindner 1970). Subadult and adult white shrimp are abundant in the Breton Sound Basin and support a valuable commercial inshore and offshore fishery in Louisiana. The Breton Sound Basin contributes an average annual proportion of 8% of the inshore landings in Louisiana (LDWF Shrimp Management Plan 2015).

10.3.1.3 Pink Shrimp

Pink shrimp (*Penaeus duorarum*) adults spawn in offshore waters, primarily during the spring to fall months. Their postlarvae are carried by tides into the Breton Sound estuary and this immigration occurs primarily at night (GMFMC 2016). Postlarval, juvenile, and sub-adult pink shrimp are found most commonly in seagrass habitats, but can also be present in SAV, soft bottom and sand/shell habitats. Adult pink shrimp are found in nearshore shallower areas, primarily on sand to shell bottoms (GMFMC 2016). While pink shrimp are not common in the Breton Sound estuary, they are associated with the Mississippi River delta portion of the Study Area, hence they are included herein.

10.3.2 Coastal Migratory Pelagics

EFH for coastal migratory pelagic fish consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the GMFMC and the South Atlantic FMC from estuarine waters out to depths of 183 m (600 ft) (NOAA 2015). Coastal migratory pelagics that may associate with EFH in the Study Area include king mackerel, Spanish mackerel, and cobia.

10.3.2.1 King Mackerel

King mackerel (*Scomberomorus cavalla*) occur throughout the Gulf of Mexico and Caribbean Sea, and along the western Atlantic from the Gulf of Maine to Brazil. In the Gulf of Mexico, king mackerel densities are centered in south Florida and Louisiana. Early juveniles are found in shallower nearshore waters (less than 9 m) from May to October, while the seasonality and depth of late juveniles in nearshore waters in unknown. King mackerel adults can be found over reefs and in coastal waters, generally in depths less than 80 m, although they rarely enter estuaries and are mostly found in oceanic salinities (32–36 psu). Migrations to the northern Gulf in the spring are believed to be temperature dependent, with the species found in highest abundances in temperatures greater than 20°C (68°F) (GMFMC 2004, 2016). King mackerel rarely enter Breton Sound Basin’s estuarine habitat but may be found in more marine areas towards the Gulf. Northwestern and northeastern Gulf shelf habitats are considered important spawning areas from May to October. Spawning adults, eggs, and larvae are found offshore and in shelf habitats outside of the Study Area (GMFMC 2004, 2016).

10.3.2.2 Spanish Mackerel

Spanish mackerel (*Scomberomorus maculatus*) occur throughout the coastal zones of the western Atlantic from southern New England to the Florida Keys, and throughout the Gulf of Mexico. In the Gulf of Mexico, highest densities are found off of Florida. Juveniles are found in estuarine and nearshore waters of the Gulf (GMFMC 2004, 2016). Juvenile stages of Spanish mackerel are the most likely to be found within the project area. Adults are found in coastal waters but may enter estuaries in pursuit of baitfish. Migrations to the northern Gulf in the spring are believed to be temperature dependent, with the species found in highest abundances in temperatures greater than 20°C (68°F), and in oceanic salinities. Spawning adults, eggs, and larvae are found offshore and in shelf habitats outside of the Study Area(GMFMC 2004, 2016).

10.3.2.3 Cobia

Cobia (*Rachycentron canadum*) are found in coastal nearshore and offshore waters of the Gulf of Mexico, in depths of 1-70 m. Cobia have not been documented as utilizing or visiting estuarine habitat, and therefore would only be potentially present in the most marine habitat within waters of the Study Area. Adults feed on fishes and crustaceans, including crabs. Spawning occurs in coastal waters from April through September at temperatures ranging from 23–28°C (73–82°F). Cobia migrate seasonally, similar to other coastal pelagic species. Eggs are found in the top meter of the water column, drifting with the currents. Larvae are found in surface waters of the northern Gulf, where they likely feed on zooplankton. Juveniles occur in coastal and offshore waters feeding on small fishes, squid, and shrimp. They may be preyed upon by dolphinfish (GMFMC 2004, 2016).

10.3.3 Red Drum

Red drum (*Sciaenops ocellatus*) occur throughout the Gulf Coast and along the Atlantic Coast to Massachusetts (Murphy and Taylor 1990). They are an estuarine-dependent species with juveniles and subadults remaining in their natal estuaries until they reach maturity and begin to aggregate to shelf regions for spawning. Red drum reach maturity at about 660-700 mm Total Length (TL) at age four, with a maximum age of 37 years reported for the northern Gulf of Mexico (Powers et al. 2010; Wilson and Nieland 1994; Patillo et al. 1997).

Red drum spawn on the northern Gulf of Mexico shelf during a relatively brief period that generally begins in August and ends in the early part of October (Wilson and Neiland 1994).

Feeding larvae are 8–15 mm TL with metamorphosis to the juvenile stage occurring at 15 mm TL (Patillo et al. 1997). The larvae and early juveniles are carried by tides and currents in late fall to the shallow estuaries with peak ingress occurring in October. Larvae are carried through barrier island passes in the surface waters and juveniles move from the bay up the estuary to quiet backwater nursery areas to grow (Perret et al. 1980; Peters and Michael 1987). Juvenile and sub-adult red drum are very euryhaline (Buckley 1984) and can be found throughout most of the Study Area (deMutsert and Cowan 2012). Early juvenile drum leave the shallow nursery habitats when they reach about 40-120 mm TL to move into bays and deeper channel waters. As juveniles approach 200 mm TL in their first spring, they may remain in deep water bays or congregate in tidal passes (Simmons and Hoese 1959, Peters and Michael 1987). Sub-adults appear to remain in the bays throughout the year while older fish (>3 years) move to the shelf in early fall and winter to spawn (Perret et al. 1980; Hein and Shepard 1986; Wilson and Nieland 1994). As this data suggests, red drum juveniles and sub-adults have a broad salinity tolerance and thus are widely distributed within the Study Area.

10.3.4 Reef Fish

EFH for reef fish consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to the boundary between the areas covered by the GMFMC and the South Atlantic FMC from estuarine waters out to depths of 183 m (600 ft) (NOAA 2015). EFH for reef fish is included in the estuarine and nearshore coastal zones of the Breton Sound Basin.

Reef fish are often found as adults associated with coral reef, limestone, hard bottom, and artificial reef substrates. Adults may also forage over sand near reefs. Adults tend to have relatively small home ranges and do not migrate long distances. Juvenile reef fish species are found in shallow, inshore areas associated with SAV beds and inshore reefs. For many species, older, larger fish are found in deeper water. Reef fish feed on a variety of invertebrates including shrimp, crabs, amphipods, octopus, and squid. Larger reef fish may also eat smaller fish (GMFMC 1981). Reef fish that may associate with EFH in the Study Area include almaco jack, gray snapper, gray triggerfish, greater amberjack, lane snapper, red snapper, and vermilion snapper.

10.3.4.1 Almaco Jack

Almaco jack (*Seriola rivoliana*) occur throughout the Gulf of Mexico. Minimal information is available on their habitat associations. Adults are benthopelagic and form small groups far offshore. Juveniles are frequently associated with floating objects and eggs are water column associated. Spawning is thought to occur from spring through fall, though the northern Gulf is probably not an important spawning area (GMFMC 2004, 2016). Almaco jack have not been documented as utilizing or visiting estuarine habitat, and therefore would only be potentially present in the most marine habitat within waters of the Study Area.

10.3.4.2 Gray Snapper

Gray snapper (*Lutjanus griseus*, also known as mangrove snapper) occur in estuaries and shelf waters of the Gulf of Mexico and are particularly abundant off south and southwest Florida. Considered to be one of the more abundant snappers inshore, the gray snapper inhabits waters to depths of about 180 m. Adults are demersal and mid-water dwellers, occurring in marine, estuarine, and riverine habitats. They occur up to 32 km (19.9 miles) offshore and inshore as far as coastal plain freshwater creeks and rivers. Gray snapper are found among mangroves, sandy grass beds, and coral reefs and over sandy, muddy, and rocky bottoms. Spawning occurs offshore around reefs and shoals from June to August. Eggs are pelagic and are present June through September after the summer spawn, occurring in offshore shelf waters and near coral reefs. Larvae are planktonic, occurring in peak abundance June through August in offshore shelf waters and near coral reefs from Florida through Texas. Postlarvae move into estuarine habitat and are found especially over dense seagrass beds of *Halodule* wrightii and *Syringodium filiforme*. Juveniles are marine, estuarine, and riverine dwellers, often found in estuaries, channels, bayous, ponds, grass beds, marshes, mangrove swamps, and freshwater creeks. They appear to prefer grass flats (*Thalassia testudinum*), marl bottoms, seagrass meadows, and mangrove roots (GMFMC 2004, 2016). Gray snapper may be present throughout the Study Area.

10.3.4.3 Gray Triggerfish

In the Gulf of Mexico, gray triggerfish can be found at depths from 10 m to 100 m; they occupy habitat types including the water column, reefs, Sargassum (drifting algae), and mangroves depending on the life stage (GMFMC 2016). Gray triggerfish have not been documented as utilizing or visiting estuarine habitat, and therefore would only be potentially present in the most marine habitat within waters of the Study Area.

10.3.4.4 Lane Snapper

Lane snapper (*Lutjanus synagris*) can be found throughout the Gulf of Mexico, and in the western Atlantic from North Carolina to southeastern Brazil. Juveniles and adults are found across most habitat types, including SAV, sand/shell, reefs, soft bottom, banks/shoals, and mangroves. Adults occupy nearshore and offshore waters, at depths of 4–132 m and temperature of 16–29°C (61–84°F) (GMFMC 2016). Lane snapper would only be potentially present in the most marine habitat within waters of the Study Area.

10.3.4.5 Red Snapper

Red snapper (*Lutjanus campechanus*) occur throughout the Gulf of Mexico shelf. They are historically abundant on the Campeche Banks and are a predominant species in the northern Gulf. Red snapper are demersal and found over sandy and rocky bottoms, around reefs, and artificial habitats from shallow water to 200 m, and possibly even beyond 1,200 m. Spawning and eggs occur in offshore waters, with spawning from May to October in depths of 18–37 m (fine sand bottom) and eggs are found in summer and fall. Larvae, postlarvae and early juveniles are found July through December in shelf waters ranging in depth of 17–183 m. Early and late juveniles are most often associated with shell and low-relief structures but can be observed over barren sand and mud bottom. Late juveniles are found year-round at depths of 20–46 m. Adults are concentrated off Yucatan, Texas, and Louisiana at depths of 7–146 m and are most abundant at depths of 40–110 m. They commonly occur in submarine gullies and depressions, and over coral reefs, rock outcroppings, shell/gravel bottoms, and offshore oil and gas platforms (GMFMC 2004, 2016). Red snapper have not been documented as utilizing or visiting estuarine habitat, and therefore would only be potentially present in the most marine habitat within waters of the Study Area.

10.3.4.6 Vermilion Snapper

Vermilion snapper (*Rhomboplites aurorubens*) are found in the nearshore and offshore water of the Atlantic Ocean from Cape Hatteras, North Carolina, to southeastern Brazil, including the West Indies, Gulf of Mexico, and Caribbean Sea (NOAA 2018). Vermilion snapper has a typical reef-fish life history where eggs and larvae are pelagic, and then juveniles settle to the bottom, associating with hard bottom habitats. They are a tropical reef fish most abundant in the Bahamas, south Florida, and the Caribbean (SEDAR 45 2016). Vermillion snapper have not been documented as utilizing or visiting estuarine habitat, and therefore would only be potentially present in the most marine habitat within waters of the Study Area.

10.3.5 Highly Migratory Species

Highly migratory species are mobile, pelagic species such as tuna, swordfish, and sharks that have wide distributions in open ocean, coastal, and estuarine waters, and vertically within the water column. EFH is established for the sailfish (*Istiophorus platypterus*) and four shark species, including the blacktip (*Carcharhinus limbatus*), bull (*Carcharhinus leucas*), spinner (*Carcharhinus brevipinna*), and lemon (*Negaprion brevirostris*), in the estuarine and nearshore waters of the Study Area. By letter dated April 19, 2019, NMFS identified a number of highly migratory species they believe to have EFH in the Study area. These species are identified in Table 10.3.5-1

Table 10.3-1
Essential Fish Habitat for Highly Migratory Species in the Study Area (Breton and Mississippi Sound Basins)[a]

Species	Scientific Name	Life History Stage[b]	Geographic Location in the Study Area
Blacktip shark (Gulf of Mexico stock)	Carcharhinus limbatus	Neonate/YOY	All estuarine and coastal waters
		Juvenile/Adult	All estuarine and coastal waters
Bull shark	Carcharhinus leucas	Neonate/YOY	Lake Borgne east to Ship Island
		Juvenile/Adult	Mississippi River delta, Chandeleur Islands
Spinner shark	Carcharhinus brevipinna	Neonate/YOY	Coastal Louisiana waters
		Juvenile/Adult	Coastal Louisiana waters
Scalloped hammerhead shark	Sphyrna lewini	Neonate Juvenile	Breton Sound and Mississippi River delta Mississippi River delta
Finetooth shark	Carcharhinus isodon	All life stages	Coastal eastern Louisiana
Sharpnose shark [a] (Gulf of Mexico stock)	Rhizoprionodon porosus	Neonate/YOY	Coastal Louisiana waters
		Juvenile/Adult	Coastal Louisiana waters
Yellowfin tuna	Thunnus albacares	Juvenile	Mississippi River delta
Sailfish	Istiophorus platypterus	Juvenile	Mississippi River delta
Bonnethead shark	Sphyrna tiburo	Neo/juvenile	Mississippi Sound
		Adult	Mississippi Sound
Lemon Shark	Negaprion brevirostris	Juvenile	Nearshore eastern Louisiana

Source: NMFS 2009
[a] As indicated in an April 19, 2019, NMFS scoping letter to the USACE.
[b] YOY= young of year.

Adult, juvenile, and especially early life stages (neonates [newborn] for sharks) may be limited by temperature, salinity, or oxygen levels (NMFS 2017). Atlantic sharks are widely distributed as adults but often use specific estuaries as nursery areas for neonate and young of year (YOY) life stages. Coastal sharks use the inshore shallow waters of the northern Gulf of Mexico as their spawning and nursery grounds. They tend to move into inshore shallow waters in the Gulf of Mexico during the spring to give birth to offspring. Young sharks spend summers in the inshore waters for feeding and refuge from predators. For example, estuarine environments provide young bull sharks protection from predation and abundant food sources that allow it to achieve high growth and survival rates (Hunt and Doering 2013). Billfish (e.g., sailfish) distributions are typically associated with hydrographic features such as density fronts between different water masses (for example, the river plume of the Mississippi River and ocean fronts over the DeSoto Canyon in the Gulf) and do not use estuarine waters during any portion of their life.

10.3.6 Other Managed Species

In addition to being designated as EFH for various federally managed species, water bodies and wetlands in the project area provide nursery and foraging habitats supportive of a variety of economically important marine fishery species that also serve as prey for federally managed species under the Magnuson-Stevens Act. This includes species such as blue crab (*Callinectes sapidus*), gulf menhaden (*Brevoortia patronus*), spotted seatrout (*Cynoscion nebulosus*), sand seatrout (*Cynoscion arenarius*), southern flounder (*Paralichthys lethostigma*), striped mullet (*Mugil cephalus*), Atlantic croaker (*Micropogonias undulatus*), pinfish (*Lagodon rhomboids*), spot (*Leiostomus xanthurus*), anchovies (*Anchoa* sp.), and gulf killifish (*Fundulus grandis*).

11.0 THREATENED AND ENDANGERED SPECIES

11.1 INTRODUCTION

The affected environment analysis for threatened & endangered (T&E) species considers all federal and state-protected threatened, endangered, at-risk, and candidate species that potentially occur in the project area. The Study Area includes the broader Breton Sound Basin, the Mississippi River Delta Basin, and the proposed project construction footprint.

This section describes the range and habitat requirements of each species included on the federal or state lists of threatened or endangered species, as well as any federal at-risk species. There is also a discussion on the presence or absence of critical habitat for these protected species within the Study Area. Additional information about available habitats and potential wildlife occurrences is presented in Section 8.0 (Terrestrial Wildlife and Habitat) and Section 9.0 (Aquatic Resources).

11.2 REGULATORY SETTING

The Federal Endangered Species Act (ESA) of 1973, as amended, was enacted to provide a program for the preservation of threatened and endangered species and to provide protection for the ecosystems upon which the species depend for their survival. All federal agencies are required to implement protection programs for these designated species and use their authorities to further the purpose of the Act. The USFWS and NMFS are the primary agencies responsible for implementing the ESA. The USFWS is responsible for terrestrial flora and fauna, including freshwater species, while the NMFS is responsible for nonbird marine species. The USFWS and NMFS share federal jurisdiction for sea turtles and Gulf sturgeon (*Acipenser oxyrinchus desotoi*) under the ESA.

The ESA defines a threatened species as "a species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" and an endangered species as "a species that is in danger of extinction throughout all or a significant portion of its range" (50 CFR 424.02). When a species is listed as threatened or endangered, the Services (USFWS and NMFS) must consider whether there are areas of habitat believed to be essential to the species' conservation and proposed for designation as critical habitat. The ESA requires the designation of critical habitat – habitat areas that contain features essential to the conservation of the species, even if not currently occupied by the species - unless designation would not be prudent or the critical habitat is not determinable[7].

11.3 FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

Review of the federal databases and correspondence with the USFWS and NMFS indicate that there are ten federally listed threatened and endangered species that are known to occur, or have the potential to occur, in the Study Area, which includes Plaquemines and St. Bernard parishes (Table 11.3-1). State-listed species and special status species of concern are discussed in Section 11.4.

Table 11.3-1
Federally Listed Species Potentially Occurring in the Project Area

Common Name	Scientific Name	Federal Status	State Status	Habitat	Parish of Potential Occurrence[a]
MARINE/ESTUARINE SPECIES					
Marine/Aquatic Mammals					
West Indian manatee	*Trichechus manatus*	T (CH)	E	Inland freshwater; coastal estuarine: tidal rivers and streams, springs, salt marshes, lagoons, canals	Plaquemines, St. Bernard
Marine Reptiles					
Green sea turtle	*Chelonia mydas*	T (CH)	--	Coastal beaches, marine areas	Plaquemines, St. Bernard
Hawksbill sea turtle	*Eretmochelys imbicata*	E (CH)	--	Coastal beaches, marine areas	Plaquemines, St. Bernard
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	--	Coastal beaches, marine areas	Plaquemines, St. Bernard
Leatherback sea turtle	*Dermochelys coriacea*	E (CH)	--	Coastal beaches, marine areas	Plaquemines, St. Bernard
Loggerhead sea turtle	*Caretta*	T (CH)	--	Coastal beaches, marine areas	Plaquemines, St. Bernard

[7] The Services are proposing to revise portions of their regulations that implement section 4 of the ESA, as amended, including the criteria for designating critical habitat. The Services propose to revise section 424.12(a)(1) to set forth a non-exhaustive list of circumstances in which the Services may find it is not prudent to designate critical habitat as contemplated in section 4(a)(3)(A) of the Act. Under the clarifications being proposed as part of this revision, the Services would have the authority but would not be required to find that designation would not be prudent in the enumerated circumstances.

Table 11.3-1
Federally Listed Species Potentially Occurring in the Project Area

Common Name	Scientific Name	Federal Status	State Status	Habitat	Parish of Potential Occurrence[a]
RIVERINE SPECIES					
Fish					
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T (CH)	T	Inland freshwater: river systems; coastal estuarine	Plaquemines, St. Bernard,
Pallid sturgeon	*Scaphirhynchus albus*	E		Inland fresh water, river systems	Plaquemines, St. Bernard
TERRESTRIAL SPECIES					
Piping plover	*Charadrius melodus*	T (CH)	T/E	Coastal beaches	Plaquemines, St. Bernard
Red knot	*Calidris canutus rufa*	T	--	Coastal beaches	Plaquemines, St. Bernard

a. Parish of potential occurrence for federally listed species indicates the parish in which a species is listed in the Information for Planning and Consultation (IPaC) system and/or USFWS-developed parish lists. A parish listing does not necessarily indicate that the species would or could occur within the project area or proposed construction footprint.

Notes: T = threatened; E = endangered; - = not listed; CH = critical habitat; P = proposed.

Sources: USFWS 2017a, 2017b; NMFS 2017.

11.3.1 Marine/Estuarine Species

11.3.1.1 West Indian Manatee

The USFWS reclassified the West Indian manatee from endangered to threatened in 2017 due to substantial improvements in the species' overall status since the original listing in 1967 (42 FR 47840) (USFWS 2017c). Threats to the species include vessel strikes (direct impact and/or propeller), entrapment and/or crushing in water control structures, entanglement in fishing and crab pot lines, exposure to cold, loss of warm water refuge, and exposure to red tide (USFWS 2008). Human causes alone are estimated to result in approximately 99 manatee mortalities per year (USFWS 2014a). Designated critical habitat includes Florida coastal and inland waters (42 FR 47841), which is outside the project area.

The West Indian manatee may occur in coastal and inland waters from Texas to Florida in freshwater, brackish, and marine environments along the entire Gulf Coast (USFWS 2015). However, manatees are tolerant of brackish and marine environments only if they have access to fresh water regularly (Fertl et al. 2005). Temperature is the dominant factor determining their range, and they respond to cold weather (less than 68 °F) by moving to warmer waters (USFWS 2008).

There are no robust estimates of total population size for this species (USFWS 2014a); studies have reported an abundance ranging from 5,076 (based on a single survey of warm-water refuges) to 6,350 manatees (based on models) (Laist et al. 2013, Martin et al. 2015). Although this population appears to be stable or increasing, there have only been 100 reported sightings of the West Indian manatee in Louisiana waters since the 1990s (Fertl et al. 2005).

These limited data suggest that this species could be present within the project area, but only as a transient visitor (particularly during the warmer months), and not a resident species. The most likely origins of manatees occurring along the northern Gulf Coast are the wintering populations from southwest Florida (Fertl et al. 2005).

11.3.1.2 Sea Turtles

Sea turtles are found throughout the tropical and subtropical seas of the world, where they occur at or near the surface of the water. All species are listed as threatened or endangered under the ESA and are under the shared jurisdiction of the USFWS and NMFS (USFWS and NMFS 1977). The USFWS has responsibility for sea turtles on nesting beaches, while NMFS has jurisdiction for sea turtles in the marine environment and all waters adjacent to the terrestrial environment. Female sea turtles nest on land; hatchlings emerge from nests and return to the ocean where they have a prolonged pelagic stage. Juveniles and adults use varying habitats, depending on the species, and adult females generally return to their natal coastal sand beaches to nest and lay their eggs. Sand beaches suitable for nesting are limited to coastal barrier islands. Although sea turtle nesting is not prevalent in the Study Area for any species, all but the hawksbill sea turtle have been identified as using areas in and around Breton Sound Basin for nesting (Fuller et al. 1987).

Green

The green sea turtle was originally listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific Coast of Mexico breeding populations, which were listed as endangered. On April 6, 2016, the original listing was replaced with the listing of 11 distinct population segments (DPSs) (81 FR 20057 2016). The Mediterranean, Central West Pacific, and Central South Pacific DPSs were listed as endangered. South Atlantic DPS and North Atlantic DPS were listed as threatened and are the two DPSs with individuals occurring in the Atlantic and Gulf of Mexico waters of the United States.

The North Atlantic DPS of green sea turtles is distributed throughout inshore and nearshore waters from Texas to Massachusetts, although most nesting occurs on Florida's southeast coast (NOAA 2018a). With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters as well as bays and lagoons. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting (Hays et al. 2001). After emergence, hatchlings swim to offshore areas where they remain pelagic for several years. Once the juveniles reach a certain age/size range, they leave the open ocean habitat and travel to nearshore foraging grounds (NOAA 2018a).

Green sea turtles face many of the same threats as other sea turtle species, with their primary aquatic threats being bycatch, poaching, natural predation, pollution, marine debris, and disease (NMFS 2015). The primary terrestrial threats to green sea turtles comes from poaching of eggs and the loss and degradation of nesting habitat (NMFS 2015). In addition to general threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989).

While green turtles regularly use the northern Gulf of Mexico, the proportion of the population using the northern Gulf of Mexico at any given time is relatively low. Green sea turtles do not nest within the project area. Juvenile or adult North Atlantic DPS of green sea turtles may potentially occur in marine aquatic areas of the project area while migrating, resting, or foraging. Green sea turtles are typically found in warm bays and oceans, often associated with seagrass beds or estuaries and are known to occur in the Mississippi River Delta Basin.

Hawksbill

The hawksbill sea turtle was federally listed as endangered on June 2, 1970 (35 *FR* 8495) with critical habitat designated in Puerto Rico on May 24, 1978 (43 *FR* 22224). The greatest threat to this species is overharvest to supply the market for tortoiseshell and stuffed turtle curios (Meylan and Donnelly 1999). Hawksbill shell (bekko) commands high prices. Japanese imports of raw bekko between 1970 and 1989 totaled 713,850 kilograms, representing more than 670,000 turtles. However, this market was closed in 1993 (Bräutigam and Eckert 2006). The hawksbill is also used in the manufacture of leather, oil, perfume, and cosmetics (NMFS 2014).

The hawksbill sea turtle occurs globally, including in the Gulf of Mexico, and nests can be found from Texas to Florida (NOAA 2017b). Adults are most commonly associated with healthy coral reefs, but also occur in rocky areas and shallow coastal areas, typically in depths of less than 65 feet (NOAA 2017b; USFWS 2018). Hawksbill sea turtles feed primarily on invertebrates such as sponges, sea urchins, and barnacles, as well as sea grasses and algae. After emergence, hatchlings swim offshore to mature among floating algal mats and drift lines before returning to coastal foraging grounds.

Hawksbill sea turtles do not nest within the Study Area. Critical habitat for the hawksbill has been established in the coastal waters of Mona Island, Puerto Rico, which is outside of the Study Area (63 FR 46693). Juvenile or adult hawksbill sea turtles may potentially occur in marine aquatic areas of the Study Area while migrating, resting, or foraging. Hawksbill sea turtle hatchlings swim offshore to mature among floating algal mats and drift lines before returning to coastal foraging grounds. Adult hawksbill turtles migrate from foraging areas to natal nesting beaches and may travel long distances each way (NOAA 2017b, USFWS 2018).

Kemp's Ridley

The Kemp's ridley sea turtle was federally listed as endangered throughout its range on December 2, 1970 (35 FR 18320). Populations of this species have declined since 1947, when an estimated 42,000 females nested in 1 day (Hildebrand 1963), to a total nesting population of approximately 1,000 in the mid-1980s. The decline of this species was primarily the result of human activities including collection of eggs, fishing for juveniles and adults, killing adults for meat and other products, and direct take for indigenous use. In addition to these sources of mortality, Kemp's ridleys have been subject to high levels of incidental take by shrimp trawlers (NMFS, USFWS, and SEMARNAT 2011). The National Research Council (NRC) Committee on Sea Turtle Conservation estimated in 1990 that 86 percent of the human-caused deaths of juvenile and adult loggerheads and Kemp's ridleys resulted from shrimp trawling (Campbell 1995). Before the implementation of turtle excluder devices (TEDs), estimates showed that the commercial shrimp fleet killed between 500 and 5,000 Kemp's ridleys each year (NRC 1990). Kemp's ridleys have also been taken by pound nets, gill nets, hook and line, crab traps, and longlines.

The primary geographic range of the endangered Kemp's ridley sea turtle is the Gulf of Mexico Basin and nearshore waters of the U.S. Atlantic Ocean. The turtle feeds on crab, fish, jellyfish, clams, and small invertebrates along the Gulf Coast from southern Florida to the Yucatan.

The Kemp's ridley is the smallest marine turtle and is notable for its nesting behavior, known as an "arribada," which involves large groups of females simultaneously coming ashore to nest, most notably in Rancho Nuevo, Mexico. Kemp's ridley nesting in the U.S. is concentrated primarily in south Texas where the number of recorded nests ranged from six in 1996 to a record high of 209 in 2012 (National Park Service [NPS] 2015). Kemp's ridleys are not known to nest in Louisiana; however, juveniles have been identified in inshore bays and offshore waters of the Project Area (Fuller et al. 1987). Further, immature and adult Kemp's ridleys were tracked moving eastward from Texas along approximately the 66-foot (20-meter) isobath to foraging areas offshore of central Louisiana, indicating the Gulf Coast provides developmental, migratory, inter- and post- nesting habitat for the turtle (Seney and Landry 2011).

Kemp's ridley sea turtles do not nest within the Study Area. No critical habitat has been established for Kemp's ridley sea turtle. Juvenile or adult Kemp's ridley sea turtles may potentially occur in marine aquatic areas of the Study Area while migrating, resting, or foraging. The primary range of Kemp's ridley sea turtles is within the Gulf of Mexico Basin, though they also occur in coastal and offshore waters of the U.S. Atlantic Ocean (USFWS 2017).

Leatherback

The leatherback sea turtle was federally listed as endangered throughout its range on June 2, 1970 (35 FR 8495), with critical habitat designated in the U.S. Virgin Islands on September 26, 1978 and March 23, 1979 (43 FR 43688–43689 and 44 FR 17710–17712, respectively). In 1999, in a rule conforming and consolidating various regulations, NMFS amended and redesignated this habitat, while also establishing a "conservation zone" extending from Cape Canaveral to the Virginia-North Carolina border and including all inshore and offshore waters; this zone is subject to shrimping closures when high abundance of leatherbacks is documented (64 FR 14067, March 23, 1999).

The leatherback sea turtle has the widest global distribution of all reptile species, as it circumnavigates the Atlantic Ocean (NOAA 2017c). The northwest Atlantic population of leatherback sea turtles nests primarily from southern Virginia to Alabama, with additional nesting beaches along the northern and western Gulf of Mexico. While leatherbacks also forage in shallower coastal waters, they appear to prefer the open ocean at all life stages where they forage for soft-bodied prey (for example, jellyfish and sea squirts). Non-nesting, adult female leatherbacks are reported throughout the U.S. Atlantic, Gulf of Mexico, and Caribbean Sea.

Leatherback sea turtles do not nest within the Study Area. Juvenile or adult leatherback sea turtles may potentially occur in more marine portions of the Study Area while migrating, resting, or foraging. Critical habitat is designated for the leatherback sea turtle in the coastal waters of the U.S. Virgin Islands (44 FR 17710), which is outside the Study Area.

Loggerhead

The North Atlantic DPS of loggerhead sea turtle was federally listed as threatened throughout its range on July 28, 1978 (43 FR 32808). The decline of the loggerhead, like that of most sea turtles, is the result of overexploitation by man, inadvertent mortality associated with fishing and trawling activities, and natural predation. Continued threats include incidental capture in fishing gear, primarily in longlines and gillnets, but also in trawls, traps, and pots; legal and illegal harvest; vessel strikes; beach armoring; beach erosion; marine debris ingestion; oil pollution; light pollution; and predation by native and exotic species (NMFS and USFWS 2008).

Loggerhead sea turtles have a global distribution and inhabit the continental shelf and estuarine habitats in tropical and temperate regions where they feed on crabs, mollusks, jellyfish, and vegetation. The North Atlantic DPS nests along the U.S. East and Gulf Coasts, but most nesting occurs from southern Virginia to Alabama (NOAA 2017d). After emerging from nests, hatchlings migrate offshore and become associated with Sargassum habitats, drift lines, and other convergence zones. Oceanic juveniles return to coastal habitats after as long as seven to 12 years. A preliminary regional abundance survey of loggerheads within the northwestern Atlantic estimated about 801,000 loggerheads (NMFS 2016).

Critical habitat for nesting loggerhead sea turtles has been established by the USFWS but does not include Louisiana due to the very low number of nests known to occur in the state (less than 10 annually from 2002 to 2011) (79 CFR 132). NMFS has established critical habitat for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle in the Atlantic Ocean and the Gulf of Mexico, including 38 occupied marine areas: nearshore reproductive habitat, winter area, breeding areas, migratory corridors, and/or Sargassum habitat. Critical habitat for the loggerhead related to Sargassum is present in the Study Area.

11.3.2 Riverine Species

11.3.2.1 Gulf Sturgeon

The federally threatened Gulf sturgeon, which is a subspecies of the Atlantic sturgeon, is an anadromous fish, reproducing in fresh water in the spring and migrating into the Gulf and estuaries in cooler months to forage. The species is jointly managed by the USFWS and NMFS, with the USFWS responsible for riverine areas and NMFS for marine areas. The present range of the Gulf sturgeon, as well as designated critical habitat, includes rivers, estuaries, bays, and nearshore waters east of the Mississippi River (68 FR 134495). Based on the known distribution of the species, it is not anticipated to occur in the Breton Sound Basin and thus no critical habitat for gulf sturgeon is in the Study Area.

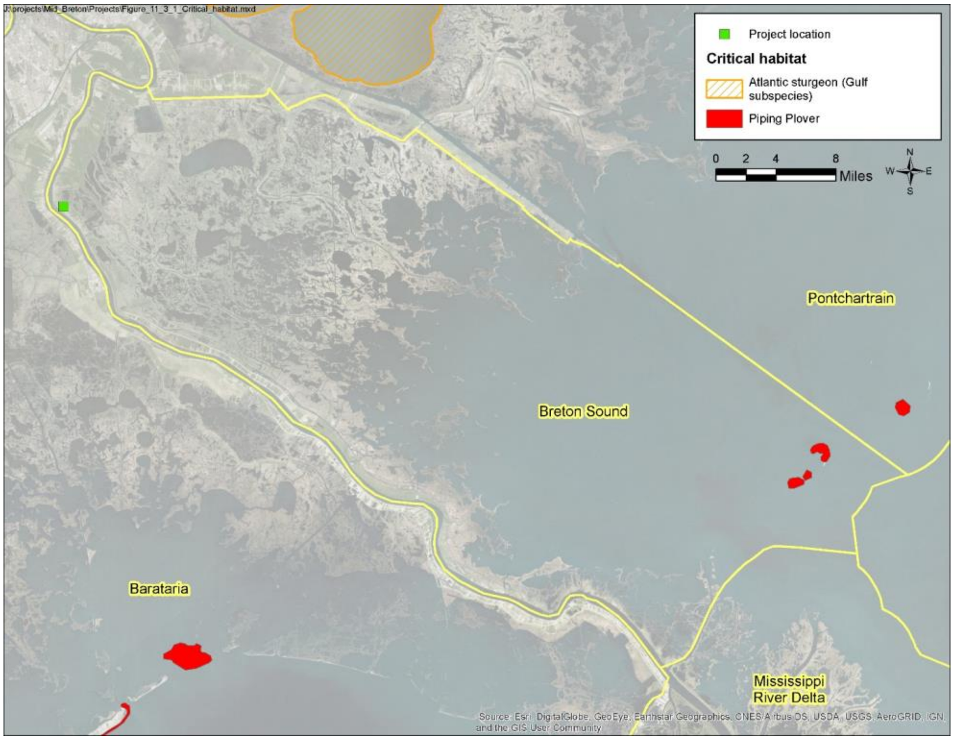


Figure 11.3-1. Critical Habitat for Federally Listed Species in the Project Area.

11.3.3 Terrestrial Species

11.3.3.1 Piping Plover

The piping plover is a migratory shorebird that breeds in the northern U.S. and Canada and winters in the southern U.S. and some Caribbean Islands. The USFWS lists three distinct breeding populations: the Atlantic Coast, Northern Great Plains, and Great Lakes populations. Each population breeds in its distinct region in sparsely vegetated upper dunes and high sandy beaches, shorelines, and depending on which region, some with gravel or scattered cobble. Foraging habitat throughout both breeding and wintering range is along shorelines, intertidal flats, mudflats, or sandflats where the birds glean various invertebrates (for example, worms, fly larvae, beetles, crustaceans, and mollusks) from the surface or occasionally probing into sand or mud (NatureServe 2017).

The USFWS has designated critical habitat for the piping plover throughout its breeding range and nonbreeding wintering areas, including coastal beaches and barrier islands of the northern Gulf of Mexico (USFWS 2017e). Critical habitat in the Study Area occurs at South Pass (Plaquemines Parish) and the Chandeleur Islands (see Figure 11.3-1). Although not preferred habitat, during migration piping plovers could occur within mudflats and estuarine habitat in the Breton Sound Basin infrequently.

11.3.3.2 Red Knot

The rufa red knot is a migratory shorebird species that migrates from breeding grounds in the Canadian Arctic to wintering grounds along the Gulf Coast, southeast U.S., and farther south. The USFWS listed the red knot as threatened in January 2015, primarily due to its dependence on horseshoe crab (*Limulus polyphemus*) populations of the Delaware Bay region, which have been declining (USFWS 2014b). No critical habitat has been designated in the Study Area for this species.

Breeding season occurs from late May until early August, and most birds depart the northern breeding areas by mid-August. Outside of breeding season, it is found primarily in intertidal, marine habitats, especially near coastal inlets, estuaries, and bays (Baker et al. 2013). Red knot have been observed within wetlands in the Mississippi River delta portion of the Study Area (ebird.org 2016).

11.4 STATE LISTED AND SPECIAL STATUS SPECIES

Based on information obtained from the LNHP, seven state-listed threatened or endangered species occur within the project area (LNHP 2018). Four of these species are also federally listed, as indicated in Table 11.3-1 and are discussed in Section 11.3.1. The three remaining state-listed species (peregrine falcon, bald eagle, and brown pelican) occur, or have the potential to occur, within the project area and are therefore included in Table 11.4-1.

In addition to the federally listed species under its purview, the USFWS also identified four species of concern including the bald eagle (federally delisted), and the saltmarsh topminnow, Louisiana eyed silkmoth, and black rail (all three of which are under review for federal listing); each of these species is discussed below. While state-listed species and federally identified species of concern are addressed in this assessment, only those species identified by the USFWS and/or NMFS as threatened or endangered are afforded federal protection under the ESA.

11.4.1 Marine/Estuarine Species

11.4.1.1 Saltmarsh Topminnow

The saltmarsh topminnow (*Fundulus jenkinsi*) is listed as “at risk” due to loss of marsh habitat, specialized habitat requirements, and a limited distribution. Threats to saltmarsh topminnows include habitat alteration such as land loss due to coastal erosion and subsequent loss of marshes.

Saltmarsh topminnows are small (typically less than 1.8 inches) fish that swim at the water surface in fresh, brackish, and salt water throughout North America, but prefer low salinity (1 to 4 ppt) marshes characterized by shallow, meandering creeks in saltmeadow cordgrass and black needle rush marshes (76 FR 49412). Saltmarsh topminnows school, sometimes in large numbers, in relatively small areas of quiet fresh waters, tidal creeks, and estuaries, but are not found far from shore (NatureServe 2017). The species is known to occur within the Gulf of Mexico from the Escambia River west to Galveston Bay and has been observed within the Breton Sound Basin (Peterson et al. 2016).

Table 10.4.1-1
State Listed Species and Species of Concern Potentially Occurring in the Study Area

Common Name	Scientific Name	Federal Status	State Status	Habitat	Parish of Potential Occurrence[a]
MARINE/ESTUARINE SPECIES					
Fish					
Saltmarsh topminnow	*Fundulus jenkinsi*	UR	--	Saltmarsh topminnows school, sometimes in large numbers, in relatively small areas of quiet fresh waters, tidal creeks, and estuaries and are not found on reefs or far from shore (NatureServe 2017).	Not available
TERRESTRIAL SPECIES					
Birds					
Bald eagle	*Haliaeetus leucocephalus*	D	E	Nest near waterbodies, marsh, and riverine systems, most commonly in cypress trees. May be present in the project area between October and May, with some remaining throughout the year.	Plaquemines, St. Bernard
Black rail	*Laterallus jamaicensis*	SOC	--	Nesting and wintering habitat is considered to be high marsh (salt, brackish, and freshwater) with infrequent flooding; including pond borders, wet meadows, and grassy “swamps” (Eddleman 1994).	Not available
Brown pelican	*Pelecanus occidentalis*	D	E	Occurs throughout the gulf coast, and in Louisiana bays and estuaries year-round, nesting in colonies on the ground and in low scrub-shrub habitats primarily on barrier islands.	Plaquemines, St. Bernard
American peregrine falcon	*Falco peregrinus anatum*	D	T/E	Range throughout North America and as non-breeding winter residents in Louisiana. Habitat in Louisiana includes coastal marshes and bays, inland riverine systems and lakes where they prey on shorebirds, doves, and other small bird species.	Plaquemines
Insects					
Louisiana eyed silkmoth	*Automeris louisiana*	UR	--	Occurs in southern Louisiana. Its entire life cycle is reliant upon saltmarsh cordgrass (*Spartina patens*)	Not available

a. Parish of potential occurrence for state listed species indicates the parish in which a species is listed in LNHP database. A parish listing does not necessarily indicate that the species would or could occur within the proposed project construction footprint in that parish. Where the parish is “not available”, the LNHP database lists the species, but not the parish of occurrence.

UR = under review; SOC = species of concern; D = delisted; E = endangered; T = threatened; C = Candidate.

11.4.2 Terrestrial Species

11.4.2.1 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is state listed as endangered (LDWF 2017). This species was listed by the USFWS in 1967 predominantly due to drastic declines in populations from pesticide use. Through prohibitions of certain pesticides and recovery programs, the bald eagle was officially recognized as recovered and delisted in June 2007 (USFWS 2007). Bald eagles remain protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act. In Louisiana, bald eagles are known to nest near, and occur in, areas with large waterbodies, expansive marsh, and riverine systems throughout the state. Bald eagles nest in large trees (most commonly used are cypress) in or near waterbodies with sufficient prey. Bald eagles are generally found in Louisiana between the months of October and May, with some remaining throughout the year. Based on previous reviews of the LNHP records by CPRA, bald eagles are known to occur in the Breton Sound Basin and nest in the vicinity of the proposed project construction footprint.

As of a 2018 survey completed by the LDWF, there were no known bald eagle nests in the project footprint. There is one active bald eagle nest approximately one mile northeast of the project boundary. Other than that one nest, as of the 2018 survey, there are no other active bald eagle nests within the remainder of the Breton Sound or Mississippi Delta basins (Michael Seymour, LDWF personal communication).

11.4.2.2 Black Rail

The black rail (*Laterallus jamaicensis*) is the smallest of the North American rail species. The black rail has been under review by the USFWS since 1994, is protected under the MBTA, and is on the LNHP list of rare species in Louisiana (USFWS 1994, USFWS 2013, LDWF 2017).Threats to the species include loss and degradation of habitat, and invasion by non-native plant species (NatureServe 2017). The species is exceedingly elusive, making accurate assessment of its range and habits difficult. Black rails nest and winter in high marsh (salt, brackish, and freshwater) with infrequent flooding, including pond borders, wet meadows, and grassy “swamps” (Eddleman 1994). The species’ range extends from North America to South America, but populations are relatively small and highly localized. In Louisiana, black rails are known to winter in the marshes of Cameron and Vermilion Parishes outside of the Study Area.

11.4.2.3 Louisiana Eyed Silkmoth

The Louisiana eyed silkmoth (*Automeris louisiana*) is a medium-sized (2.5 to 3.5-inch wingspan) moth, light brown to yellow-brown in color; and named for the distinctive blue-black “eye-spot” on the hindwings (Covell 2005). Due to its limited range and rare occurrence, the species was petitioned for listing in 2010; the 90-day finding specified that federal listing for the silkmoth may be warranted based on multiple factors, including habitat modification. The species’ entire life cycle is reliant upon saltmeadow cordgrass. Eggs are laid on the cordgrass, the only documented food of the caterpillar. A cocoon is spun onto the cordgrass about 6 to 12 inches above the ground from which (non-feeding) adults emerge to repeat this cycle. Three to four broods might be reared between February and early November (Covell 2005). The current known range is southwestern Mississippi, southern Louisiana, and adjacent extreme southeast Texas (NatureServe 2017). Verified sightings in the Study Area have been reported in Plaquemines Parish (Lotts and Naberhaus 2017).

12.0 SOCIOECONOMICS

12.1 INTRODUCTION

This section describes the affected environment for socioeconomic resources for the region that may be affected by the project, which is in general the Breton Sound Basin and Mississippi River Delta Basin. The proposed Mid-Breton Sediment Diversion (Breton) project is located in Plaquemines Parish on the east bank of the Mississippi River at RM 68.6 near Wills Point. The Study Area for socioeconomic resources includes Plaquemines and St. Bernard parishes, the geographic area mostly likely to be affected by the project (see Figure 12.1-1).

This section provides a description of community profiles within the two parishes; demographic characteristics; business activity and regional economic conditions; housing and property values; public services; subsistence activities; environmental justice; and protection of children.

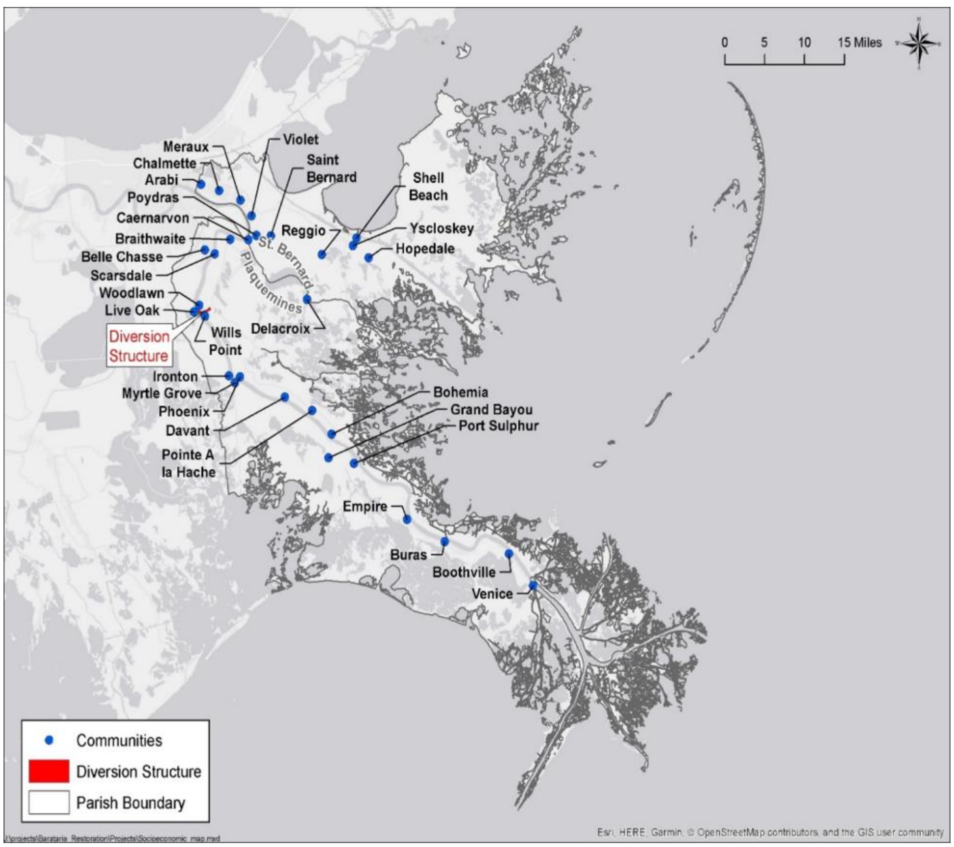


Figure 12.1-1. Map of the Socioeconomics Study Area.

12.2 DEMOGRAPHIC CHARACTERISTICS

This section describes population, race and ethnicity, and age characteristics for the two parishes in the Study Area.

Plaquemines and St. Bernard parishes experienced a decrease in population following the devastating hurricane season of 2005. Plaquemines Parish lost 45% of its population, while St. Bernard Parish lost 14% of its population between 2000 and 2010 (Table 12.2-1). Hurricanes Katrina, Rita, Gustav and Ike in 2005 and 2008 contributed to a loss of population in the coastal parishes as people moved further north and to higher ground. Since 2010, population has increased in these parishes, although the populations have not increased to the 2000 population levels. St. Bernard Parish currently has about twice the population of Plaquemines Parish. For comparison, the New Orleans-Metairie, Louisiana Metropolitan Statistical Area (MSA) in 2017 had a population of 1,260,000, accounting for about 27% of the state's population (U.S. Census Bureau 2017a). Both Plaquemines and St. Bernard parishes are in the MSA, along with six additional parishes: Jefferson, Orleans, St. Charles, St. James, St. John the Baptist, and St. Tammany.

The population of the Study Area is projected to grow in the future, with Plaquemines Parish anticipated to grow by 21% and St. Bernard Parish anticipated to grow by 4% over the 15 year time-period (2015–2030). These coastal parishes are sparsely populated, with the bulk of the populations residing in the northern portion of the parishes near New Orleans.

Table 12.2-1
Parish Populations in the Study Area

Population	Plaquemines Parish	St. Bernard Parish	Louisiana
Population – 2000	26,757	66,988	4,468,976
Population – 2010	23,042	36,808	4,533,372
Population – 2017	23,394	45,067	4,663,461
Percent Change in Population – 2000 to 2017	-13%	-33%	4%
Percent Change in Population – 2000 to 2010	-14%	-45%	1%
Percent Change in Population – 2010 to 2017	2%	22%	3%
Projected Parish Population Growth (2015-2030)	21%	4%	7%
Land Area (square miles)	972	594	46,776
Population Density (people per square mile)	24	76	100

Notes: Per guidance from LSU, for St. Bernard Parish, we have used the "High Series" for 2010-2020 and the "Medium Series" for 2025-2030; for Plaquemines Parish, we have used the "Medium Series" for 2010-2030 (LSU 2009). The rate of migration for the "Medium Series" is based on the observed rate between 2000 and 2005, which is assumed to remain constant through 2030. The rate of migration for the "High Series" is assumed to be on and on-half times that of the 2000-2005 migration rate (LSU 2009).

Sources:

1. U.S. Census Bureau. ACS 5-year estimates. 2017a, 2010a; Decennial Census. 2000a
2. Louisiana State University Population Projections, 2010-2030 (2009)

Table 12.2-2 summarizes the race and ethnicity characteristics of the Study Area and the state of Louisiana. As compared to the state and New Orleans-Metairie MSA as a whole, the populations in Plaquemines and St. Bernard parishes comprise fewer African American populations, and slightly higher proportions of White and Native American populations.

Table 12.2-2
Percent Race and Ethnicity of Parish Populations in the Study Area (2017)

Race or Ethnicity	Plaquemines Parish	St. Bernard Parish	New Orleans-Metairie MSA	Louisiana
Total Population	**23,394**	**45,067**	**1,260,660**	**4,663,461**
Race				
White Alone	68.8%	69.9%	57.8%	62.4%
Black or African American Alone	20.9%	22.6%	35.0%	32.2%
American Indian Alone	1.0%	0.6%	0.3%	0.6%
Asian Alone	3.3%	2.4%	2.9%	1.7%
Native Hawaiian and Other Pacific Islander	0.0%	0.0%	0.0%	0.0%
Some other race alone	2.2%	1.9%	2.0%	1.2%
Two or more races	3.8%	2.5%	1.9%	1.9%
Ethnicity				
Hispanic or Latino	6.7%	9.9%	8.7%	5.0%

Note: Populations can identify as both a race and an ethnicity.
Sources: U.S. Census Bureau. 2017a. ACS 5-year estimates.

The age characteristics in the Study Area parishes are fairly similar to those across the state (Table 12.2-3). There are slightly more people 19 and under and fewer older people over 65 in Plaquemines and St. Bernard parishes when compared with the population across the state and the New Orleans-Metairie MSA as a whole.

Table 12.2-3
Age Characteristics of Parish Populations in the Study Area (2017)

Age	Plaquemines Parish	St. Bernard Parish	New Orleans-Metairie MSA	Louisiana
Total Population	**23,394**	**45,067**	**1,260,660**	**4,663,461**
Median Age	35.9	33.6	37.7	36.4
Under 5	7%	8%	6%	7%
5-19	22%	22%	18%	20%
20-34	20%	23%	22%	22%
35-64	39%	37%	40%	38%
Over 65	12%	10%	14%	14%
Sources: U.S. Census Bureau. (2017). ACS 5-year estimates.				

12.3 COMMUNITY PROFILES

This section presents community profiles using social and economic data obtained from the U.S. Census Bureau, as well as information obtained from research and literature related to these communities. Additional information is provided for the Study Area parishes in Tables 12.3-1 and 12.3-2, while community-level data is provided in Table 12.3-3.

12.3.1 Plaquemines Parish

Plaquemines Parish is Louisiana’s southernmost parish. The northern reaches of the parish are coastal marshland, while the southern and delta areas are part of the Mississippi River floodplain (NOAA 2005). Plaquemines Parish is part of the New Orleans-Metairie-Kenner MSA due to its proximity to New Orleans, with workforce in the northern part of the parish commuting within the metropolitan area. Geography further divides the primarily agricultural northern end of the parish from a fisheries-and-oilfield dominated southern region. The Mississippi River bisects the parish into the east and west banks, connected only by two ferry crossings. There is no bridge across the Mississippi River in Plaquemines Parish; to travel across the river without using a ferry crossing would require travel into New Orleans to HWY 90. Everything downriver of Bohemia on the east side, and Venice on the west, is only accessible by boat or aircraft. Plaquemines Parish is a highly productive area for seafood, the hub of Louisiana’s citrus industry, and a leading producer of oil and natural gas. The proposed Mid-Breton Sediment Diversion (Breton) project is located in Plaquemines Parish on the east bank of the Mississippi River at RM 69 near Wills Point.

The 972 square mile parish is sparsely populated. In 2000, Plaquemines Parish had a population of approximately 26,800. Hurricane Katrina in 2005 devastated southern Plaquemines Parish, with refugees moving northward within the parish and to other areas, many to the relatively unscathed Belle Chasse area (Austin et al. 2014). Between 2005 and 2006, Plaquemines Parish lost 24% of its population (7,229 residents) (U.S. Census Bureau 2018). Northward migrations in the wake of hurricanes and floods are a familiar pattern for the parish. By 2010, Plaquemines Parish had regained 85% of its pre-Katrina population, but the majority had shifted northward to Belle Chasse, which is located on the protected side of the West Bank and Vicinity Hurricane Protection Levee, part of the HSDRRS. Between 2011 and 2017, the parish population had slightly increased, by 418 residents or 1.8% (Table 12.3-2).

The economy of Plaquemines Parish depends on the natural resources common to this region. Agriculture, fishing and hunting, and mining (includes oil and gas) sectors account for around 10% of the employment. Commercial fishing and agricultural production is an important sector of the local economy and deeply rooted in the parish's geography and culture (Plaquemines Parish 2012), accounting for approximately 4.5% of the employed labor force in 2017. The parish accounts for 70% of Louisiana's total commercial seafood landings and is home to the largest commercial fishing fleet in the contiguous United States (Plaquemines Parish 2012). Employment in the shipbuilding and seafood processing plants is also prevalent in lower Plaquemines Parish, linked directly with the oil and gas and commercial fishing sectors. Plaquemines Parish also has a growing recreational fishing industry (Plaquemines Parish 2012).

The Deepwater Horizon (DWH) oil spill in April 2010 had an impact on Plaquemines Parish, still struggling to recover from Hurricane Katrina. Plaquemines Parish was the nearest land mass to the Macondo well, and its marshes were first to be affected by the oil spill. Effects were most evident in ethnically-diverse south Plaquemines, whose economy relies mainly on the oil industry and fisheries (Austin et al. 2014). Fishing closures in the region brought to a halt most seafood fishing and associated economic activity (e.g., servicing and provisioning fishing boats). As part of the response to the spill, freshwater was released through the Caernarvon and Davis Pond Freshwater Diversions in an attempt to keep oil from moving into the estuaries. The freshwater lowered the salinity in oyster breeding grounds within close proximity to the diversion outfalls, resulting in adverse effects to some of the oyster harvests (Buskey 2010; Austin et al. 2014). In addition, the drilling moratorium for deep water wells following the spill affected the oil and gas jobs in the region, as considerable economic activity in south Louisiana is linked with energy production. Some of the people out of work in oil and gas and fisheries jobs were employed temporarily with the cleanup effort.

12.3.1.1 West Bank Communities

The communities located on the west bank of the Mississippi River in Plaquemines Parish include Belle Chasse, Live Oak, Ironton, Myrtle Grove, Grand Bayou, Port Sulphur, Empire, Buras, Triumph, Boothville, and Venice, listed in order from north to south. Belle Chasse is the largest community in Plaquemines Parish with 13,600 residents in 2017 (U.S. Census Bureau 2017), located in the northern part of the parish approximately 10 miles southeast of downtown New Orleans. Less than 1% of the employed labor force in Belle Chasse works in the farming and fishing occupations.

Ironton, a former plantation, is located between Louisiana HWY 23 and the Mississippi River. The town of Ironton was founded by freed slaves during Reconstruction and the founders' descendants remain in this community. Ironton is almost entirely Black or African American and working class (Rich 2014). According to the U.S. Census Bureau, there were four white residents in Ironton in 2000 and 2010, while the remaining population -- 116 residents -- were African American (U.S. Census Bureau 2010).

Grand Bayou is located just west of the Mississippi River and HWY 23, between the communities of West Pointe à la Hache and Port Sulphur. Grand Bayou village is home to around 40 residents of the Atakapa-Ishak/Chawasha tribe (Marshall 2016). However, the U.S. Census Bureau block data only recorded 19 residents in 2000 and 14 residents in 2010 who identify as Native American or Alaska Native (U.S. Census Bureau 2010). The Atakapa-Ishak/Chawasha tribe trace their ancestry within the region back thousands of years. The community is accessible only by boat, and the residents are highly dependent on their surrounding environment. Residents use the bayou for transportation, sustenance, and recreation. The community fishes, hunts, and traps local natural resources, including oysters, crab, softshell crab, nutria, alligator, and fish (Bethel et al. 2011). Most residents are commercial fishermen, while others work outside of Grand Bayou in the menhaden industry, schools, hospitals, or oil production (Austin et al. 2014a; Marshall 2016). The community is spiritually tied to the land – the sense of place and self are irrevocably bound (Nienaber 2012; Marshall 2016). The population of the village is in decline as residents move to higher ground.

Port Sulphur is generally considered the beginning of lower Plaquemines Parish, the region hardest hit by repeated hurricanes. Port Sulphur has small retail businesses and residential areas as well as canals and points of freshwater access. The estuaries and canals east of Port Sulphur access the deeper waters of Barataria Bay and the Gulf of Mexico. Surrounded by fresh water marsh, the community was historically a small subsistence-oriented village (NOAA 2005a). In 1932, the Freeport Sulphur Company set up operations after acquiring extraction rights to Lake Grande Ecaille's mineral resources (NOAA 2005a). The town developed with the company, including schools, a hospital, clubhouses and lodges, and a park (NOAA 2005a). Port Sulphur's sulfur-based economy declined when Freeport's operations slowed in the 1980s, and the company left Port Sulphur in 2000.

Port Sulphur is heavily dependent on fishing and felt the impact of the DWH oil spill (Austin et al. 2014a). Some local retail businesses lost employees to cleanup employment. In 2000, Port Sulphur's population was 3,115 people (U.S. Census Bureau 2000). In 2005, Hurricane Katrina devastated Port Sulphur, destroying almost all of the single-family homes. After Hurricane Katrina, many residents relocated to other parts of Louisiana and the southeast. By 2010, the population was 1,760. The population has remained relatively stable at approximately 2,000 residents since 2012, and in 2017 was 1,934 residents (U.S. Census Bureau 2017).

Current industries in Port Sulphur include oilfield support businesses, commercial fishing docks, seafood processing, sports fishing charters, trucking, and construction, among others. Port Sulphur has the only medical facilities in lower Plaquemines Parish (Austin et al. 2014a). The main industries now in Port Sulphur according to the U.S. Census Bureau are education, health, and social services (23.7%) and agriculture, fishing, hunting and mining (includes oil and gas) (19.2%). In 2017, 18.2% of the employed labor force was in farming and fishing occupations (U.S. Census Bureau 2017). The community is primarily black or African American (U.S. Census Bureau 2017), with 82% of the population identifying as minority.

Empire-Venice (and Boothville and Buras) is the top seafood-producing port in Louisiana (NOAA 2005). Empire is a small village located along the lower west bank of the Mississippi, between Port Sulphur and Buras. Venice is the town at the end of HWY 23; travel south of Venice can only occur by boat. Buras and Boothville are also small communities located between Empire and Venice adjacent to HWY 23.

Empire is an important gateway to Gulf fishing grounds on both sides of the Mississippi River (Austin et al. 2014a). The community, with a shipyard and marina, has always housed more boats than people. Empire's economy is based almost entirely on commercial and (to a smaller extent) sport fishing. Many west bank oyster farmers have extensive oyster leases passed down for generations. Empire is also a primary landing area for Gulf shrimp and a shrimp wholesaler operates in the community. In addition, a menhaden fishing fleet and processing plant have operated there since the 1940s. Delta Marina attracts a stream of recreational fishermen and charter boats and holds annual tourist events such as tarpon rodeos.

Similar to other southern Plaquemines Parish communities, Hurricane Katrina had a devastating impact on this area. As of 2012, much of Empire's civic and public infrastructure, including a grocery store, gas station, hardware store, and civic center, had not yet been rebuilt (Austin et al. 2014a). As of 2018, it appears that a number of businesses have returned and/or opened; a church, marina, boat fuel and oil supplier, restaurant, bar, sportsman's lodge, RV park and campground, and a number of wholesale seafood suppliers and processers are currently located in Empire. In addition, a seafood market, motel, and sportsman lodge are located just north of the town of Empire.

The shrimp fishery in the Gulf of Mexico has been in decline since 2001 because of higher costs of fuel and equipment and lower prices shrimpers receive at the dock because of market competition from low-priced, imported shrimp. Although there was a decline in the number of commercial shrimp boats operating in the Gulf of Mexico after 2001, the shrimp fishery was still considered overcapitalized until the hurricane season of 2005, when Hurricanes Katrina and Rita ravaged the northern Gulf (Ingles and McIlvaine-Newsad 2007).

Empire's population was approximately 2,200 in 2000 (Table 12.3-1). In 2010, Empire's population had decreased to 990; its population was 1,054 in 2017 (U.S. Census Bureau 2017). In 2017, the portion of the population in Empire, Buras, Boothville, and Venice that identifies as minority was 57, 17, 52, and 16%, respectively. There are primarily Asian (Vietnamese and Cambodian) and African American populations in the area. In the early 1980s, Vietnamese and Cambodian refugees settled in the region. Most became shrimpers and crab fishermen (Austin et al. 2014a). A number of Vietnamese families became seafood processors, dock owners, and restaurant or store owners. Since Hurricane Katrina, many Vietnamese fishermen live in Plaquemines Parish only during fishing season and spend the rest of the year in larger Vietnamese communities in the New Orleans metropolitan area (Austin et al. 2014a).

12.3.2 St. Bernard Parish

St. Bernard Parish is located in southeastern Louisiana, just east and northeast of Plaquemines Parish. The northern reaches of the parish are coastal marshland, while the southern and delta areas are part of the Mississippi River floodplain (U.S. Department of Commerce, NOAA 2005). St. Bernard Parish is part of the New Orleans-Metairie MSA due to its proximity to New Orleans, with workforce in the northern part of the parish commuting within the metropolitan area.

The 594 square mile parish is sparsely populated. In 2000, St. Bernard Parish had a population of approximately 67,200. Hurricane Katrina in 2005 devastated St. Bernard Parish. More than 170 residents died in the storm, and some survivors never returned. A year after the storm, the parish population dropped to about 25,000, down from 67,000 (Laviolette 2015). More than 8,300 unsalvageable houses were eventually demolished, leaving gaps of empty lots sitting between refurbished houses (Laviolette 2015). In 2000, St. Bernard Parish had 27,700 residents; between 2010 and 2017, the parish population increased by 17,328, an increase of 62%.

The DWH oil spill in April 2010 had an impact on the fishing villages, especially St. Bernard, Delacroix, and the cluster communities of Shell Beach, Yscloskey, and Hopedale. The parish was still struggling to recover from Hurricane Katrina. Fishing closures in the region brought to a halt most seafood fishing and associated economic activity (e.g., servicing and provisioning fishing boats).

The economy of St. Bernard Parish includes natural resource industry employment; in 2017, employment in agriculture, forestry, fishing, hunting, and mining (includes oil and gas) accounted for 3% of the industry employment in the parish. Commercial fishing is an important sector of the local economy; although agricultural, fishing, and forestry occupations account for only 1.7% of the St. Bernard Parish employed labor force in 2017, fishing occupations are much more prevalent in the communities of Delacroix, St. Bernard, and Poydras. St. Bernard Parish is home to petrochemical, oil and gas, seafood processing, and commercial fishing industries (Greater New Orleans, Inc. Regional Economic Development 2019).

This section describes the communities in St. Bernard Parish. The communities are categorized into two groups: communities that are located on the East Bank of the Mississippi River; and those that are further east of the Mississippi River adjacent to the marshes and wetlands of Breton Sound.

12.3.2.1 East Bank Communities

The communities of Arabi, Chalmette, Meraux, Violet, Poydras, and Caernarvon are located on the east bank of the Mississippi River, listed here in order from north to south. The city of Chalmette is the parish government seat, with a 2017 population of 22,907 residents (U.S. Census Bureau 2017a). These Mississippi River communities account for 96% of the population in St. Bernard Parish. The communities with the highest proportions of minority residents include the communities of Violet and Chalmette, with 67 and 30% of their populations identifying as minority (U.S. Census Bureau 2017a). The majority of minority populations identify as Black or African American, with small populations of Asian (Vietnamese), Native American, Hispanic, and other races. The percentage of the individuals living below the poverty level in these communities range from 9% in Meraux to 37% in Poydras. The community of Caernarvon lies on the western side of the parish and is the southernmost community in St. Bernard Parish adjacent to the east bank of the Mississippi River. It is a small community of 114 residents.

Accounting for most of the parish population, these communities were devastated by Hurricane Katrina in 2005, with the parish losing more than half of its population between 2000 and 2010. Population growth was not adversely impacted by the DWH oil spill in 2010 as the parish population has experienced steady population growth since 2010.

Agriculture and fishing occupations range from 0% of the workforce in Violet to 4.8% of the workforce in Poydras, with farming and fishing occupations accounting for 2.2% of the workforce in Arabi, 0.7% in Chalmette, 2.2% in Meraux, 0% in Violet, and 4.8% in Poydras. Caernarvon had an estimated 11% of its employed labor force in fishing and agriculture occupations in 2016 (the U.S. Census Block Group in which the community of Caernarvon is located is located within the Census-designated Place of Poydras). Fishing is notably more prevalent for the southern communities along the east bank of the Mississippi River in closer proximity to Breton Sound and its marshes and wetlands.

12.3.2.2 Breton Sound Communities

The communities of St. Bernard, Delacroix, Reggio, Yscloskey, Hopedale, and Shell Beach are east of the Mississippi River and southeast of New Orleans in the wetlands and marshes of St. Bernard Parish, generally listed in order from west to east. The proposed Mid-Breton sediment diversion structure is located approximately 13 miles west of the community of Delacroix. The community of St. Bernard is located just east of Poydras and is the closest of these communities to the downtown center of New Orleans. With an estimated population of 1,900 residents in 2016, St. Bernard is bordered on the north by HWY 46 and the south by the Caernarvon diversion outfall ditch and levee. In 2016, an estimated 14% of the employed workforce in St. Bernard was in farming and fishing occupations (U.S. Census Bureau 2016a).

Delacroix is a fishing community that houses a considerable number of boats and few other services or stores (Gramling and Hagleman 2005). Community activities center on boats, the maintenance of boats, and the use of boats. With shallow-water access to the networks of canals, small lakes, the larger Lake Lery, Black Bay, and Breton Sound, Delacroix fishing vessels tend to be medium to small-size vessels. The boats are equipped with skimmer rigs and geared to handle crab pots or are dual rigged for both shrimp and crabs. Delacroix supplies crabs for the restaurants and markets of New Orleans and out of state (Gramling and Hagleman 2005).

Yscloskey, Shell Beach, and Hopedale are contiguous communities located along Bayou La Loutre. Boats here are generally larger than those in Delacroix and are of greater variety. Because of its proximity to New Orleans, this area hosts a mix of commercial and recreational fisheries (Gramling and Hagleman 2005). Delacroix and the communities of Yscloskey, Shell Beach, Reggio, and Hopedale reported 178 residents in 2010. Hurricane Katrina and the DWH oil spill had a profound impact on this region. Between 2000 and 2010, the population decreased by 644 residents, with a reported population of 822 residents in 2000 (U.S. Census Bureau 2000b, 2010b). There are small numbers of minority residents in these communities (Table 12.9-3). In 2010, 15% of Delacroix's residents identified as Black or African American, and all of Reggio's 11 residents identified as Black or African American (U.S. Census Bureau 2010b).

12.4 BUSINESS ACTIVITY AND REGIONAL ECONOMIC CONDITIONS

This section describes the largest employers in the Study Area, employment by industry, personal income, commuting patterns, and average annual wages.

St. Bernard Parish is home to petrochemical, oil and gas, seafood processing, and commercial fishing industries. The largest corporations in the parish are: Associated Terminals; Boasso American (warehousing and transportation services); Chalmette Refining; Domino Foods; Rain Carbon (industrial chemicals); and Valero Energy (Greater New Orleans, Inc. Regional Economic Development 2019).

Plaquemines Parish, located at the southernmost tip of Louisiana, is an operational center for the offshore oil and gas industry. It is also home to the seafood industry and is a citrus and agricultural region, growing crops such as tangerine, orange, satsuma, melon, and Creole tomato crops. In addition, the parish is home to petrochemical refineries and coal transfer terminals. The largest corporations in the parish are: Baker Hughes Oilfield Operations; Belle Chasse Academy; C&C Marine (ship building); Chevron Oronite; Daybrook Fisheries; Fab-Con, Inc. (marine construction and fabrication), Naval Air Station Joint Reserve Base; Point Eight Power Company; Scott Armature (electro-mechanical repair); TECO Bulk Terminal; and Versatruss Americas (aluminum truss manufacturing) (Greater New Orleans, Inc. Regional Economic Development 2019).

Figures 12.4-1 and 12.4-2 summarize employment by service sectors, non-service sector, and government[8] for Plaquemines and St. Bernard parishes, respectively. In general, employment in the service sectors have been slowly increasing over time, although employment in these sectors decreased following Hurricane Katrina in 2005. St. Bernard Parish was especially affected by the hurricane, losing about 73% of the service sector employment between 2004 and 2006. Service sectors include tourism services, such as retail and food and beverage establishments, as well as professional services, waste services, administrative services, among others. Since 2006, service sector employment has been steadily increasing in both parishes.

Non-service sector employment decreased in the mid-1980s likely due to a considerable drop in oil prices and related activity in the early to mid-1980s. Much of the manufacturing industry in the region, such as ship-building, is directly tied to both oil and gas activities and contracts and commercial and recreational fisheries. Since 2001, employment in the non-service sectors has declined slightly. Non-service sectors include construction; manufacturing; mining and oil and gas; and agriculture and fishing sectors. A decrease in employment in these non-service sectors occurred in both parishes in 2005 associated with the hurricane devastation, followed by increases in 2006 and 2007 as the region rebuilt. The DWH oil spill occurred in 2010, which resulted in a moratorium affecting off-shore oil and gas development as well as in commercial fisheries closures in the region. Despite the impacts to these industries, there was little change in employment in the non-service and service sectors in 2010 and 2011. Many of the out-of-work oil and fisheries workers were temporarily engaged with the clean-up efforts (Austin et al. 2014).

[8] Non-service sectors include farming and agriculture, fishing, mining and oil and gas, construction, and manufacturing. Service sectors include wholesale and retail trade, utilities, transportation and warehousing, real estate, financial and insurance, professional and technical services, management of companies, administrative and waste services, educational services, health care and social services, arts entertainment and recreation, accommodation and food services, and other services. Government enterprises include federal (military and civilian), state, and local government.

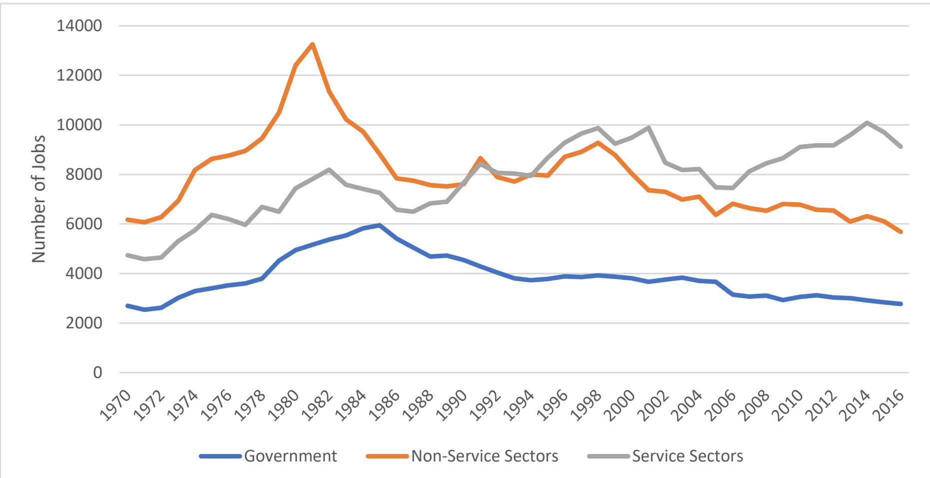


Figure 12.4-1. Employment by major industry category for Plaquemines Parish, 1970 - 2016

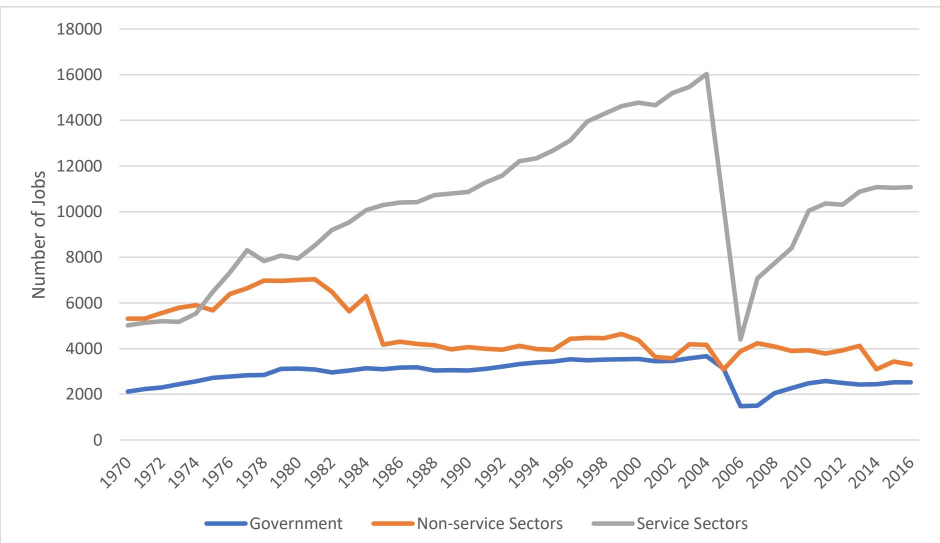


Figure 12.4-2. Employment by major industry for St. Bernard Parish, 1970 - 2016

Note: In 2001, the classification of employment changed from the standard industry code (SIC) to the North American Industrial Classification System (NAICS). Readers should use caution when making comparisons across this time period.
Source: U.S. Department of Commerce, Bureau of Economic Analysis. 2016.

Tables 12.4-1 and 12.4-2 summarize the number of business establishments and employment by industry for Plaquemines and St. Bernard parishes, respectively. The number of business establishments include both employing industries as well as business establishments without paid employees. The U.S. Census Bureau terms these businesses as “non-employers,” which are typically sole proprietors. The vast majority of businesses in the Study Area are non-employers. There are 750 and 419 agriculture, fishing, and hunting business establishments in Plaquemines and St. Bernard parishes, respectively, almost all of which are non-employers. These types of businesses account for approximately 1,200 jobs or 7% of employment in each of the parishes.

The largest employment sectors in Plaquemines Parish are government; transportation and warehousing; and manufacturing, accounting for 14, 13, and 9% of the employment, respectively. The largest employment sectors in St. Bernard Parish are government; retail trade; and manufacturing, accounting for 14, 12, and 11 percent of employment, respectively.

Table 12.4-1
Business Establishments and Employment by Industry for Plaquemines Parish

Industry/Government	No. of Business Establishments (2016)1	Percent of Establishments that are Non-Employers[1]	Non-Employer Receipts (in thousands) (2016)[1]	Number of Jobs (2017)[23]	Percent of Total Jobs[2]
Total	3,160	78%	$137,143	17,892	100%
Agriculture, Forestry, Fishing and Hunting	750	98%	$50,973	1,188	7%
Mining, Quarrying, and Oil and Gas Extraction	56	34%	$1,655	1,248	7%
Utilities	D	D	D	315	2%
Construction	270	77%	$14,823	1,099	6%
Manufacturing	64	44%	$2,062	1,663	9%
Wholesale Trade	83	29%	$2,170	919	5%
Retail Trade	208	69%	$5,168	797	4%
Transportation and Warehousing	242	64%	$14,086	2,347	13%
Information	19	90%	$14,883	28	0%
Finance and Insurance	48	52%	$282	286	2%
Real Estate and Rental and Leasing	255	86%	$1,443	1,004	6%
Professional, Scientific, and Technical Services	221	74%	$8,124	555	3%
Management of Companies and Enterprises	D	D	D	61	0%
Administrative and Support and Waste Management and Remediation Services	266	86%	$7,786	921	5%
Educational Services	37	81%	$368	674	4%
Health Care and Social Assistance	107	79%	$1,650	442	2%
Arts, Entertainment, and Recreation	80	80%	$1,664	153	1%
Accommodation and Food Services	114	50%	$1,979	740	4%
Other Services (except public administration)	331	84%	$8,027	836	5%
Government					14%
Federal (Civilian and Military)	NA	NA	NA	1074	6%
State and Local	NA	NA	NA	1495	8%

Source: [1] U.S. Census Bureau County Business Patterns and Nonemployer Statistics. 2016b. [2] U.S. Department of Commerce, Bureau of Economic Analysis. 2001-2017. [3] It should be noted that undisclosed employment by industry data for 2017 was reported for the most recent year with data.

Table 12.4-2
Business Establishments and Employment by Industry for St. Bernard Parish

Industry/Government	No. of Business Establishments[1]	Percent of Establishments that are Non-Employers[1]	Non-Employer Receipts (in thousands)[1]	Number of Jobs[2]	Percent of Total Jobs[2]
Total	4,294	84%	$146,396	16,583	100%
Agriculture, Forestry, Fishing and Hunting	419	99%	$35,486	1,231	7%
Mining, Quarrying, and Oil and Gas Extraction	10	70%	$44	91	1%
Utilities	7	43%	$35	34	0%
Construction	595	84%	$29,580	1,612	10%
Manufacturing	68	52%	$1,067	1,805	11%
Wholesale Trade	64	63%	$2,024	357	2%
Retail Trade	376	61%	$14,211	1,945	12%
Transportation and Warehousing	370	91%	$11,331	973	6%
Information	28	86%	$375	98	1%
Finance and Insurance	59	49%	$1,282	313	2%
Real Estate and Rental and Leasing	234	92%	$12,204	538	3%
Professional, Scientific, and Technical Services	237	82%	$6,789	432	3%
Management of Companies and Enterprises	D	D	D	187	1%
Administrative and Support and Waste Management and Remediation Services	437	92%	$6,286	1,088	7%
Educational Services	42	91%	$336	197	1%
Health Care and Social Assistance	303	80%	$3,165	436	3%
Arts, Entertainment, and Recreation	164	93%	$4,629	330	2%
Accommodation and Food Services	172	53%	$2,791	1,203	7%
Other Services (except public administration)	707	92%	$14,761	1,266	8%
Government					14%
Federal (Civilian and Military)	NA	NA	NA	223	1%
State and Local	NA	NA	NA	2,224	13%

Source: [1] U.S. Census Bureau County Business Patterns and Nonemployer Statistics. 2016b. [2] U.S. Bureau of Economic Analysis. 2001-2017. [3] It should be noted that undisclosed employment by industry data for 2017 was reported for the most recent year with data. Agriculture, forestry, fishing, and hunting data was not available for the years 2001 to 2016; as a result, the employment by industry was estimated by subtracting the employment by industry for all other industries from the total employment.

Table 12.4-3 summarizes the commuting patterns or the flow of earnings in and out of Plaquemines and St. Bernard parishes. The flow of earnings into the parish by residents who work in neighboring parishes and bring money home to the parish in which they reside is considered an “inflow.” The flow of earnings from residents who live in neighboring parishes and commute into the parish for work is considered an "outflow" of earnings, because the earnings and associated economic activity flow to the parish in which the worker lives. The difference between the inflow and outflow of earnings is termed the "net residential adjustment." The two parishes in the Study Area are different in terms of their communing patterns. In Plaquemines Parish, there is quite a bit of “outflow” of earnings where workers come into the parish to work while their permanent residence is outside the parish, which leads to a negative net-residential adjustment. In 2016, almost 50% of the personal income left the parish. In St. Bernard Parish, there are more workers who live in the parish and work elsewhere (“inflows”), such as New Orleans, than workers who live elsewhere and work in St. Bernard Parish (“outflows”), leading to a positive net-residential adjustment in 2016.

Table 12.4-3
Commuting Patterns in the Study Area (thousands of $2017)

Component	Plaquemines Parish			St. Bernard Parish		
	2010	2016	Change	2010	2016	Change
Personal Income	$1,093,558	$1,117,748	$24,190	$1,245,948	$1,407,773	$161,825
Cross-Parish Commuting Flows						
Inflow of Earnings	$262,954	$278,026	$15,072	$444,822	$555,697	$110,875
Outflow of Earnings	$800,569	$766,444	-$34,125	$465,556	$413,405	-$52,151
Net-residential Adjustment (Inflows-Outflows)	-$537,615	-$488,418	$49,197	-$20,734	$142,292	$163,026
Net-residential Adjustment Share of Personal Income	-70.4%	-49.2%	NA	-1.7%	10.1%	NA

Sources: U.S. Department of Commerce. 2016. Bureau of Economic Analysis, Regional Economic Accounts. Reported by Headwaters Economics Economic Profile System.

Average annual wages by industry in the Study Area are summarized in Table 12.4-4. On average, wages are almost 40% higher in Plaquemines Parish than in St. Bernard Parish. Some of the higher-paying industries include mining and oil and gas, manufacturing, professional and business services, and federal government, while lower-paying industries include agriculture and fishing, leisure and hospitality, other services, and education and health services. In general, employment in higher paying industries, such as oil and gas and transportation and warehousing, accounts for a higher percentage of employment in Plaquemines Parish, while employment in lower paying sectors, such as retail trade and accommodations and food services, accounts for relatively more employment in St. Bernard Parish. As a result, the average annual wages are lower in St. Bernard Parish than in Plaquemines Parish.

Table 12.4-4
Average Annual Wages by Industry for Plaquemines and St. Bernard Parishes (2017)

Industry/Government	Plaquemines Parish	St. Bernard Parish
Total/Average	$64,516	$46,458
Private	$66,736	$48,339
Natural Resources and Mining (and Oil and gas)	$110,553	NA
Agriculture, Forestry, Fishing and Hunting	$30,088	NA
Mining, Quarrying, and Oil and Gas Extraction	$117,108	NA
Construction	$53,385	NA
Manufacturing	$84,385	$101,308
Trade, Transportation, and Utilities	$61,413	$32,286
Information	NA	$55,307
Financial Activities	$61,017	$35,805
Professional and Business Services	$80,431	$47,529
Education and Health Services	$35,882	$34,927
Leisure and Hospitality	$21,575	$15,593
Other Services	$34,275	$28,062
Government	$53,708	$39,673
Federal	$67,530	$52,212
State	$39,138	$38,241
Local	$47,866	$39,511

Source: U.S. Department of Labor. 2017. Bureau of Labor Statistics, Quarterly Census of Employment and Wages, reported by Headwaters Economics Economic Profile Systems.

Note: It should be noted that the Quarterly Census of Employment and Wages only includes wages for businesses with paid employees and does not include nonemployers or self-employed wages.

12.5 TAX REVENUE

Between fiscal years 2013 and 2017, tax revenues in Louisiana have fluctuated between 7 and 9 billion dollars (Louisiana Department of Revenue 2019). Sales and income taxes are the largest sources of revenues in the state, each accounting for more than a third of revenues during this period. Sales taxes in the Study Area total about $30.8 million, property taxes total $114.9 million, and state income taxes total $35.4 million (see Table 12.5-1) (Louisiana Department of Revenue 2019).[9]

[9] The Louisiana Department of Revenue does not capture comprehensive parish-specific sales tax data. This is because firms with establishments in multiple locations may report sales tax as a single entity. As a result, the sales

Table 12.5-1
Sales, Property, Income, and Severance Tax Revenues by Parish

Parish	**Gross Sales and Use Tax** (FYE[b] 17)	**Sales Tax (Per Capita)** (FYE 17)	**Local Property Taxes** (2018)	**Property Taxes (Per Capita)** (2018)	**LA Adjusted Individual Income Tax** (FYE 17)	**LA Adjusted Income Tax (Per Capita)** (FYE 17)	**Total Severance Tax** (FY 2017)	**Severance Taxes (Per Capita)** (FY 2017)
Louisiana	$2,578,265,547	$551	$4,674,236,156	$998	$2,790,884,750	$1,331	$374,295,711	$80
Plaquemines	$11,395,200	$486	$64,989,262	$2,955	$18,320,451	$781	$75,259,898	$3,217
Plaquemines % of Louisiana	0.4%	NA	1.4%	NA	0.7%	NA	20.1%	NA
St. Bernard	$19,416,682	$425	$49,929,688	$986	$17,077,343	$374	$2,506,535	$56
St. Bernard % of Louisiana	0.8%	NA	1.1%	NA	0.6%	NA	0.7%	NA

Source: Louisiana Department of Revenue 2019 and Louisiana State Tax Commission 2018. .
FYE is fiscal year end
Sales and Use taxes for Louisiana include only tax receipts from the parishes, not from locations outside of the parishes.
Per capita based on population estimates for 2017 (release date March 2017); Louisiana population 4,681,666; Plaquemines 24,464; St. Bernard 45,668

Figure 12.5-1 summarizes the total assessed value in the Study Area by parish from 2000 to 2018. Property taxes are levied on the assessed value of the property, and therefore typically track closely with property tax receipts. Hurricane Katrina had considerable impacts on the assessed values of properties in both parishes, with St. Bernard Parish experiencing more profound decreases between 2004 and 2005.

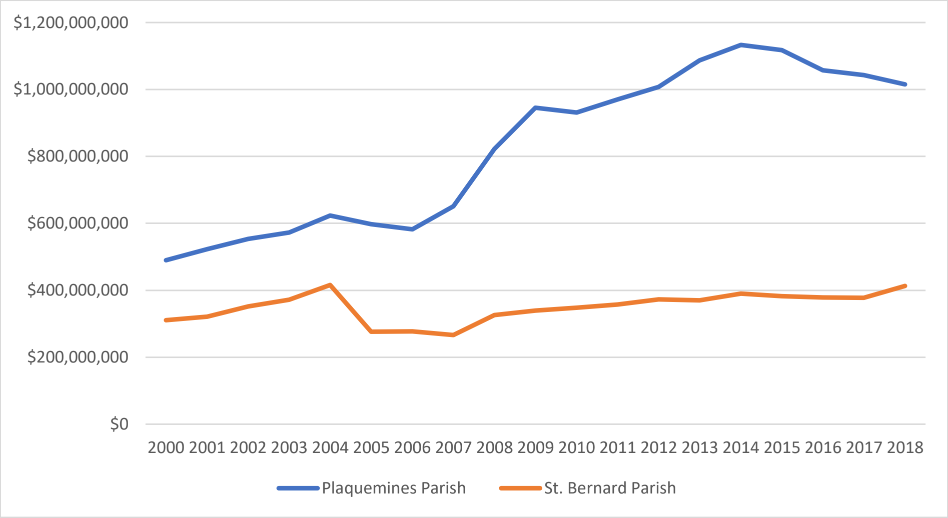


Figure 12.5-1. Total Assessed Values in the Study Area (2000–2018).

Source: Louisiana State Tax Commission, 2018; 2014; 2007; 2001.

Table 12.5-2 summarizes the severance taxes for 2017, 2017, and 2018 for the Study Area and the state of Louisiana. Severance tax revenues are closely tied to the amount of oil and gas produced in the parish as well as the price of oil and gas. Plaquemines Parish accounts for 18 to 20% of severance tax revenues in the state, with $80.9 million in revenues in 2018. Severance tax revenues in St. Bernard Parish account for 1% of the state revenues, with $2.6 million in severance tax revenues in St. Bernard Parish in 2018.

Table 12.5-2 Severance Tax Revenues by Parish and State (2016, 2017, 2018)			
Study Area Parish	**2016**	**2017**	**2018**
Plaquemines Parish	$81,838,556	$75,259,898	$80,893,887
Plaquemines Percent of State	18%	20%	18%
St. Bernard Parish	$2,792,428	$2,792,428	$2,554,327
St. Bernard Percent of State	1%	1%	1%
Louisiana	$456,116,291	$374,295,711	$441,241,878
Source: Louisiana Department of Revenue, 2019; 2018; 2017.			

12.6 HOUSING AND PROPERTY VALUES

In the Study Area, there were approximately 27,000 residential housing units, approximately 13% of which were vacant in 2017 (Table12.6-1). These housing units account for approximately 5% of the New Orleans-Metairie MSA's 554,706 housing units. In 2010, there was a higher proportion of the housing units that were vacant, likely from the devastating hurricanes in 2005 and 2008. Between 2000 and 2010, the Study Area lost a total of about 16,000 housing units, most of which were in St. Bernard Parish. Of the occupied housing units, 31 and 32% were renter-occupied in Plaquemines and St. Bernard parishes in 2017, respectively, while the remaining were owner-occupied. Between 2000 and 2017, there has been an increasing trend in the percentage of renter-occupied housing. The median housing value of owner-occupied residential housing units in 2017 was $165,900 and $139,200 in Plaquemines and St. Bernard parishes, respectively. For comparison, the median housing value was $152,900 across the state of Louisiana and $184,100 in the New Orleans-Metairie MSA in 2017.

Table 12.6-1
Housing Units, Vacancy, and Median Value (2000, 2010, 2017)

Parish	Plaquemines Parish	St. Bernard Parish
Total Housing Units		
2000	10,481	26,790
2010	9,596	16,794
2017	10,094	16,925
Percent Vacant/Occupied		
2000	13.9% / 86.1%	6.2% / 93.8%
2010	15.8% / 84.2%	21.3% / 78.7%
2017	13.2% / 86.8%	12.6% / 87.4%
Percent of Occupied Housing Renter/Owner-Occupied		
2000	21.1% / 78.9%	25.4% / 74.6%
2010	25.2% / 74.8%	31.1% / 68.9%
2017	31.0% / 69.0%	32.4% / 67.6%
Median Housing Value of Owner Occupied Units		
2000	$110,100	$85,200
2010	$203,100	$132,400
2017	$165,900	$139,200

Source: US Census Bureau American Community Survey 2017c; 2010c; Decennial Census 2000c (Summary File 1).

12.7 PUBLIC SERVICES

There are two health centers in Plaquemines Parish, one in Belle Chasse and one in Port Sulphur, and two health centers in St. Bernard Parish, one in the community of St. Bernard and one in the city of Chalmette. In addition, the St. Bernard Parish Hospital is located in Chalmette. There are two designated medically underserved areas in St. Bernard and Plaquemines parishes (one in each parish) (Health Resources and Services Administration 2019).

Plaquemines Parish is divided into seven fire districts served by 12 fire stations. Fire stations and/or sub-stations are located in Pointe à la Hache, Phoenix, Belle Chasse, Jesuit Bend, Port Sulphur, Empire, Buras, Boothville, Lake Hermitage, and Braithwaite. Staffing is accomplished through a combination of paid firefighters and volunteers (Plaquemines Parish

2012). Emergency medical services are co-located with fire stations in Boothville-Venice, Pointe à la Hache and Port Sulphur. The Ambulance Department has six ambulance districts:

- Belle Chasse
- Port Sulphur
- Buras
- Boothville/Venice
- Braithwaite
- Pointe à la Hache

St. Bernard Parish hosts 10 fire stations located in Arabi (2), Chalmette (2), Meraux (1), Violet (1), and St. Bernard (4).

The Plaquemines Parish Sheriff's Office is headquartered in Belle Chasse and provides 24-hour crime prevention, investigation and enforcement services to parish residents. The Sheriff's Office is divided into twelve divisions, departments and offices, employing approximately 180 full and part-time staff (Plaquemines Parish 2012b). The St. Bernard Sherriff's Office has two stations in Chalmette and one in Arabi (St. Bernard Sheriff's Office 2019). The Woodlawn Station in Plaquemines Parish works with St. Bernard Sheriff's Office.

There are three library facilities in Plaquemines Parish: Belle Chasse, Buras, and Port Sulphur. In 2008, FEMA approved the Parish's plan to consolidate ten pre-Katrina community service-oriented facilities into four new consolidated community centers located in Davant, Port Sulphur, Buras, and Boothville-Venice (Plaquemines Parish 2012b). There are two library facilities in St. Bernard Parish, the main library in Chalmette, and the courthouse branch in St. Bernard.

There are two school districts in Plaquemines Parish, Belle Chasse Academy and Plaquemines Parish School Districts. Belle Chasse Academy District includes only one school that provides education for kindergarten through 8th grade. Plaquemines Parish School District includes elementary schools in Belle Chasse, Boothville, and Port Sulphur; middle schools in Belle Chasse; and high schools in Belle Chasse, Braithwaite, and Buras. Phoenix High School in Braithwaite provides education for prekindergarten through 12th grade students, while South Plaquemines High School in Buras provides education for 7th through 12th graders (National Center for Educational Statistics, 2018).

St. Bernard Parish include one school district – the St. Bernard Parish School District. There are six elementary schools in St. Bernard Parish located in Arabi, Chalmette, St. Bernard, Meraux, and Violet; three middle schools located in Chalmette, Meraux, and St. Bernard; and two high schools located in Chalmette (National Center for Education Statistics, 2018).

12.8 ENVIRONMENTAL JUSTICE

Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its activities on minority and low-income populations. Executive Order 12898, issued in 1994, directs federal agencies to incorporate environmental justice as part of their mission by identifying and addressing the effects of programs, policies, and activities on minority and low-income populations. The fundamental principles of Executive Order 12898 are as follows:

- Ensure full and fair participation by potentially affected communities in the decision-making process.
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority or low-income populations.
- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations.
- Encourage meaningful community representation in the NEPA process through the use of effective public participation strategies and special efforts to reach out to minority and low-income populations.
- Identify mitigation measures that address the needs of the affected low-income and minority populations.

An environmental justice assessment requires an analysis of whether a proposed federal action would disproportionately and adversely affect minority and low-income populations (i.e., populations of concern). Of primary concern is whether adverse impacts fall disproportionately on minority and/or low-income members of the community compared to the larger community and, if so, whether they meet the threshold of "disproportionately high and adverse." If disproportionately high and adverse effects are evident, then EPA guidance advises that it should initiate consideration of alternatives and mitigation actions in coordination with extensive community outreach efforts (U.S. EPA 1998). Consistent with EO 12898 and the Federal Interagency Working Group (FIWG) on Environmental Justice & NEPA Committee (2016), this document describes the approach to identify environmental justice populations and the path forward for the environmental consequences evaluation.

Following the guidance provided by the FIWG, this analysis identifies and describes the environmental justice populations potentially impacted by the proposed Breton project. This includes communities that are located within close proximity to the project and/or are dependent on industries that could be impacted by the project (e.g., subsistence or commercial fishing). Further evaluation may be needed to identify and describe additional communities and low income and minority populations once the ecological implications of the project are evaluated.

The prevalence of minority populations in the Study Area were identified through a "no threshold" analysis (U.S. EPA 1998, FIWG 2016). Minority populations are defined as a race and/or ethnicity other than Non-Hispanic White Alone.

Low-income populations are defined as individuals living below the poverty line, as defined by the U.S. Census Bureau (1995). The U.S. Census Bureau defines a poverty area as 20% to 40% of the population living below the poverty level, while an extreme poverty area is 40% or more of the population living below the poverty level (U.S. Census Bureau, 1995). The poverty levels vary by the household size and number of children. For example, in 2017, for one individual with no other people or children in the household, the poverty level is $12,488. Thus, any communities with more than 20% of individuals living below the poverty level are often identified as low income.

Granular level of detail from the U.S. Census Bureau was obtained for the environmental justice data. Community-level environmental justice data for "Census-Designated Places" was used, while non-Census Designated Places used the U.S. Census Bureau Block and Block Group level data to characterize the communities. For minority data, data is available at the U.S. Census Block level, while poverty data is available at the U.S. Census Block Group level.

The section provides a description of the parish-level environmental justice data followed by a summary of the data for communities in the Study Area.

12.8.1 Plaquemines Parish

Across Plaquemines Parish in 2017, approximately 35% of the population identifies as minority race or ethnicity (Table 12.9-1). Once part of the colonial Territory of Orleans, Plaquemines Parish has attracted a diverse cultural mix over the last three centuries: French and Spanish colonists, Croatians, African-Americans, Creoles of Color, Native Americans, Anglo-Americans, Italians, and Vietnamese (Austin et al. 2014a). Over the last two decades, the percent of the population living below poverty level has fluctuated between 9.4 - 19.3%, with 19.3% of the population living below the poverty level in the parish in 2017 (Table 12.9-1). Since 2011, the percent of minorities living below the poverty level has been increasing in Plaquemines Parish.

Table 12.9-1
Socioeconomic Indicators in Plaquemines Parish for 2000 and from 2010-2017

Socioeconomic Indicator	2000	2010	2011	2012	2013	2014	2015	2016	2017
Population	26,757	23,042	22,976	23,220	23,385	23,545	23,599	23,584	23,394
Employed Labor Force	9,960	9,614	10,154	10,227	9,894	10,004	9,777	9,919	9,849
Percent Minority	31.2%	32.2%	32.1%	32.2%	32.5%	33.0%	33.5%	33.8%	34.8%
Percent Living Below Poverty Level	18.0%	11.6%	9.4%	11.0%	12.7%	13.7%	16.2%	17.2%	19.3%
Percent of employment in agriculture, forestry, fishing and hunting, mining industry[1]	12.2%	5.3%	5.4%	8.8%	9.8%	12.0%	10.4%	10.9%	9.4%
Percent of employment in farming, fishing, and forestry occupations[2]	NA	NA	NA	NA	NA	NA	5.3%	5.6%	4.5%

Source: U.S. Census Bureau, 2017a; 2017d; 2016a; 2016c; 2016d; 2015a; 2015b; 2014a; 2014b; 2013a; 2013b; 2012a; 2012b; 2011a; 2011b; 2010a; 2010d; 2000a; 2000d.

Notes:

1. Industry data describe the kind of business conducted by a person's employing organization. The U.S. Census reports the agriculture, forestry, fishing and hunting, and mining (includes oil and gas) industries as one category. Plaquemines Parish (2016) notes that the employment data in the agriculture, forestry, fishing and hunting, and mining industry are likely under reported because some commercial fishing operations are undocumented and other activities related to seafood preparation and packaging are recorded as part of the manufacturing sector (Plaquemines Parish, 2016).
2. Occupation data describe the kind of work a person does on the job. The U.S. Census reports occupations in farming, fishing, and forestry independently from occupations in mining (includes oil and gas).

12.8.2 St. Bernard Parish

Across St. Bernard Parish in 2017, around 30% of the population identifies as minority race or ethnicity (Table 12.9-2). Most of the minority populations are Black or African American and Hispanic, with small numbers of American Indian and Asian people. The Isleños people are an ethnic group that live in lower St. Bernard Parish, in the communities of Delacroix, Reggio, Yscloskey, Shell Beach, and Hopedale. They are descendants of colonists from the Canary

Islands, who arrived in Louisiana in 1778, as part of a colonization initiative supported by the Spanish governor.

Over the last two decades, the percent of the population living below poverty level has fluctuated between 13 - 20%, with 19.7% of the population living below the poverty level in the parish in 2017 (Table 12.9-2). Since 2014, the percent of population living below the poverty level has been increasing in St. Bernard Parish (U.S. Census Bureau 2014a, 2015a, 2016c, 2017d).

Table 12.9-2
Socioeconomic Indicators in St. Bernard Parish for 2000 and from 2010-2017

Socioeconomic Indicator	2000	2010	2011	2012	2013	2014	2015	2016	2017
Population	67,229	27,739	32,347	35,947	38,850	41,114	42,858	44,091	45,067
Employed Labor Force	29,303	11,853	13,702	14,975	16,072	17,061	17,494	17,719	18,382
Percent Minority	11.7%	22.5%	22.9%	23.6%	25.3%	26.1%	27.8%	28.8%	30.1%
Percent Living Below Poverty Level	13.1%	15.0%	14.6%	18.2%	18.7%	17.1%	19.3%	20.1%	19.7%
Percent of employment in agriculture, forestry, fishing and hunting, mining industry[1]	1.9%	2.8%	2.4%	2.4%	2.4%	3.0%	3.1%	2.7%	3.0%
Percent of employment in farming, fishing, and forestry occupations[2]	1.1%	NA	NA	NA	NA	NA	1.7%	1.4%	1.7%

Source: U.S. Census Bureau, 2017a; 2017d; 2016a; 2016c; 2016d; 2015a; 2015b; 2014a; 2014b; 2013a; 2013b; 2012a; 2012b; 2011a; 2011b; 2010a; 2010d; 2000a; 2000d.

Notes:

3. Industry data describe the kind of business conducted by a person's employing organization. The U.S. Census reports the agriculture, forestry, fishing and hunting, and mining (includes oil and gas) industries as one category. Plaquemines Parish (2016) notes that the employment data in the agriculture, forestry, fishing and hunting, and mining industry are likely under reported because some commercial fishing operations are undocumented and other activities related to seafood preparation and packaging are recorded as part of the manufacturing sector (Plaquemines Parish, 2016).
4. Occupation data describe the kind of work a person does on the job. The U.S. Census reports occupations in farming, fishing, and forestry independently from occupations in mining (includes oil and gas).

12.8.3 Communities in the Study Area

The focus of this effort has been on 30 communities in Plaquemines and St. Bernard parishes that could be adversely impacted through impacts to commercial, recreational, and subsistence fishing (listed below and in Table 12.9-3).

- Plaquemines Parish: Belle Chasse, Live Oak, Ironton, Myrtle Grove, Pointe à la Hache, Grand Bayou, Port Sulphur, Empire, Buras, Boothville, Venice, Braithwaite, Scarsdale, Woodlawn, Wills Point, Phoenix, Davant, and Bohemia
- St. Bernard Parish: Arabi, Chalmette, Meraux, Violet, St. Bernard, Poydras, Caernarvon, Reggio, Delacroix, Shell Beach, Yscloskey, and Hopedale

Note that while this section is considering the communities near the project site that may be adversely affected by the project, the environmental justice affected environment may need to be broadened or refined as the resource area environmental consequence evaluations are undertaken.

Table 12.9-3
Environmental Justice Indicators for Communities in the Breton Study Area

Parish	Community	Population	Percent Minority	Minority Populations	Percent Living Below Poverty Level
Plaquemines Parish (34.8% minority; 19.3% living below poverty level)	**West Bank Communities**				
	Belle Chasse CDP	13,585	21%	Black or African American; Asian; American Indian; Hispanic	12%
	Live Oak	2,830	29%	Black or African American; Native American; Asian	25%
	Ironton	120	97%	Black or African American	25%
	Myrtle Grove	Unknown	0%	Not Applicable	25%
	Grand Bayou	44	43%	American Indian	25%
	Port Sulphur CDP	1,934	82%	Black or African American	51%
	Empire CDP	1,054	57%	Black or African American; Asian (Vietnamese)	32%
	Buras CDP	877	17%	Asian (Vietnamese); Some Other Race	14%
	Boothville CDP	701	52%	African American; Asian (Vietnamese)	36%
	Venice CDP	269	16%	Hispanic; Americas Indian; Two or More races	19%
	East Bank Communities				
	Braithwaite	263	41%	Black or African American	23%
	Scarsdale	66	2%	Some Other Race	23%
	Woodlawn	37	8%	Black or African American	23%
	Wills Point	196	26%	Black or African American	23%
	Phoenix	386	99%	Black or African American	28%
	Davant	318	94%	Black or African American; Asian	28%
	Pointe à la Hache CDP	251	100.0%	Black or African American	51%
	Bohemia	33	97%	Black or African American	28%
St. Bernard Parish	**East Bank Communities**				

Table 12.9-3
Environmental Justice Indicators for Communities in the Breton Study Area

Parish	Community	Population	Percent Minority	Minority Populations	Percent Living Below Poverty Level
(30.1% minority; 19.7% living below poverty level)	Arabi CDP	4,319	19%	Black or African American; American Indian; Asian; Hispanic	19%
	Chalmette CDP	22,907	30%	Black or African American; American Indian; Asian; Hispanic	20%
	Meraux CDP	7,073	20%	Black or African American; American Indian; Asian; Hispanic; Two or More Races	9%
	Violet CDP	5,705	67%	Black or African American; American Indian; Hispanic; Two or More Races	23%
	Poydras CDP	2,695	23%	Black or African America; Hispanic; Two or More Races	37%
	Caernarvon	114	3%	Black or African American; Hispanic	31%
	Breton Sound Communities				
	St. Bernard	1,864	12%	Black or African American; American Indian; Hispanic; Two or More Races	17%
	Reggio	11	100%	Black or African American	32%
	Delacroix	72	15%	Black or African America	32%
	Shell Beach	20	0%	Not Applicable	32%
	Yscloskey	35	9%	Some Other Race; Two or More Races	32%
	Hopedale	40	10%	American Indian; Two or More Races	32%

Note: CDP = Census-designated places

Sources:

1. Census Designated Places (CDP) use socioeconomic statistics currently available from the U.S. Census Bureau's 2017 American Community Survey (ACS) five-year estimates from 2013 to 2017.
2. Minority data for the non-CDP communities was obtained for 2010 from the Census Bureau for Block level data for U.S. Census Blocks that include and encompass the community. The percentage of individuals living below the poverty level for non-CDP communities was obtained for the Census Block Group in which the community is located.

12.9 SUBSISTENCE ACTIVITIES

Subsistence include activities that contribute to meeting minimal dietary needs, living off the land, and harvests intended for one's household use (Regis and Walton 2015). Researchers have narrowed the definition of subsistence to include activities that take place outside those that are industrial, technologically intensive, or market-based. For purposes of this socioeconomic analysis, the definition of subsistence proposed by Regis and Walton (2015) will be adapted: "subsistence describes a set of activities (practices) that contribute to food needs and also contributes to the pleasure of producing foods and sharing those with friends and family." This definition expands subsistence beyond nutritional needs to include activities that strengthen social ties to family, neighbors, and coworkers. Studies have indicated that subsistence in this form is very common for many households across coastal Louisiana, where many residents participate in a hybrid economy which includes traditional types of employment with firms operating in a market economy while also engaging in various self-provisioning activities.

Regis and Walton (2015) evaluated subsistence habits in Lafourche and Terrebonne parishes and identified a number of foods that were harvested, exchanged or shared among households. Those items relevant to the proposed Breton project include 12 types of fish; common forms of seafood (crabs, shrimp, oysters and some crawfish); and game, such as duck and other water fowl. Regis and Walton (2018) also indicated in their study that loss of access to fishing, hunting, and harvesting can have environmental justice implications, with poorer households impacted most heavily. In lower Plaquemines Parish, there is a large degree of subsistence fishing; local people depend on the estuary to feed their families and for social networks (Austin et al. 2014). In coastal Louisiana communities, people benefit from commercial and recreational fishing activities most of whom directly or indirectly live off the land. Networks of barter, trade, and gifts are strong, and the richness of social and family networks is embedded in traditions that have been handed down for generations (Gramling and Hagelman 2005).

While various subsistence activities are very important and entwined in the culture and lifestyles of many coastal Louisiana households, there is evidence that these practices are even more important to specific cultural groups. Cajun culture and identity has come increasingly to signify a subsistence fishing and trapping lifestyle that incorporates long-standing, intimate connections with the south Louisiana wetland landscape (Austin et al. 2014, Bernard 2003, Wiley 2002). Subsistence fishing is also crucial in Native American and Vietnamese communities (Austin et al. 2014). For example, the Natural Resources Defense Council (2010) found in their survey after the DWH oil spill that some Gulf Coast communities, especially Vietnamese-American and Native American fishing communities in Mississippi and Louisiana, ate between 3.6 and 12.1 times more shrimp and twice as much oysters and crabs than assumed in the federal risk assessment, which was based on the 90th percentile of seafood consumers nationally.

Unlike many other areas in the U.S., fishing and hunting to meet household food needs and for bartering is widespread throughout the region, particularly in south Louisiana, and not just among commercial fishermen. Game and seafood also play important roles in many social occasions and events along the coast. For example, seafood boils provide a very common locus for community gatherings. Locally fished and hunted seafood and game are important in more formal social occasions, for instance during religious holidays and local festivals (Austin et al. 2014).

12.10 PROTECTION OF CHILDREN

In 1997, EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, required that federal agencies identify and assess environmental health risks and safety risks that may disproportionately affect children. Further, the EO directs each federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health and safety risks.

This section and the previous section include data that can be used to analyze the status of the children under 18 years old in the Study Area, and for comparison purposes, in Louisiana and the U.S. Table 12.10-1 presents information about children living in poverty by parish. In general, there are slightly smaller percentages of children living in poverty in St. Bernard and Plaquemines parishes than in the state of Louisiana but more than the percentages of children living in poverty across the nation.

The previous section provided information on employment and income, which are indicators of the economic circumstances of the households of which children are a part.

12.10-1
Percentage of Children in Poverty by Parish (2013-2017)

Parish	Under 5 years	5 to 17 years	Total Under 18 years
Plaquemines	25%	21%	22%
St. Bernard	28%	27%	27%
Comparison Areas			
Louisiana	31%	27%	28%
U.S.	23%	20%	20%

Source: U.S. Census Bureau 2017. ACS 5-year estimates.
[a] Data were not available for individual block groups. Shading indicates areas where percentage of children in poverty exceeds state percentage.

13.0 COMMERCIAL FISHERIES

13.1 INTRODUCTION

Commercial fishing is an important economic driver for many communities across coastal Louisiana. Commercial fishing activity includes landings of shrimp, oysters, crab and finfish, which support a range of related activities for nearby communities. The Project Area for commercial fishing shown in Figure 13.1-1 is Breton Sound Basin which includes Areas Fished 421 and 42202, and the lower Mississippi River Basin, which includes Areas Fished 704 and 706. Areas Fished are defined by LDWF and used to identify the location where a majority of seafood was harvested on a particular trip when reporting landings using trip tickets. Current activity within the Project Area will be discussed across major species groups including shrimp, oysters, crab, and finfish including saltwater (not including mendaden) and freshwater finfish. In addition, some aggregated data across species is included to provide an accurate picture of the total number of unique license holders active in Breton Sound Basin and the overall landings by weight and value from the area.

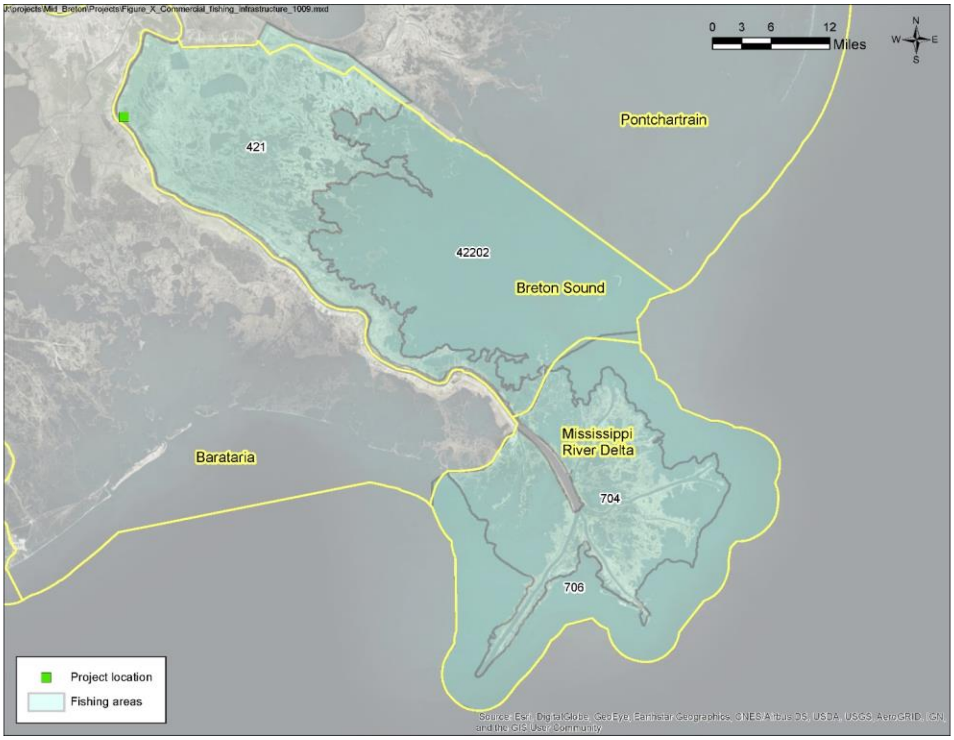


Figure 13.1-1. Trip ticket sub-basins in Project Area

Commercial fishing activity in Louisiana is managed by the Louisiana Department of Wildlife and Fisheries (LDWF), the Louisiana Wildlife and Fisheries Commission (Commission), and the Louisiana Legislature (LDWF 2019a). The Louisiana Department of Health and Hospitals also plays an active role in the management of oyster activity through the Molluscan Shellfish Program, which can issue closures due to public health concerns. The Louisiana Shrimp Task Force, the Louisiana Oyster Task Force, the Louisiana Crab Task Force, and the Louisiana Finfish Task Force were established to study and monitor the industries and make recommendations to the fisheries managers to help enhance the industries (Bourgeois et al. 2016; Banks et al. 2016; Bourgeois et al. 2014; Louisiana Finfish Task Force 2014).

Trends in participation for commercial fishing license holders in the Study Area across species groups are presented in Figure 13.1-2 and 13.1-3 covering the Breton Sound Basin and lower Mississippi River Basin areas, respectively. Trip ticket data on landings within the Project

Area (with Area Fished 42202 delineated within Area Fished 422) are available starting in 2011 so all years of available data are included. As shown, the number of license holders landing shrimp and crab is highest in Breton Sound Basin while Shrimp and Saltwater Fish have the highest number of licensees in the lower Mississippi River Basin. The overall number of license holders active in Breton Sound Basin has been fairly stable, with a modest increase for shrimp and blue crab in recent years. The trend in the lower Mississippi River Basin is one of notable declines in the number of license holders landing shrimp, which dropped from over 350 to 211 between 2011 and 2018, and saltwater fish, which dropped from over 200 to under 150 during that period.

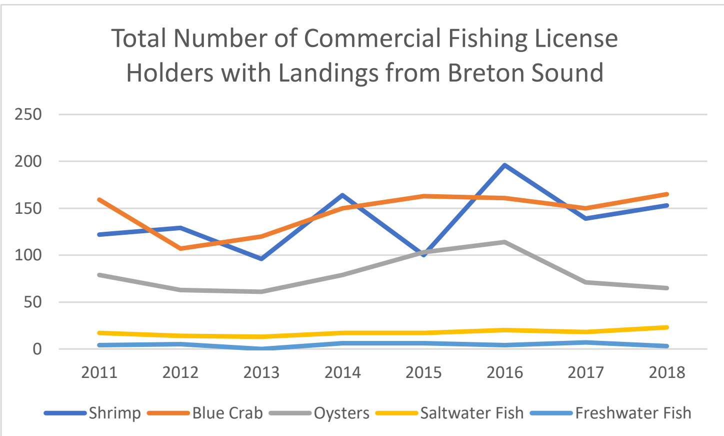
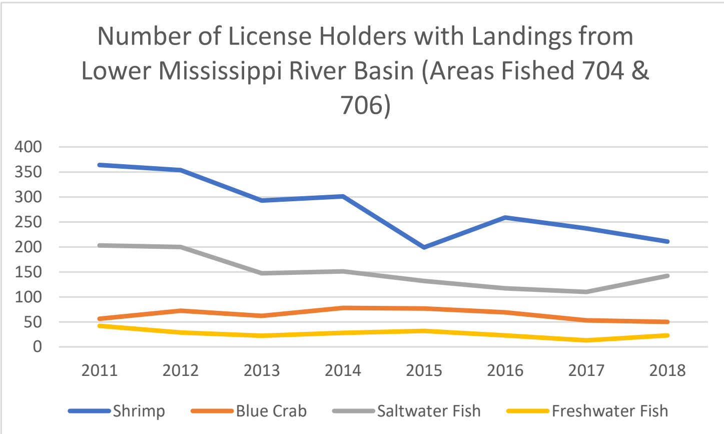


Figure 13.1-2. Total Number of Commercial Fishing License Holders with Landings from Breton Sound Basin, 2011-2018

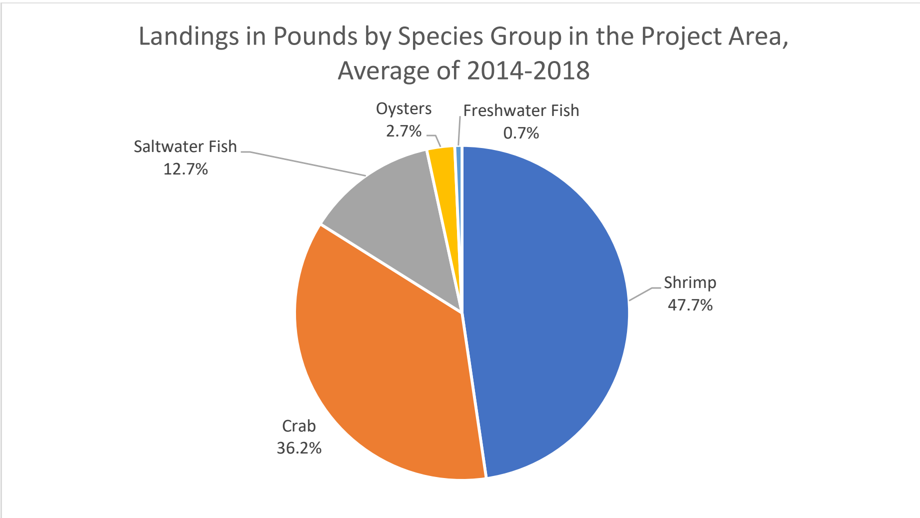


Source: LDWF Trip Ticket Data

Figure 13.1-3. Total Number of Commercial Fishing License Holders with Landings from lower Mississippi River Basin (Areas Fished 704 & 706), 2011-2018

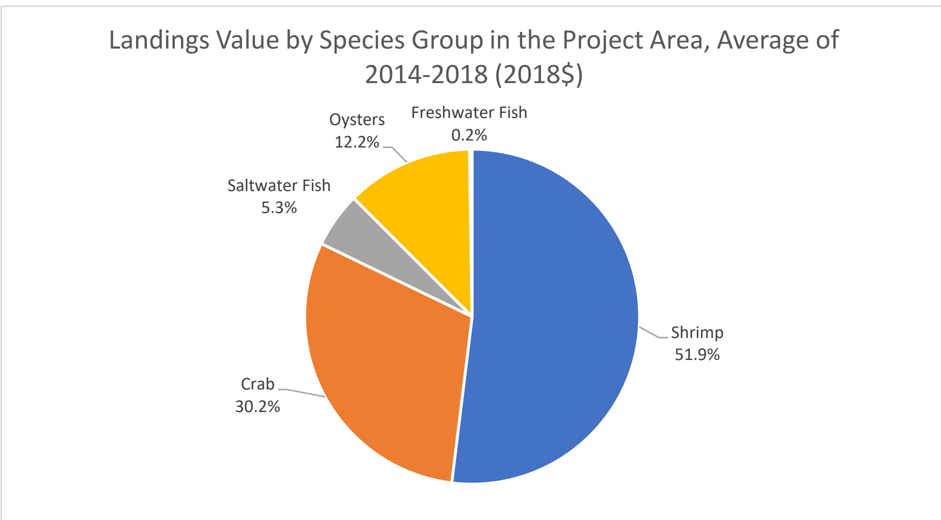
To operate a commercial fishing vessel in Louisiana waters, individuals must have a commercial license (LDWF 2019a). However, not all individuals engaged in this activity will necessarily maintain a commercial license. Beyond the commercial fishing license holder, there may be additional crew, as well as the dealers, suppliers, and seafood processors who support the industry. However, licensing data provide an important benchmark and can be tracked over time to gauge changes in the overall level of activity in an area.

LDWF trip ticket data show that shrimp, crab and saltwater fish are the primary species groups landed from the Project Area. Figure 13.1-4 illustrates the distribution of catch from 2014 to 2018 based on landings in pounds. Nearly half of the commercial landings were shrimp with crab making up 36.2% and saltwater fish making up 12.7%. Figure 13.1-5 provides a similar graph showing how the value of landings is distributed across species group based on landings data updated to 2018 dollars using the Gross Domestic Product Implicit Price Deflator. In terms of value, shrimp and crab are also the largest contributors, but the value of those landings is skewed much more heavily toward oysters. Shrimp made up just over half of the value of landings from the Project Area between 2014 and 2018 with crab making up 30%, oysters making up approximately 13%, and saltwater fish comprising just over 5% of the value of landings during that time.



Source: LDWF Trip Ticket Data

Figure 13.1-4. Landings in Pounds by Species Group in Project Area, Average of 2014-2018



Source: LDWF Trip Ticket Data

Figure 13.1-5. Landings Value by Species Group in Project Area, Average of 2014-2018

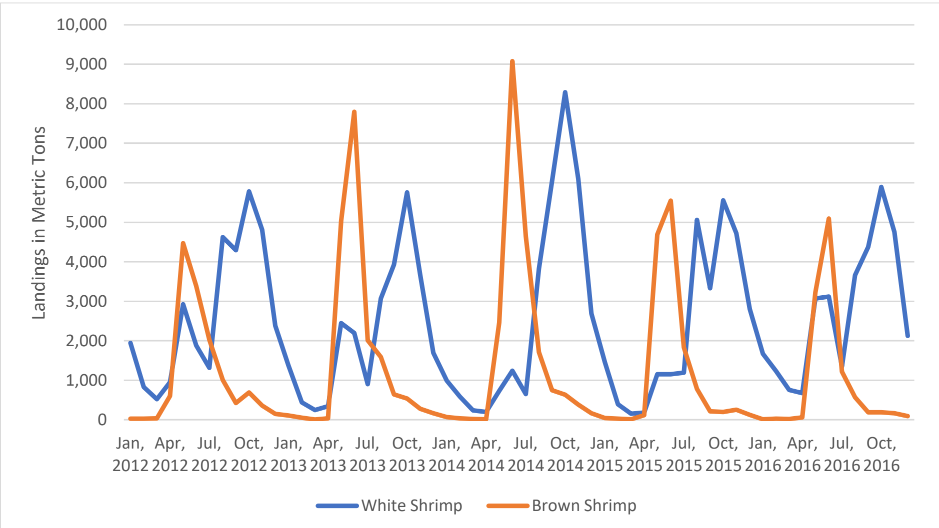
13.2 SHRIMP FISHERY

13.2.1 Overview of the Fishery

The shrimp fishery is the largest by value in coastal Louisiana and also in the Project Area. Shrimp landings are primarily composed of white and brown shrimp with 2018 landings of 4.2 million pounds of white shrimp valued at $6.6 million and 1.7 million pounds of brown shrimp valued at $1.6 million. According to the 2016 Louisiana Shrimp Fishery Management Plan, fewer than 5,600 licensed fisherman were estimated to be active in Louisiana based on license sales of certain gear types (Bourgeois 2016). Similarly, the number of licensed fishermen landing shrimp coastwide was 2,659 in 2018 (LDWF Trip Ticket Program). In the project area, an estimated total of 364 commercial fishing license holders landed shrimp in 2018.[10]

Shrimping activity exhibits marked seasonal fluctuations. Monthly statewide landings for white and brown shrimp are displayed in Figure 13.2-1 for the period 2012-2016. Brown shrimp landings tend to peak earlier in the year than white shrimp landings. For brown shrimp, landings in May, June, and July typically comprise the vast majority of landings within a year. For white shrimp, landings also begin to increase in May, but are typically much higher in late summer and fall.

[10] Value is based on the sum of license holders with landings from Breton Sound and the lower Mississippi River Basin, which may include some duplication causing this estimate to overstate the number of unique license holders in the combined Project Area.

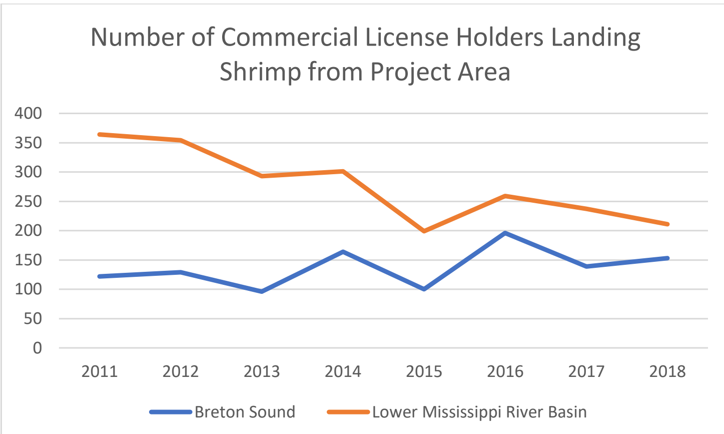


Source: Monthly Commercial Landing Statistics, Commercial Fisheries Statistics, NOAA National Marine Fisheries Service

Figure 13.1-5: White and Brown Shrimp Landings by Month (2012-2016)

13.2.2 Catch Statistics and Trends

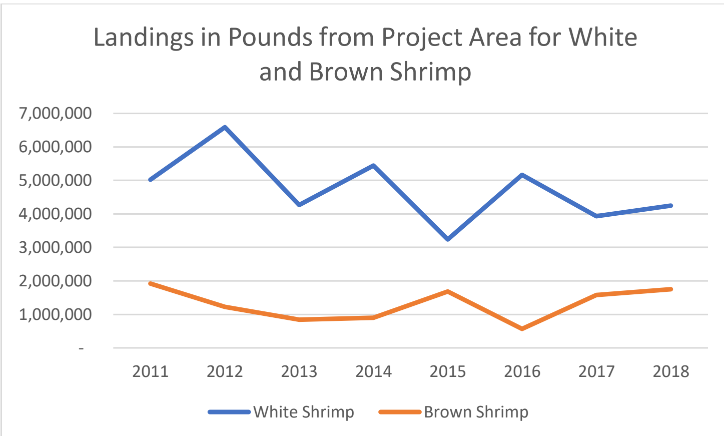
The number of commercial fishing license holders landing shrimp from the project area is displayed in Figure 13.2-2. More license holders landing shrimp are active in the lower Mississippi River Basin than in Breton Sound Basin, but the difference has been narrowing as fewer land shrimp from the lower Mississippi River and more land shrimp from Breton Sound Basin. In 2011, there were roughly 3 times as many commercial license holders landing shrimp from the lower Mississippi River Basin (364) than from Breton Sound Basin (122), but by 2018 the lower Mississippi River Basin was frequented by only about 40 percent more license holders than Breton Sound Basin (211 compared to 153, respectively).



Source: LDWF Trip Ticket Data

Figure 13.2-2: Number of Commercial Fishing License Holders Landing Shrimp from Project Area (2011-2018)

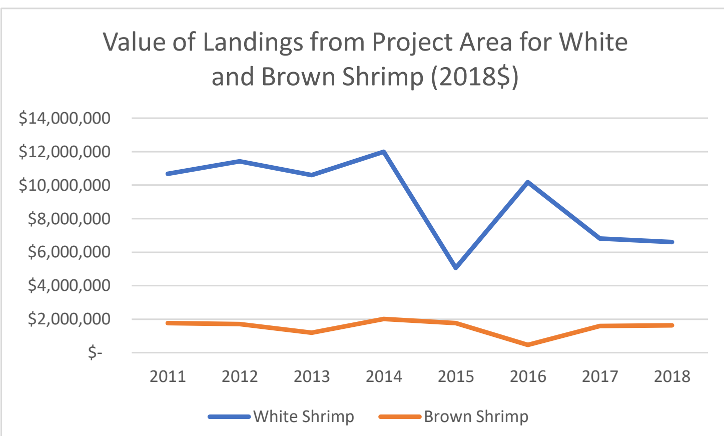
Data on landings within the Project Area (with Area Fished 42202 delineated within Area Fished 422) are available starting in 2011 and are shown in Figures 13.2-1 and 13.2-2 illustrating the pounds and value landed each year by type of shrimp. White shrimp landings have consistently been much higher than brown shrimp though white shrimp landings have exhibited a general downward trend since 2011. The average value for white shrimp during this period was $1.92 per pound compared to $1.22 per pound for brown shrimp leading to an even larger contribution of white shrimp to the total value of landings. However, in addition to the pattern of decline in white shrimp landings, the price per pound has dropped from $2.13 per pound in 2011 to $1.55 per pound in 2018 leading to a larger percent decline in the value of white shrimp landings than seen purely because of declining catch. This trend of falling prices coincides with continued downward pressure from increasing imports, which set records in 2016, 2017 and 2018 according to NOAA Fisheries data from the Office of Science and Technology (White, 2019).



Source: LDWF Trip Ticket Data

Notes: Calculation sum Breton Sound Basin and the lower Mississippi River Basin. Confidential values were suppressed for brown shrimp from Area Fished 704 in 2012, 2014 and 2016 and assumed to be zero.

Figure 13.2-1. Landings in pounds from Project Area for White and Brown Shrimp (2018$)



Source: LDWF Trip Ticket Data

Notes: Calculation sum Breton Sound Basin and the lower Mississippi River Basin. Confidential values were suppressed for brown shrimp from Area Fished 704 in 2012, 2014 and 2016 and assumed to be zero.

Figure 13.2-2. Value of Landings from Project Area for White and Brown Shrimp (2018$)

To better illustrate the link between commercial fishing in the Project Area and nearby communities, estimates of distances traveled by commercial license holders were pulled from Barnes et al. 2016. Table 13.1-1 provides estimates of the average distance traveled among those landing shrimp[11] from the Project Area, which was developed by estimating a minimum distance traveled between the license holder's address and the nearest point on the edge of the sub basin while accounting for the road network. Three estimates of average distance are provided using weights that correspond to the number of trips, total landings, and total value for each license holder. In general, the distance traveled to sub basin 422 is considerably longer than sub basin 421, which is consistent with its location further from population centers along the coast. Following that general pattern, Areas Fished in the Mississippi River Basin have even higher average distances travelled demonstrating a correlation between distance travelled and location of area fished relative to higher-density population centers.

Table 13.1-1
Average Estimated Distance Traveled Among Those Landing Shrimp[a] from Project Area, 2014[b]

	Distance Weighted by Trips	Distance Weighted by Landings	Distance Weighted by Value
Area Fished 421	6.0	3.8	3.5
Area Fished 422[b]	21.3	21.6	21.1
Area Fished 704	45.6	51.7	54.2
Area Fished 706	38.6	29.6	31.7

a Data are based on trip tickets for all shellfish though white and brown shrimp make up the vast majority of landings for these trips

b Most recent year for which travel estimates are available for all Fishing Areas

c Data include all of Area Fished 422 rather than the 42202 portion of the Area Fished defined as within the Project Area.

Source: LDWF Trip Ticket Data; Barnes et al. 2016

13.3 OYSTER FISHERY

13.3.1 Overview of the Fishery

The oyster fishery is one of the largest in coastal Louisiana and also a sizeable contributor to activity in the Project Area. In 2018, commercial license holders landed just over 260,000 pounds of oysters valued at $2 million from the Project Area. The number of licensed fishermen landing oysters coastwide was 728 in 2018. In the Project Area, a total of 207 commercial fishing license holders landed oysters in 2018.

Seasonal fluctuations in statewide landings for oysters from 2012 to 2016 as displayed in Figure 13.4-1. Oyster landings tend to be lower between November and February and higher in the spring and summer.

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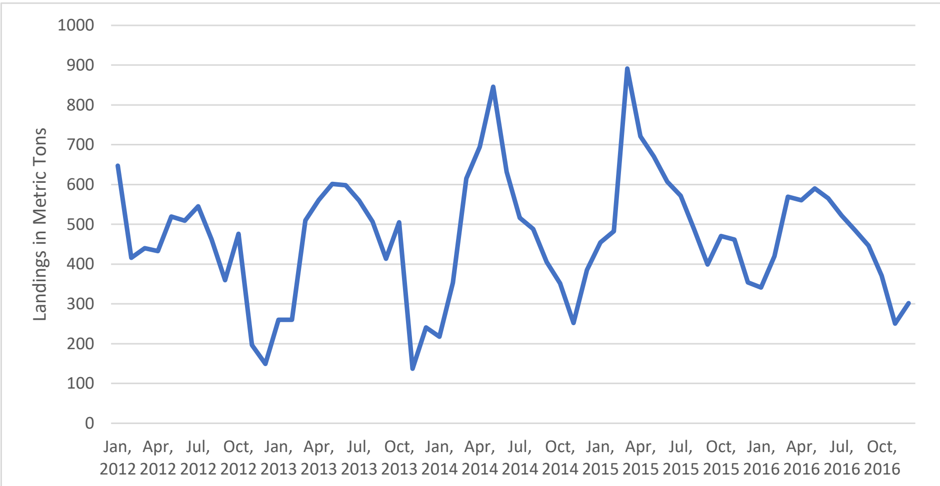
[11] Data are based on trip tickets for all shellfish though white and brown shrimp make up the vast majority of landings for these trips



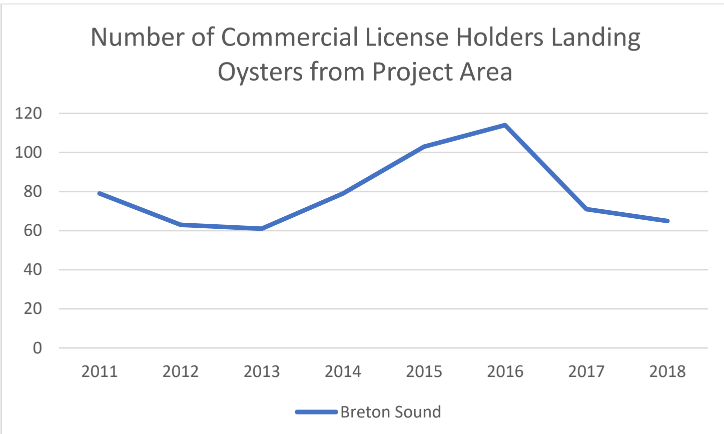
Source: Monthly Commercial Landing Statistics, Commercial Fisheries Statistics, NOAA National Marine Fisheries Service

Figure 13.4-1: ***Oyster Landings by Month (2012-2016)***

Oysters can occur in four areas: 1) public oyster areas, 2) state-issued private oyster leases, 3) unleased state-owned water bottoms, and 4) privately-owned water bottoms. Oysters from private leases have constituted the majority of commercial landings in Louisiana for many years with the percent from private leases reaching 95% in 2014 (Banks et al. 2016). The LDWF works with the Office of State Lands to manage leases. Each lease requires an annual rental payment of $3 per acre, which was increased from $2 per acre by HB 579 in the 2015 legislative session (LDWF 2019b).

13.3.2 Catch Statistics and Trends

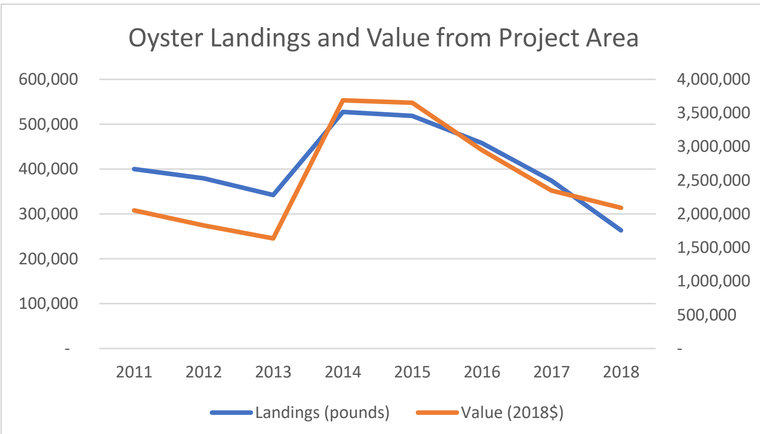
The number of commercial fishing license holders landing oysters from the Project Area is displayed in Figure 13.4-2. The only locations within the Project Area reported to have oyster landings are in Breton Sound Basin. The number active in a given year was similar in the last couple of years to levels of participation in 2011 among license holders. However, the number of license holders nearly doubled from 61 to 114 between 2013 and 2016 before falling back to 65 by 2018.



Source: LDWF Trip Ticket Data

Figure 13.4-2: Number of Commercial Fishing License Holders Landing Oysters from Project Area (2011-2018)

Total oyster landings by year from the Project Area are shown in Figure 13.4-3. Prior to the availability of data that aligns with the Project Area (including Area Fished 42202), landings of oysters in this part of the coast had dropped in 2010 coinciding with the Deepwater Horizon oil spill (Barnes et al. 2016). The level of activity in the Project Area remained fairly low between 2011 and 2013, before landings began to rebound in 2014. However, landings have fallen since that time slipping to less than 265,000 pounds in 2018. While the value of landings shows a similar pattern of ups and downs, the price per pound has shifted over time, increasing from $5.13 per pound in 2011 to $7.93 per pound (all values in 2018$). This increase in price has slowed the drop in revenue with the value of landings falling only 40 percent while weight dropped by half between 2014 and 2018.



Source: LDWF Trip Ticket Data

Figure 13.4-3: Oyster Landings by Weight (pounds) and Value from Project Area (2011-2018)

To better illustrate the link between commercial oyster activity in the Project Area and nearby communities, estimates of distances traveled by commercial license holders were pulled from Barnes et al. 2016. Table 13.4-1 provides estimates of the average distance traveled among those landing oysters from the Project Area, which were developed by estimating a minimum distance traveled between the license holder's address and the nearest point on the edge of the sub basin while accounting for the road network. Three estimates of average distance are provided using weights that correspond to the number of trips, total landings, and total value for each license holder. The average distance weighted by number of trips is larger in both areas than the averages weighted by landings and value. This pattern suggests that those traveling to the Project Area to land oysters who have longer trips tend to have smaller landings per trip. Weighting the data by landings in pounds or value provides a sense of distance traveled that is more typical for those landing the greatest quantities of oysters from this area and the average distance of 10 miles suggests that a large portion of oysters are landed by commercial fishermen from nearby communities.

Table 13.4-1
Average Estimated Distance Traveled Among Those Landing Oysters from Project Area, 2012[a]

	Distance Weighted by Trips	Distance Weighted by Landings	Distance Weighted by Value
Area Fished 421	62.4	10.6	10.6
Area Fished 422[b]	25.9	14.0	13.2

a Most recent year for which travel estimates are available for all Fishing Areas (no oyster landings reported from 704 and 706)

b Data include all of Area Fished 422 rather than the 42202 portion of the Area Fished defined as within the Project Area.

Source: LDWF Trip Ticket Data; Barnes et al. 2016

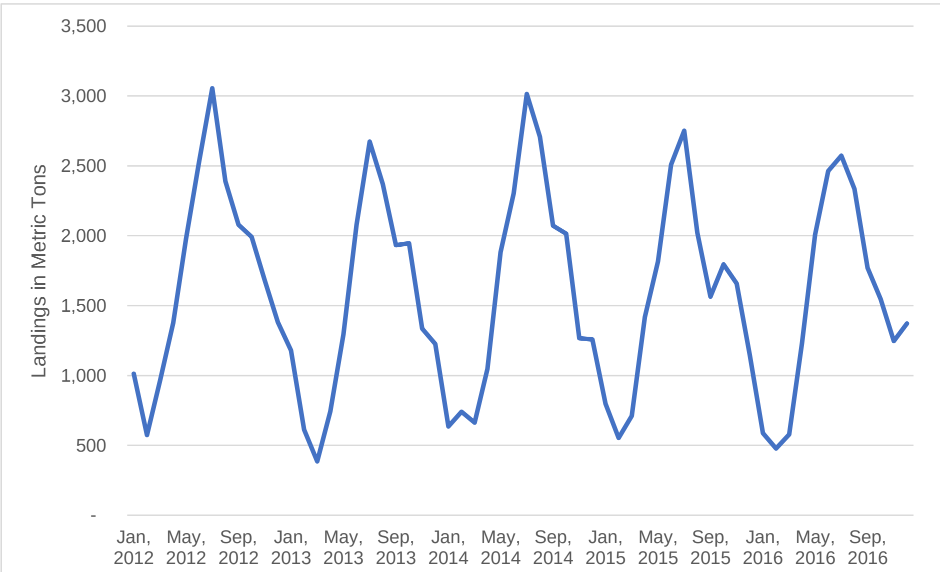
13.4 CRAB FISHERY

13.4.1 Overview of the Fishery

Commercial fishing of crab is the third largest species group of commercial landings in coastal Louisiana and one of the most important contributors to activity in the Project Area. Blue crab landings, which is the primary crab species targeted, topped 5 million pounds in the Project Area in 2018 with an associated dockside value of more than $6.6 million. The number of licensed fishermen landing blue crab coastwide was 1,437 in 2018. In the Project Area, an estimated total of 215 commercial fishing license holders landed crab in 2018.[12]

Seasonal fluctuations in landings for blue crabs are displayed in Figure 13.3-1 for the most recent 5 years of monthly data available (2012 to 2016). Landings exhibit strong seasonality with higher landings from late spring through early fall, peaking in July in each of the last 5 years

[12] Value is based on the sum of license holders with landings from Breton Sound and the lower Mississippi River Basin, which may include some duplication causing this estimate to overstate the number of unique license holders in the combined Project Area.

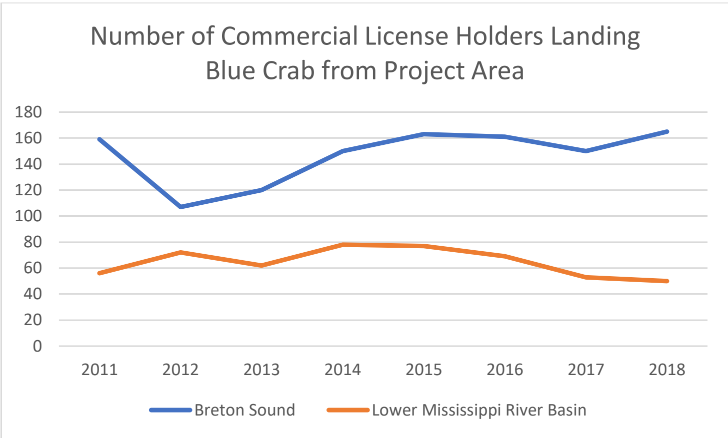


Source: Monthly Commercial Landing Statistics, Commercial Fisheries Statistics, NOAA National Marine Fisheries Service

Figure 13.3-1: Blue Crab Landings by Month (2012-2016)

13.4.2 Catch Statistics and Trends

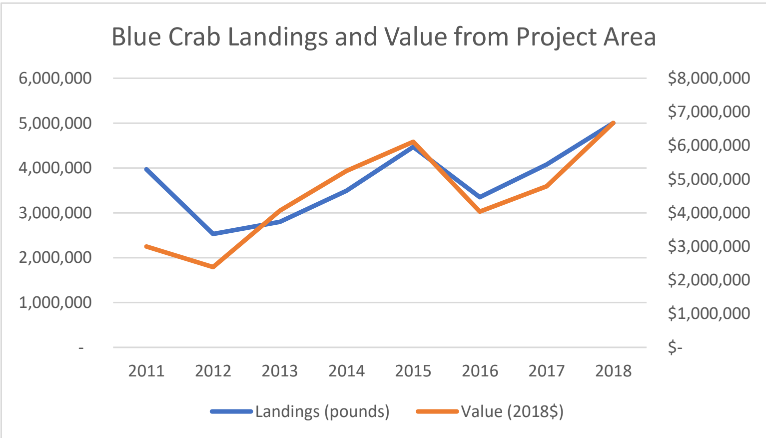
The number of commercial fishing license holders landing crab from the Project Area is displayed in Figure 13.3-2. The overall number of license holders active in the Project Area has remained fairly similar over time, though a notable drop in 2012 in Breton Sound Basin was followed by a gradual return to a similar level around 160 license holders in the last several years. In recent years, the number of license holders landing blue crab from the lower Mississippi River Basin has dropped slightly, hovering around 60 in recent years.



Source: LDWF Trip Ticket Data

Figure 13.3-2: Number of Commercial Fishing License Holders Landing Blue Crab from Project Area (2011-2018)

Total crab landings by year from the Project Area are shown in Figure 13.3-3 for the period 2011 to 2018. Aside from 2011 when blue crab prices were particularly low, landings and values in the Project Area have followed a similar trend over time. Overall, blue crab activity has increased in the project area aside from a dip in 2016. However, by 2018 landings and values were at their highest point since data for Breton Sound Basin (distinguishing area 42202 from all of 422) began collection in 2011.



Source: LDWF Trip Ticket Data

Figure 13.3-3: Crab Landings by Weight (pounds) and Value from Project Area (2011-2018)

To better illustrate the link between commercial crab activity in the Project Area and nearby communities, estimates of distances traveled by commercial license holders were pulled from Barnes et al. 2016. Table 13.3-1 provides estimates of the average distance traveled among those landing crab from the Project Area, which were developed by estimating a minimum distance traveled between the license holder's address and the nearest point on the edge of the sub basin while accounting for the road network. Three estimates of average distance are provided using weights that correspond to the number of trips, total landings and total value for each license holder. The average distance weighted by number of trips is relatively small across all metrics in Breton Sound Basin suggesting that a majority of activity is that area is based in communities adjacent to the Project Area. However, distances travelled among those landing blue crab from the lower Mississippi River Basin in Areas Fished 704 and 706 are considerably larger, suggesting that those targeting blue crab in these areas are currently traveling well beyond their home communities in order to operate.

Table 13.3-1
Average Estimated Distance Traveled Among Those Landing Crab[a] from Project Area, 2014[b]

	Distance Weighted by Trips	Distance Weighted by Landings	Distance Weighted by Value
Area Fished 421	4.8	2.9	3.1
Area Fished 422[c]	6.6	7.0	7.1
Area Fished 704	54.2	50.3	54.0
Area Fished 706	109.3	102.8	102.8

a Data are based on trip tickets for all crab, though blue crab make up the vast majority of landings for these trips

b Most recent year for which travel estimates are available for all Fishing Areas

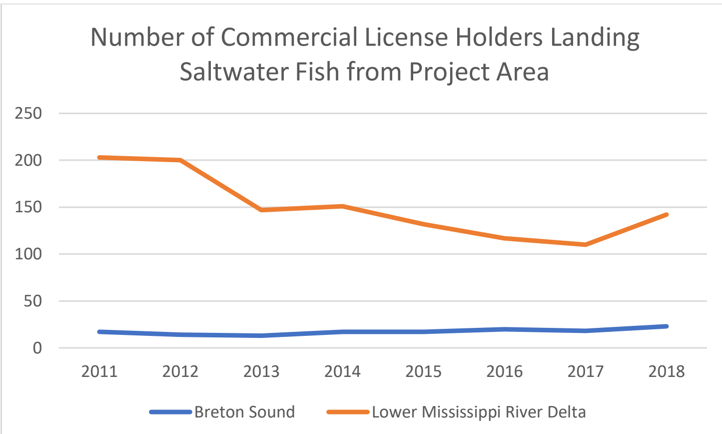
c Data include all of Area Fished 422 rather than the 42202 portion of the Area Fished defined as within the Project Area.

Source: LDWF Trip Ticket Data; Barnes et al. 2016

13.5 FINFISH FISHERY

13.5.1 Overview of the Fishery

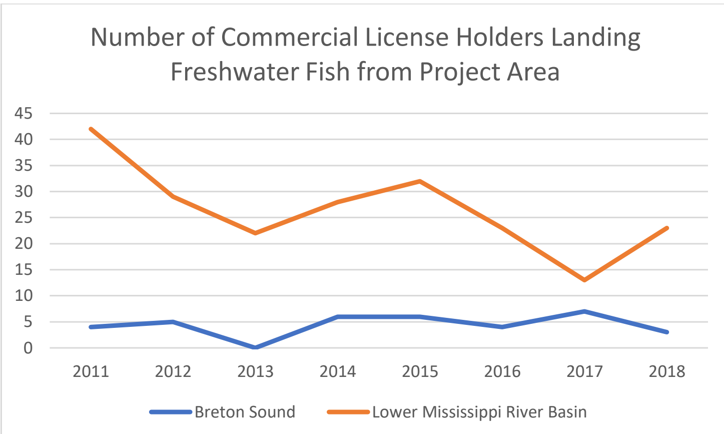
The number of commercial fishing license holders landing saltwater and freshwater fish from the Project Area is displayed in Figures 13.4-1 and 13.4-2, respectively. The number of license holders actively landing saltwater fish in the lower Mississippi River Basin is far greater than in Breton Sound Basin, though the level of participation among license has dropped considerably in the lower Mississippi River Basin in recent years. Between 2011 and 2017, the number of license holders had fallen by almost half, before rebounding in 2018 to 142. The number of license holders reporting landings of saltwater shrimp from Breton Sound Basin has been low, hovering around 20 for the last several years.



Source: LDWF Trip Ticket Data

Figure 13.5-1: Number of Commercial Fishing License Holders Landing Saltwater Fish from Project Area (2011-2018)

The number of commercial license holders reporting landings of freshwater fish from the Project Area is much lower than seen for saltwater fish. The relative importance of the lower Mississippi River Basin is similar, but the numbers are much lower than was seen among those landing saltwater fish. In 2011, just over 40 commercial fishing license holders reported landing freshwater fish from the lower Mississippi River Basin, but that number was only 23 by 2018. The level of activity in Breton Sound Basin is much lower, still, averaging around 5 license holders per year since 2011.



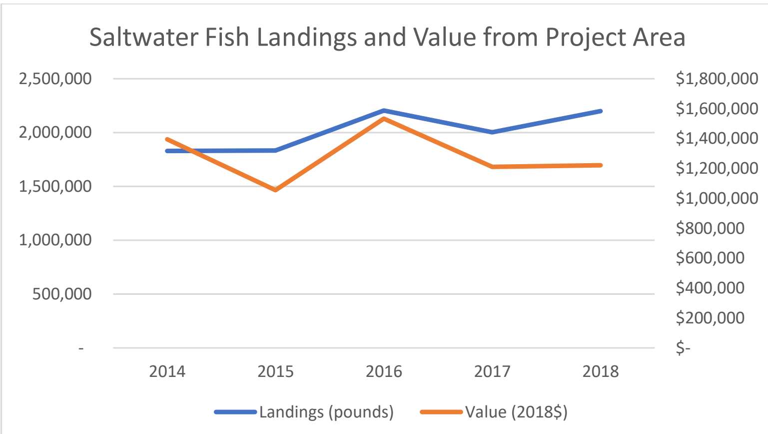
Source: LDWF Trip Ticket Data

Figure 13.5-2: Number of Commercial Fishing License Holders Landing Freshwater Fish from Project Area (2011-2018)

13.5.2 Catch Statistics and Trends

13.5.2.1 Saltwater Finfish Catch Statistics and Trends

Total saltwater fish landings from the Project Area averaged 2 million pounds valued at $1.3 million between 2014 and 2018. Of those landings, 92 percent were landed from the lower Mississippi River Basin. The most recent five years of data are shown in Figure 13.5-3. While no significant trends are detectible during this timeframe, total pounds has been slightly increasing while values have remained relatively flat. As expected, this is due to lower prices in recent years, which fell to $0.56 per pound in 2018 from $0.76 per pound in 2014.



Source: LDWF Trip Ticket Data

Figure 13.5-3: Saltwater Fish Landings by Weight (pounds) and Value from Project Area (2014-2018)

To better illustrate the link between commercial saltwater finfishing activity in the Project Area and nearby communities, estimates of distances traveled by commercial license holders were pulled from Barnes et al. 2016. Table 13.5-1 provides estimates of the average distance traveled among those landing saltwater finfish from the Project Area, which were developed by estimating a minimum distance traveled between the license holder's address and the nearest point on the edge of the sub basin while accounting for the road network. Three estimates of average distance are provided using weights that correspond to the number of trips, total landings and total value for each license holder. The average distance weighted by number of trips is much larger among those landing saltwater finfish from sub basin 421 suggesting that these individuals travel from much further inland and may focus fishing effort in areas closer to shore. In areas 704 and 706, longer distances travelled are of an order of magnitude that suggests a high concentration of commercial license holders based nearby in Plaquemines Parish.

Table 13.5-1
- Average Estimated Distance Traveled Among Those Landing Saltwater Finfish from Project Area, 2013[a]

	Distance Weighted by Trips	Distance Weighted by Landings	Distance Weighted by Value
Area Fished 421	54.8	41.8	46.5
Area Fished 422c	5.7	5.3	4.6
Area Fished 704	34.8	26.5	37.4
Area Fished 706	23.6	21.2	21.6

a most recent year for which travel estimates are available for both basins

Source: LDWF Trip Ticket Data; Barnes et al. 2016

13.5.2.2 Freshwater Finfish Catch Statistics and Trends

Total freshwater fish landings from the Project Area averaged 111,000 pounds valued at $59,000 between 2014 and 2018. Of those landings, 88 percent were landed from the lower Mississippi River Basin. The most recent five years of data are shown in Figure 13.5-4. Aside from a high level of landings in 2015, the level of activity has been very low in recent years with landings hovering around 50,000 pounds and $20,000 in value. Prices have also been fairly stable over this time period, moving from $0.51 per pound in 2014 to $0.47 per pound in 2018.

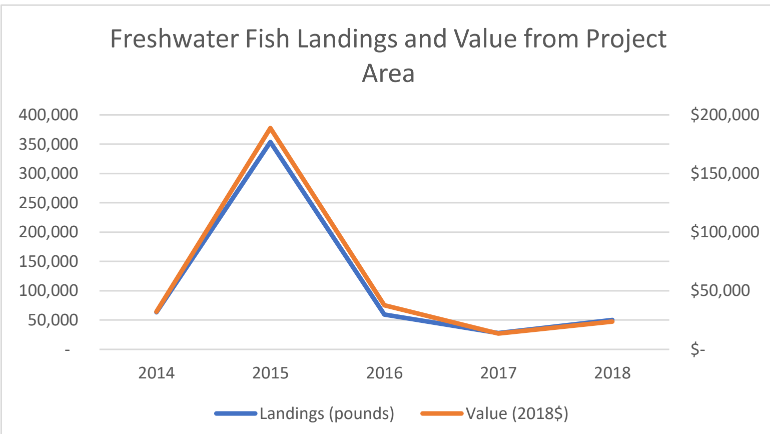


Figure 13.5-4: Freshwater Fish Landings by Weight (pounds) and Value from Project Area (2014-2018)

13.6 AQUACULTURE

According to the LSU AgCenter, there are a small number of aquaculture producers in Plaquemines and St. Bernard parishes. These producers include crawfish and bait fish. These operations have many shared interests with commercial fishing activity in the Study area including the potential for shared suppliers, processors, and distribution networks. Aquaculture activity in Study Area parishes is summarized in Tables 13.5-1 and Tables 13.5-2 for crawfish farming and fish bait, respectively. In each parish and for each type of aquaculture, there are less than three producers and across all categories of activity in these parishes, a total gross farm value of just over $750,000 in 2017.

Table 13.5-1
Crawfish (farm) Activity in Plaquemines and St. Bernard Parishes, 2017

Parish	Number of Producers	Acres in Production	Total Pounds	Gross Farm Value
Plaquemines	<3	200	150,000	$202,500
St. Bernard	<3	75	45,000	$60,750

Source: LSU AgCenter 2017

Table 13.5-2
Fish Bait Aquaculture Activity in Plaquemines and St. Bernard Parishes, 2017

Parish	Number of Producers	Total Pounds	Gross Farm Value
Plaquemines	<3	23,000	$253,000
St. Bernard	<3	23,000	$253,000

Source: LSU AgCenter 2017

Harvesting of wild alligators is also an important source of commercial resource-based activity in Louisiana. Since the inception of the management of alligator by the Louisiana Department of Wildlife and Fisheries, the number of commercial hunters and wild-caught alligators taken has grown over time with 3,281 hunters active and 33,613 alligators taken in Louisiana in 2016, valued at $9.7 million including skin and meat (LDWF 2017). With parishes adjacent to the Project Area, total 2017 production of wild-caught alligators were estimated to include a total of 6,237 feet and $179,626 in value in Plaquemines Parish and a total of 892 feet and $25,692 in value in St. Bernard (LSU AgCenter 2017). The management of alligators includes assessment of nest density and population in order to set quotas, which is coupled with a wild-egg harvest program that allows alligator ranchers to harvest eggs from the wild, but requires ranchers to return a quantity of juvenile alligators equal to 10% of eggs hatched to the wild within 2-years. This program has helped sustained the wild population while also cultivating a robust alligator farming/ranching program. However, this connection also demonstrates how both segments of this industry can be impacted by environmental changes.

14.0 CULTURAL RESOURCES

14.1 INTRODUCTION

The affected environment for cultural resources consists of historic properties, which are any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior.

The project area for cultural resources includes the proposed construction footprint Area of Potential Effect (APE) as well as a mile radius out from the boundary of the construction footprint and the proposed outfall area (preliminary operations APE) in Plaquemines Parish (refer to Figure 4-1 in Appendix A – Cultural Resources Research Design).

This section provides a brief description of the historical setting of the properties within one mile of the construction footprint (Table 14.2-1). Construction and Operations APEs are TBD. CPRA will propose APEs to USACE and USACE will consult with SHPO, Tribes, and ACHP on whether or not the proposed APEs are appropriate. Also, CPRA will most likely use basin-wide Delft modeling to determine the largest extent in the operations area to propose as the Operations APE.

14.2 HISTORICAL SETTING

The proposed project is located within Plaquemines Parish, an area that lies within the Mississippi Alluvial Plain, Holocene Meander Belts as mapped by the LDA (Girard et al. 2018). The general chronology of the Mississippi Alluvial Plain, Holocene Meander Belts can be grouped into five general cultural-historical time periods: Paleoindian, Archaic, Late Prehistoric, Woodland, and Historic. Table 14.2-1 presents an overview of the relevant culture history for the project area.

Table 14.2-1
Cultural History and Chronology of the Project Area

Period	Approximate Dates
Paleoindian/Early Archaic	11500–6000 B.C.
Middle Archaic	6000–2000 B.C.
Late Archaic	2000-800 B.C.
Poverty Point	1730–1350 B.C.
Woodland	800 B.C.–1200 A.D.
Tchula/Tchefuncte	500 B.C.–A.D. 100
Marksville	A.D. 100–400
Troyville/Coles Creek	A.D. 400–1100
Plaquemine	A.D. 1100–1600
Mississippian	A.D. 1200–1700
Historic	A.D. 1700–present
Exploration/Colonization	A.D. 1541–1803
Antebellum	A.D. 1803–1860
Civil War/Postbellum	A.D. 1860–1890
Industrialization/Modernization	A.D. 1890–Twentieth Century

Plaquemines Parish was not extensively occupied by Native American groups at the beginning of the historic period. However, two Native American groups, the Chawasha (Tunican) and Bayougoula, are known to have inhabited the upper area of present-day Plaquemines Parish. The Chawasha crossed the Mississippi River into western Plaquemines Parish in 1722. Following the Natchez War in 1729, the Chawasha were attacked in an attempt to eliminate the group. By 1739, the Chawasha had withdrawn to an area north of New Orleans where they slowly dwindled in numbers and finally disappeared by the early 19th century (Paulson et al. 2008).

Following an attack by the Taensa, the Bayougoula fled south of New Orleans on the opposite side of the Mississippi River from the Chawasha. By 1725, the tribe had relocated to an area north of New Orleans where they gradually amalgamated with other tribes and finally, migrated further west and south (Paulson et al. 2008).

Robert Cavelier, Sieur de La Salle was the first Frenchman to travel to the mouth of the Mississippi River, eventually claiming the whole Mississippi Valley for France in 1682. To mark his travels, La Salle placed a wooden cross in what is now Plaquemines Parish. Unable to later relocate the cross on a subsequent expedition, La Salle was murdered by his men in Texas. In 1698-99. Pierre Le Moyne, Sieur d'Iberville intensively explored the Gulf Coast and mouth of the Mississippi. His associate, Jean-Baptist Le Moyne, Sieur de Bienville, led an expedition up the Mississippi River in 1699 in which he encountered a British ship. Bienville convinced the English captain to cease his exploration of the area near English Turn. By 1700, Iberville built the first French fortifications (Fort de la Boulaye) along the Mississippi River in Plaquemines Parish that was ultimately abandoned in 1707. The Spanish took possession of Louisiana in 1762. In an effort to bolster military and commercial security, in 1792 the Spanish built Fort St. Philip (Paulson et al. 2008).

After ceding Louisiana to France in 1800, France almost immediately transferred the colony to the United States in 1803. When the United States purchased the Louisiana territory, agriculture grew at a quick rate. As America continued to take over more of the land in Louisiana, indigenous groups were forced out. In 1812, Louisiana gained statehood, and by 1815, the War of 1812 had ended. As soon as these two events occurred, a land race began. This also signaled a larger push to remove indigenous people from the area. By 1860, most Native Americans had been removed (Smith et al. 1983).

Another development during the antebellum period of Louisiana history was river trade. In 1811, the steamboat New Orleans made the trip between Pittsburgh and New Orleans. After the successful trip, steamboats began to replace keelboats as a means of transportation and trade, and New Orleans saw a rapid increase in population.

Plaquemines Parish was formed in 1807, when the twelve counties of the Territory of Orleans were reorganized, with Pointe a la Hache being named as the parish seat. The wet, saline soils of the area made the parish suitable for growing sugar with sugar quickly becoming the most important cash crop below New Orleans. As such, many of the smaller land holdings were eventually consolidated into larger plantations. By 1820, the population of the parish had doubled and continued to grow throughout the remainder of the antebellum period with approximately 67% of the population being enslaved. The plantations that developed differed from others upriver in that Plaquemines plantations were wide in frontage and shallow in depth since most of the arable land was found near the Mississippi River. Also, during this period are the beginnings of the fruit and fishery industries in the parish made possible from the regular steamboat service to New Orleans (Paulson et al. 2008).

In 1861, Louisiana joined the Confederate States of America. Although involved in the Civil War effort, major battles did not occur in Louisiana until 1862. Despite the ideal location of the Mississippi River, it was never heavily guarded. The United States was quick to take advantage of this and effectively crippled Louisiana by taking control of New Orleans. At the onset of the Civil War, many Plaquemines Parish residents relocated their families further inland. Upon their return, many plantation owners faced hardships in keeping their plantations with many being forced to sell and small plantations being consolidated into large single plantations. It was also during this time crop production shifted from sugarcane to rice. Disrepair of the levee system led to destruction of low-lying sugarcane areas but was ideal for rice cultivation. By 1875, Plaquemines Parish was the largest producer of rice in the state. The parish also faced several severe hurricanes during this time (1867, 1871 and 1893) that destroyed crops, houses, and levees as well as a yellow-fever epidemic in 1867 (Valk et al. 2010).

The turn of the century marked another shift in Plaquemines Parish. By the late 1800s, most of the rice production in the state had moved away from the Mississippi River and the plantations were steadily shutting down leaving only a few large holdings like Magnolia, Belair, and Braithwaite. Instead of rice production, the economy turned to industries such as truck farms, citrus crops, fur trapping and later oil and gas along with fishing, shrimping, and oyster harvesting. Hurricanes and flooding remained problematic for the parish (Valk et al. 2010).

14.3 CULTURAL RESOURCES INVESTIGATIONS

Although the proposed construction footprint has not been previously surveyed in its entirety, at least four previous investigations have occurred along the banks of the Mississippi River within the proposed construction footprint. These investigations took place between 1977 and 1984 and did not result in the identification of cultural resources within the proposed construction footprint. Additionally, at least nine other investigations have occurred within one mile of the proposed construction footprint. These investigations occurred between 1981 and 2011 and did not result in the identification of cultural resources within the proposed construction footprint.

The results of the records review identified five previously recorded archaeological sites (16PL114, 16PL124, 16PL128, 16PL129, and 16PL170), the Dobard Cemetery, and one National Oceanic and Atmospheric Administration (NOAA) Enc Obstruction within one mile of the proposed construction footprint (Table 14.3-1).

Table 14.3-1
Previously Recorded Resources within One Mile of the Proposed Project Construction Footprint

Resource	Resource Type	Determination of Eligibility
16PL114	Fanny Plantation (1860-1890)	Undetermined
16PL124	Exile Plantation (19th and 20th century)	Undetermined
16PL128	Euro-American or Afro-American [sic] house foundation/pillars	Ineligible
16PL129	19th century homesite of Pierre Bertrand Sr.	Undetermined
16PL170	Sarah Plantation (late 19th to early 20th century)	3 loci ineligible, remainder is undetermined
Dobard Cemetery	Cemetery	Unknown/Undetermined
NOAA Enc Obstruction	Mississippi River obstruction	Unknown/Undetermined

Source: Louisiana Division of Archaeology 2019b.

14.4 PENDING INVESTIGATIONS AND COMPLIANCE

A Phase I cultural resources survey should be conducted to locate and define the boundary of archaeological sites within the proposed construction APE and operations APE to evaluate cultural resources for eligibility for listing in the NRHP.

A non-archaeological historic resources survey should also be performed, at minimum, within and adjacent to the proposed construction APE to identify, evaluate, and document buildings, structures, objects, and districts 50-years-old or older in accordance with the provisions of the Secretary of the Interior's Standards for the Identification, Evaluation and Documentation (48 FR Parts 4471 6-42) and the Louisiana DHP's Louisiana Historic Resource Inventory Guidelines for determining the presence of and documenting historic-age properties.

15.0 LAND USE AND LAND COVER

15.1 INTRODUCTION

The following is a description of the general land use types in the project area which includes the Breton Sound Basin and the proposed project construction footprint.

15.2 HISTORICAL LAND COVER

Plaquemines Parish was established in 1807 and is the largest parish in the state, in terms of area (Carmon 2017, University of Washington Department of Urban Planning and Design 2006). Storm events in the first 30 years of the 20th century and more recently (2005 and 2011) have destroyed infrastructure and inundated uplands.

Largely surrounded by water and marshland, St. Bernard Parish was also established in 1807 and includes 465 square miles of land. Hurricane Katrina damaged virtually every structure in St. Bernard Parish and dislocated nearly its entire population of approximately 67,000 people.

15.3 EXISTING LAND USE/LAND COVER

The Breton Sound Basin occupies approximately 381,600 acres. The dominant land use type within the Breton Sound Basin is emergent herbaceous wetlands (188,657 acres) followed by open water (169,648 acres) (Figure 15.3-1). Figure 15.3-2 shows land uses within the project footprint. Table 15.3-1 summarizes the acreages of each land use type within the Project Area and is based on the 2011 National Land Cover Dataset (NLCD) (Multi-Resolution Land Characteristics Consortium [MLCC] 2011). The definitions of each land use type are as follows:

- Open Water -waterbodies, such as streams, lakes, and ponds, which are generally void of vegetation and soil;
- Wetlands - areas that are saturated with or covered by water, and include emergent herbaceous and woody wetlands;
- Agricultural - cultivated crop land that may be actively tilled or fallow and includes orchards and vineyards, as well as active hayfields and grazing/pasture land;
- Developed - areas that are generally void of vegetation and include barren land, developed open space, as well as low, medium, and high intensity developed lands;
- Barren Land - areas of rock, sand, clay, and other earthen material;
- Shrub/Scrub Land – areas dominated by shrubs (< 5 m tall); and
- Forest Land - deciduous, evergreen, and mixed forest.

The NLCD does not include a residential land use category; however, residential areas have been identified within the project area and are discussed below. The proposed diversion structure would discharge into the outfall area.

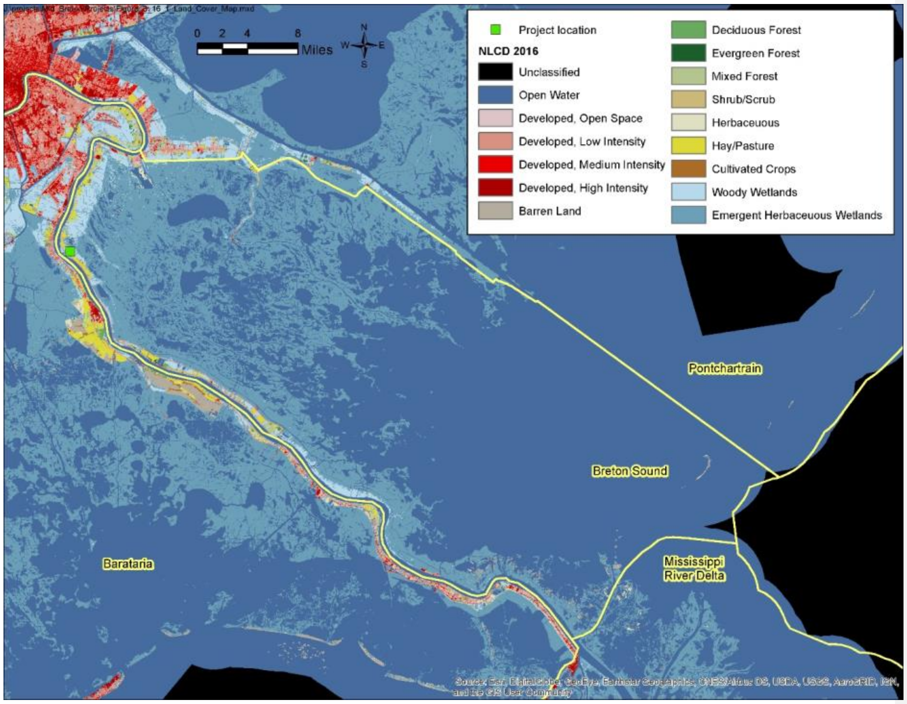


Figure 15-3.1 Existing Land Use in the Breton Sound Basin.

Source: 2011 National Land Cover Dataset (NLCD)

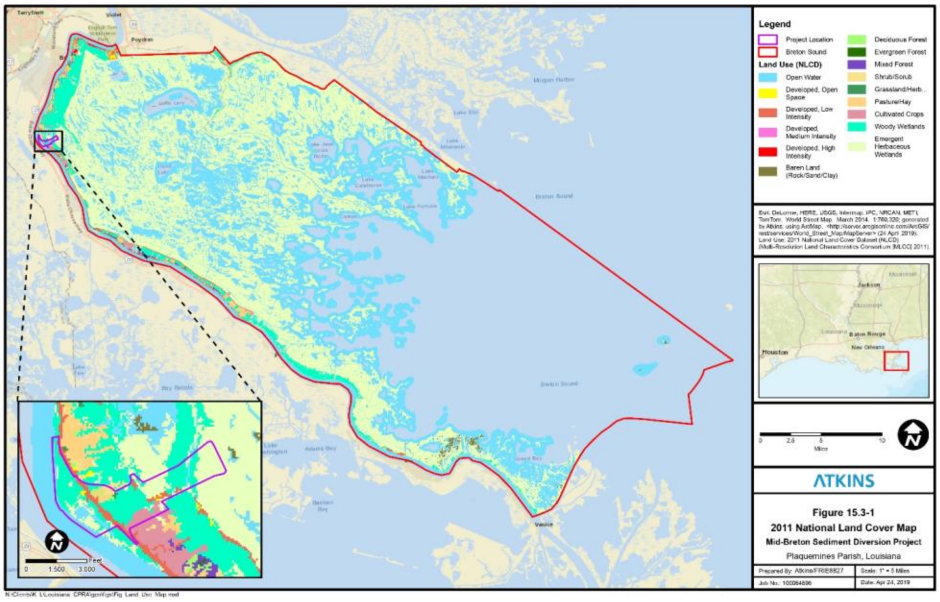


Figure 15.3-2 Land Use within the Project Footprint.

Source: 2011 National Land Cover Dataset (NLCD)

Table 15.3-1: Land Use Types within Breton Sound Basin and Proposed Project Construction Footprint

Land Use Type	Breton Sound Basin (acres)	Proposed Construction Footprint (acres)
Open Water	169,648	35
Developed, Open Space	643	2
Developed, Low Intensity	2,492	34
Developed, Medium Intensity	188	--
Developed, High Intensity	137	--
Barren Land	1,545	--
Deciduous Forest	271	4
Evergreen Forest	112	--
Mixed Forest	695	--
Shrub/Scrub Land	514	4
Grassland/Herbaceous	296	1
Pasture/Hay	1,556	8
Cultivated Crops	905	22
Woody Wetlands	13,941	169
Emergent Herbaceous Wetlands	188,657	108
TOTAL	**381,600**	**387**

15.3.1 Zoning

All of the parishes in Louisiana manage land use and development through zoning ordinances and established comprehensive management plans. Since the proposed diversion structure would be located in Plaquemines Parish, the discussion that follows focuses on the current and future land use within Plaquemines Parish.

Plaquemines Parish utilizes 19 zoning districts to regulate development and land use including: 10 residential districts (including single, two, and multiple family, and mobile home park), one medical service district, five commercial/industrial districts, two rural or agricultural districts, and one floodplain district. The floodplain district is intended to comprise those areas which are subject to periodic or occasional inundation from stream overflows, storms, and tidal conditions and which are not within publicly owned hurricane protection levees and pump drainage systems. Existing zoning for areas near the proposed diversion site include: small community mixed use; transportation, communication and utilities; and agricultural (Plaquemines Parish, 2012). Public Lands

One National Wildlife Refuge (NWR) and one Wildlife Management Area (WMA) occur within the project area, but no public lands are located within or near the proposed project construction footprint.

15.3.1.1 National Wildlife Refuges and Wildlife Management Areas

Located in the Bird's Foot Delta, the Delta NWR comprises approximately 48,800 acres of marsh and open water in Plaquemines Parish within the Mississippi River Delta Basin. The Delta NWR, managed by the USFWS, was established in 1935 under the authority of the Migratory Bird Conservation Act to provide sanctuary and habitat for wintering waterfowl. According to the refuge's 2008 Comprehensive Conservation Plan, management objectives for the Delta NWR also include protecting endangered and threatened coastal fish and wildlife species, providing quality outdoor recreation opportunities for visitors, and managing, restoring, and conserving marshland and coastal wetland habitat (USFWS 2008). Access to the NWR requires crossing and navigating the Mississippi River by boat (USFWS 2018b).

Pass A Loutre WMA comprised of approximately 115,000 acres is also located in Plaquemines Parish the Mississippi River Delta Basin. This WMA allows fishing and hunting on a restricted basis.

15.3.1.2 National and State Parks

There are no national or state parks within the proposed project construction footprint in Plaquemines Parish.

15.4 FUTURE LAND USE

State and local governments have developed comprehensive management plans to help guide development in coastal Louisiana as described below.

15.4.1 Comprehensive Master Plans

According to Louisiana's CMP (2017), over 1.1 million acres of coastal land were lost between 1932 and 2010, with 16.7 percent of this loss occurring over a four-year period (2004 to 2008) due to hurricanes (CPRA 2017). Other factors contributing to land loss identified in the

2017 CMP include "…climate change, sea-level rise, subsidence, storm surges, flooding, disconnecting the Mississippi River from coastal marshes and human impacts." Therefore, state efforts are focused on projects that would aid in maintaining the coastline that exists and restoring lost resources in order to protect communities and infrastructure and maintain current land use and natural resources. The 2017 CMP serves as the state's blueprint for guiding coastal restoration and flood protection activities over the next 50 years. The restoration and flood protection projects in the CMP were selected based on extensive technical analysis, and after a transparent public vetting process and approval by the Louisiana State Legislature.

The Plaquemines Parish Comprehensive Master Plan, adopted in 2003 and updated in 2012, is focused on recovery and prosperity though the year 2030, with a core goal of improving the quality of life for residents. The plan includes an analysis of a variety of planning elements, such as population, economic development, multi-modal transportation systems, coastal protection, drainage and stormwater management, public facilities and services, water and wastewater systems, land use, and government structure that will influence and inform future development throughout the parish. Like the 2017 CMP, the parish's plan identifies the redistribution of sediment from the Mississippi River as a priority but identifies dredging rather than diversion projects as the method of transport.

16.0 AESTHETICS AND VISUAL RESOURCES

16.1 INTRODUCTION

This section provides a general description of the environment related to aesthetic and visual resources. Visual resources refer to all landscape features in an area that affect the visual appeal of the area. These landscape features include both natural and anthropogenic resources, including buildings/structures, vegetation, water bodies, topographic features, etc. This section describes the visual resources located within the proposed project construction footprint and the greater project area, including the Mississippi River and the Breton Sound Basin.

16.2 EXISTING ENVIRONMENT

The proposed project construction footprint is located on the east bank of the Mississippi River at approximately RM 68.8 AHP. The footprint includes (from west to east) the Mississippi River and batture, the Mississippi River and MR&T levee, LA HWY 39, agricultural and residential areas, forested/scrub areas, a non-federal hurricane protection levee, scrub/shrub wetlands, and fresh/intermediate marsh. There are no federal or state lands, scenic rivers, or publicly significant visual features in the proposed project construction footprint. There are also no public use areas such as marinas or recreation areas.

The larger project area includes the Mississippi River, the Breton Sound Basin, and the Mississippi River Delta Basin. The Breton Sound Basin includes fresh, intermediate, brackish and saline marsh types, with a general gradient of fresh to saline wetlands from northwest to southeast. These wetlands are interspersed with bayous, ridges, man-made canals, open water areas and SAV. The Mississippi River Delta Basin is comprised almost entirely of fresh and intermediate marsh. Habitat types are described more thoroughly in Sections 5.0 (Wetland Resources and Waters of the U.S. and 8.0 (Terrestrial Wildlife and Habitat) of this report.

16.2.1 Potential Visual Receptors

Within the proposed project construction footprint, the best vantage points for viewing the aesthetic qualities of the area are the Mississippi River and MR&T levee and the non-federal hurricane protection levee. The area is generally very flat, and these levees represent the highest points of elevation in the viewshed. From the Mississippi River and MR&T levee, the river side viewshed is comprised of batture forest. The batture area is the alluvial land between the low tide of the river and the levee and is generally comprised of flood-tolerant bottomland hardwood species. This batture area obscures a direct view of the Mississippi River and its associated vessel traffic. An eastward view from the MR&T levee includes rural and agricultural settings. The area includes very little development and no industrialization.

From the non-federal hurricane protection levee, the viewshed includes the wetlands and open water areas of the Breton Sound Basin. The best option for viewing the aesthetic resources of the Breton Sound Basin and the Mississippi River Delta Basin is by boat. There is no public boat access to Breton Sound Basin in the vicinity of the proposed project construction footprint. The closest public boat launch access to the Breton Sound Basin is the Pointe a la Hache marina approximately 15 miles south of the proposed project construction footprint. Another popular option for accessing the Breton Sound Basin are several public boat launches in the town of Delacroix, located east of the proposed project construction footprint on LA HWY 300. The Mississippi River Delta Basin, which includes the Delta NWR and the Pass a Loutre WMA, can be accessed from numerous public launches south of the proposed project construction footprint. Boat launches and other areas for public access are described in more detail in Section 17.0 (Recreation and Tourism).

17.0 PUBLIC HEALTH AND SAFETY, INCLUDING FLOOD RISK REDUCTION AND SHORELINE PROTECTION

17.1 INTRODUCTION

This section provides an overview of public health and safety throughout the project area (Breton Sound Basin and greater New Orleans area) and characterizes the potential hazards to public health and safety within the vicinity of the proposed project construction footprint, as well as measures taken to mitigate against these hazards. Other sections of this report that are related to public health and safety include water quality, noise, air quality, and hazardous materials. Because these are covered in other sections, they are not discussed further here.

17.2 STATE DATA ON PUBLIC HEALTH AND SAFETY

The Louisiana Department of Health and Hospitals (LDHH) compiles data and information on the health of state residents. They maintain information relating to all aspects of public health, including births, deaths, diseases, access to health care, etc. Similarly, the Louisiana Department of Environmental Quality (LDEQ), is charged with emergency response and maintaining information about other aspects of public health, including environmental hazards, pollutants, water quality, and air quality.

17.3 RISKS TO PUBLIC HEALTH AND SAFETY

17.3.1 Severe Storm Events

One of the greatest risks to public health and safety to workers and residents within the project area stems from severe weather events, primarily hurricanes and other tropical storms. The topography of the project area is such that severe storm events frequently result in flooding, structural damage, and public safety concerns. Populated places within the project area, such as New Orleans, are almost all contained within the levee systems to protect against the potential damage from such events.

The project area and southeast Louisiana in general have experienced numerous hurricanes and tropical storms According to the National Centers for Environmental Information Storm Events Database, Plaquemines Parish has experienced 17 hurricanes and 32 tropical storms between 1998 and 2019 (NOAA, 2019). The most well-known, and likely the most destructive, was Hurricane Katrina. In 2005, Katrina produced 10–20-foot storm surge levels in southeast Louisiana (NOAA 2018), causing catastrophic damage. Approximately 1,200 deaths occurred as a result of this storm in Louisiana and Mississippi. Infrastructure damage in Louisiana and Mississippi was estimated to be $75 billion, making this the costliest storm in U.S. history (NOAA 2018). Storm surge from Hurricane Isaac in 2012 inundated parts of Plaquemines and St. Bernard Parish outside of the HSDRSS with 8–17 feet of water above ground level. This storm surge overtopped the non-federal levee in northern Breton Sound Basin, and flooded an 18-mile stretch between the non-federal levee and the Mississippi River and Tributaries levee, including the community of Braithwaite (Berg 2013) and the Stolthaven New Orleans petroleum and chemical storage facility (Berg 2013). The flooding of the Stolthaven facility resulted in the release of an unknown quantity of toxic chemicals.

The Breton Sound Basin has suffered substantial wetland loss due to natural and anthropogenic processes. This wetland loss translates to less natural protection from future storms. The elimination of natural depositional processes due to the Mississippi River levee system has resulted in wetlands that are less able to maintain elevation relative to sea level rise. This results in marshes that are submerged more frequently and are more vulnerable to loss. The addition of saline water to a naturally fresh marsh system through the dredging of canals has further weakened the marshes of the Breton Sound Basin. These wetlands that were once resilient and able to withstand the impacts of large storms are less able to do so in their less resilient condition. A study of the effects of recent storm events showed that Hurricane Katrina resulted in over 11% new water areas (Palaseanu-Lovejoy et al. 2012). Figure 17.3-1 shows the extensive losses that occurred during Hurricane Katrina. This loss was largely due to the shearing of weakened marsh platforms and transfer of this material to other areas. In Figure 15.3-1, this effect is apparent. The areas in bright blue represent new open water areas after Katrina while the red areas are primarily the places where this sheared material was placed by the storm. This reduction in marsh area then further reduces the wetlands available to combat storm surge in the future, leaving populated areas more at risk.

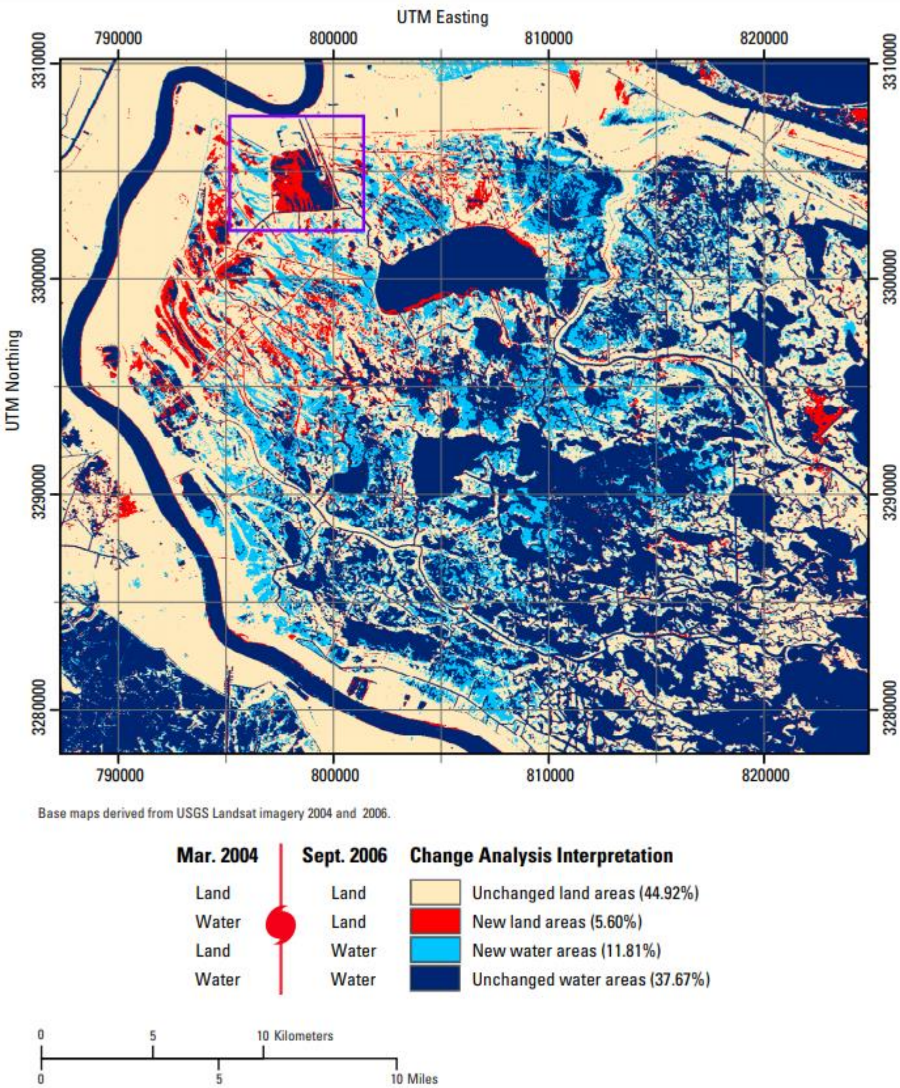


Figure 17.3-1: Land change analysis map 2004–2006 (Palaseanu-Lovejoy et al. 2012)

17.4 RISK REDUCTION MEASURES

Within the project area, natural barriers to damaging winds and storm surge that frequently occur with tropical events are limited. Unlike other parts of coastal Louisiana, the

Breton Sound Basin does not have a series of barrier islands to serve as a first line of defense against storms. The natural barriers contained in the Breton Sound Basin are limited to marsh and remnant ridge features. As mentioned in 15.3.1, marshes in the Breton Sound Basin provide some natural protection but have been weakened by anthropogenic and natural causes.

Extensive levee systems and hurricane protection features exist within the project area (Figure 17.4-1). In 2005 after Hurricanes Katrina and Rita, the USACE began construction of the HSDRRS to strengthen flood and storm surge protection infrastructure in Jefferson, Orleans, St. Bernard, and Plaquemines Parishes (USACE 2018). The HSDRRS infrastructure was engineered to reduce risks from a 100-year storm event and includes 350 miles of levees and floodwalls (USACE 2018).

The HSDRSS components near the project area include a portion of the Lake Pontchartrain and Vicinity system that protects areas of St. Bernard and Plaquemines parishes. These hurricane protection features are managed by the Lake Borgne Levee District and form the northern boundary of the Breton Sound Basin. In addition to this, there are non-federal levee systems in Plaquemines Parish that, when combined with the Mississippi River levee and MR&T levee, reduce flood risk to communities along the Mississippi River. These levees, along with pump stations, help to mitigate against flooding impacts.

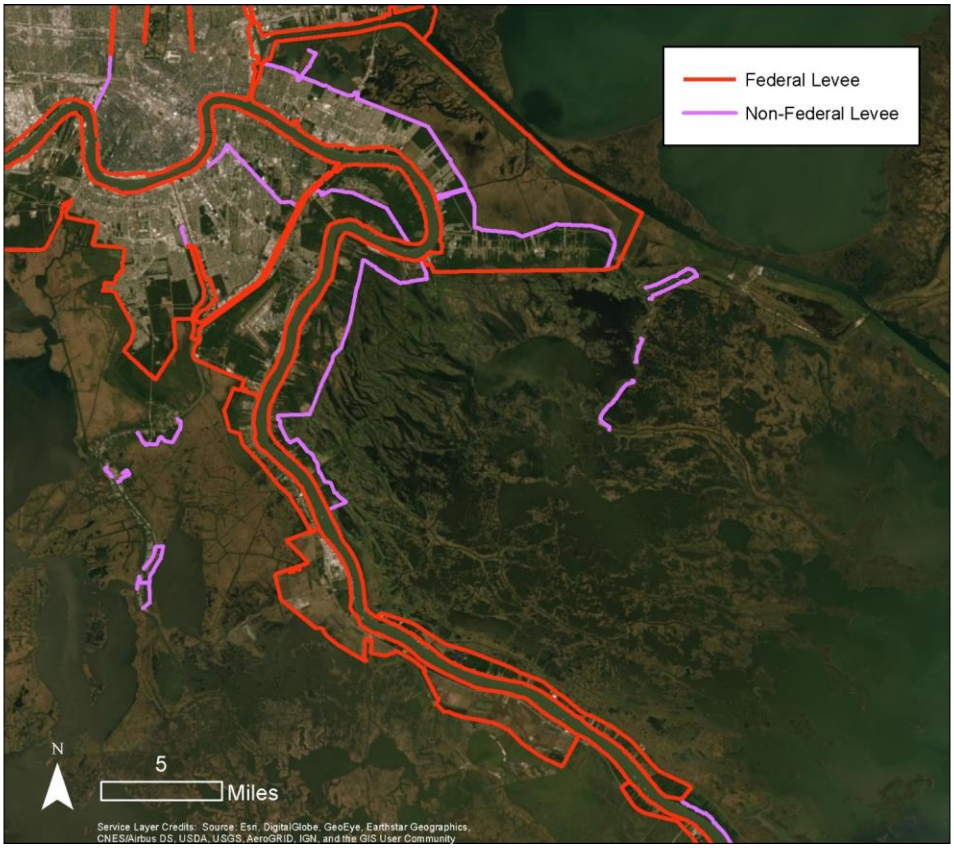


Figure 17.4-1: Federal (red) and Non-Federal (purple) levee systems within the project area. Note: What appears as a non-federal levee south of the federal levee at the bottom of the image is not a levee but a concrete revetment to reduce scour on the river banks.

In addition to these structural protection features, CPRA's 2017 CMP puts a greater emphasis on other methods of flood risk reduction. These methods include nonstructural projects, increasing flood risk awareness, and supporting policies that promote greater resilience and more strategic development across the Louisiana coast. The 2017 CMP includes several nonstructural projects in Plaquemines and St. Bernard Parishes. These projects would provide funding for the elevation of homes and in some cases relocation if necessary.

In many major tropical events, evacuations are either recommended or mandated by local or state governments. Louisiana HWY s 39 and 46 form the major hurricane evacuation routes in the project area. LA HWY 39 extends along the east bank of the Mississippi River north to New Orleans and is the primary evacuation route for residents of eastern Plaquemines Parish. LA HWY 46 runs east-west from Hopedale to New Orleans and is the primary evacuation route for residents of St. Bernard Parish in the project area.

Hazardous material spill prevention and response is guided by the EPA. The EPA provides guidance on requirements for the prevention, control, and response to oil spills (40 CFR 112). The EPA's Facility Response Plan rule requires that certain facilities maintain a plan for responding to a worst-case release of oil into the environment (40 CFR 112.20). Facilities that implement the EPA's guidelines of oil pollution prevention are better prepared for spill events when they occur.

18.0 NAVIGATION

18.1 INTRODUCTION

This section describes the commercial and recreational navigation in the Mississippi River and Breton Sound Basin. The Lower Mississippi River is the nation's busiest waterway, with shipments from thousands of ports received and distributed through the network of connected waterborne commerce pathways (USACE 2018a).

18.2 COMMERCIAL NAVIGATION

The Mississippi River is the major navigable waterway in the vicinity of the proposed diversion location, where deep and shallow draft commercial vessel traffic is heavy. The Breton Sound Basin mostly supports shallow draft recreational and commercial fishing vessels and oil and gas maintenance vessels.

18.2.1 Mississippi River

The Lower Mississippi River consists of the segment that extends from Cairo, Illinois to the Gulf of Mexico. The deep-draft portion of the Lower Mississippi River begins at Baton Rouge, Louisiana (RM 232.4 AHP) and extends to the Gulf, where the navigation channel is maintained to a depth of 45 feet (USACE 2018a), although authorized to a depth of 55 feet by the Supplemental Appropriations Act of 1985 (PL 99-88) and the 1986 Water Resources Development Act (WRDA) (PL 99-662). Maintaining the river at this depth requires significant maintenance dredging (Table 18.2-1). The area that requires the most maintenance dredging occurs at the mouth of the river (Figure 18.2-1). Between Venice and the Gulf of Mexico (RM 13.0 AHP to RM 22.0 BHP) requires on average over 40 million cubic yards (mcy) of maintenance dredging annually (USACE 2018b).

The current maintained depth of 45 feet requires some bulk carrier vessels to light load cargo in order to navigate the Mississippi River. Because of this, USACE conducted a reevaluation study of deepening the channel to 50 feet in 2016 (USACE 2016b). The study limited the investigation to a maximum depth of 50 feet at the request of the local sponsor, LADOTD. In this study, USACE investigated depths between 45 and 50 feet. The TSP was the deepening of the navigation channel from 45 to 50 feet from RM 13.4 AHP to RM 22 BHP. In 2018, USACE Director of Civil Works James Dalton signed the Director's Report, authorizing the increased channel maintenance depth. This increase could occur as early as late 2019.

Table 18.2-1
Average Annual Maintenance Dredging Requirements in the Mississippi River below Baton Rouge

River Segment	RM Range	Average Annual Maintenance Dredging
Baton Rouge to New Orleans	RM 232.4 AHP to RM 115.0 AHP	19 mcy
New Orleans Harbor	RM 114.9 AHP to RM 80.2 AHP	0.7 mcy
New Orleans to Venice	RM 80.1 AHP to RM 13.1 AHP	0 mcy
Venice to the Gulf	RM 13.0 AHP to RM 22.0 BHP	42.3 mcy

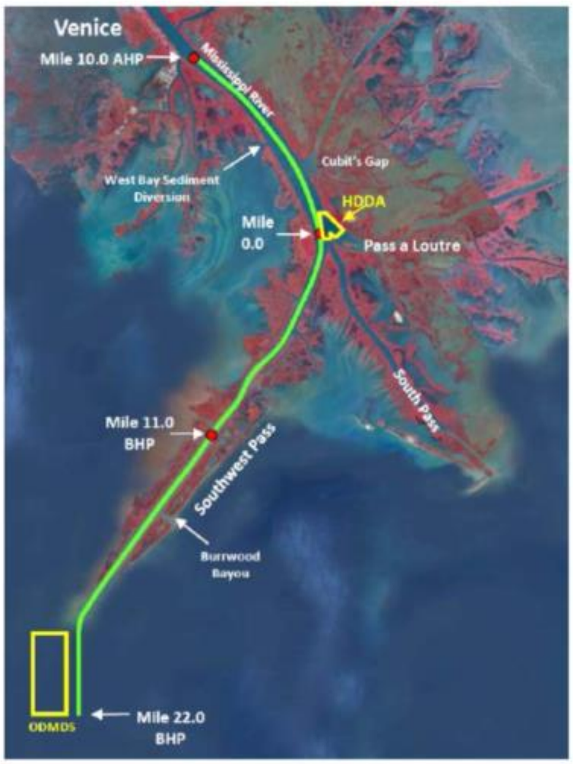


Figure 18.2-1: Area of the Lower Mississippi River requiring high levels of maintenance dredging, including approved disposal areas (USACE 2016)

To the greatest extent possible, the USACE utilizes beneficial use to dispose of dredge material in the Mississippi River Delta. Large portions of this area are approved for sediment disposal (Figure 18.2-2). Both the Delta NWR and Pass a Loutre WMA are located in the vicinity of active dredging and are frequently the recipients of this beneficially used dredge material (USACE 2016). West Bay is another frequently used beneficial use disposal area. A large-scale sediment diversion project exists to divert sediment, water, and nutrients into the West Bay receiving area. This project was constructed by USACE under the CWPPRA program in 2003.

The combination of beneficially placed sediment and the reestablishment of deltaic processes in the area have led to a substantial increase in subaerial land.

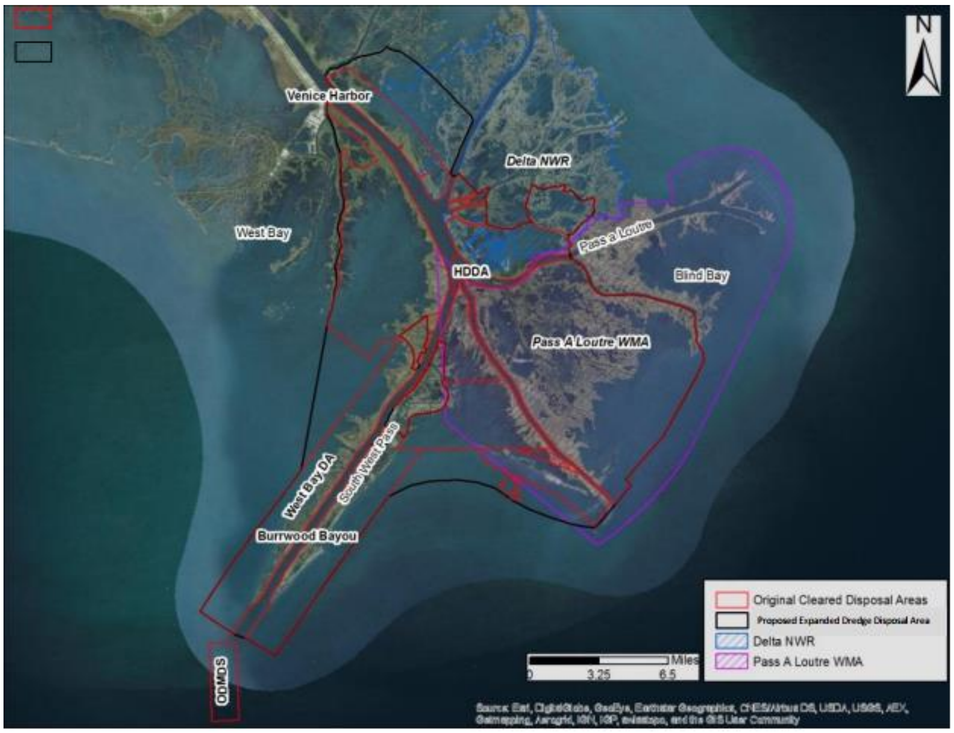


Figure 18.2-2: Approved dredge material disposal areas in relation to public lands (USACE 2016)

The proposed project is located on the east bank of the river at RM 68.6 AHP, in an area of the river known as Jesuit Bend. There is no existing industry near the proposed diversion intake structure. Near the proposed project, the federal navigation channel is located on the opposite side of the river. Traffic in this part of the river is mixed between deep and shallow-draft vessels Table 18.2-2). Deep-draft vessels are confined to the navigation channel, but shallow-draft vessels can utilize the entire river and therefore are more likely to be in close proximity to the proposed diversion location. Just south of the proposed project is the Wills Point Anchorage area, extending from RM 66.5 AHP to RM 67.6 AHP (USACE 2015).

Table 18.2-2 Mississippi River Channel Vessel Transits, New Orleans to the Gulf					
Vessel Draft, feet	**2016**	**2015**	**2014**	**2013**	**2012**
Less than 14	121,021	207,932	185,440	208,505	229,970
Greater than 14	13,550	13,451	46,822	12,959	14,293
Total	134,571	221,383	232,262	221,464	244,263
Source: USACE 2018c. Notes: Transits include both upbound and downbound traffic.					

A mix of foreign and domestic cargo utilize the Mississippi River. In 2016, nearly 500 million tons of cargo was conveyed in the deep-draft area of the river between Head of Passes and Baton Rouge (WCUS 2018). Over half of this cargo is comprised of petroleum and farm commodities (WCUS 2018). In this stretch of the river, there are four deep-draft cargo ports: the Port of Baton Rouge; Port of South Louisiana; Port of New Orleans; and Port of Plaquemines (Figure 18.2-3). These four ports are among the largest in the United States (USACE 2018c).

Figure 18.2-3: Ports along the Mississippi River

Table 18.2-3
2017 Port Tonnage Statistics (tonnages presented in millions)

Port	National Tonnage Rank	Domestic Tons	Foreign Tons	Total Tons
Port of South Louisiana	1	140.2	134.9	275.1
Port of New Orleans	4	50.7	45.7	96.4
Port of Baton Rouge	8	45.7	31.3	77.0
Port of Plaquemines	12	31.4	23.1	54.5

Source: USACE 2018c

18.2.2 Mississippi River Gulf Outlet

The northeastern side of the Breton Sound Basin is bounded by the MRGO (Figure 18.2-4). The MRGO is a former federally maintained navigation channel that was closed in 2009 after 45 years of operation. The MRGO was originally created to provide a shortened shipping route between the Port of New Orleans and the Gulf of Mexico (USACE 2013). The 76-mile channel has been linked to the direct and indirect loss of over 50,000 acres of wetlands in the Breton Sound Basin and Pontchartrain Basin (USACE 2012). During Hurricane Katrina, the MRGO shoaled in to reduce the depth to 22 feet (channel previously maintained to a depth of 35 feet). Many residents of Orleans and St. Bernard parishes believe the MRGO increased flooding during Katrina by serving as a pathway for storm surge (USACE 2007). In 2008, Congress authorized the closure of the MRGO, which was accomplished in 2009 by constructing a rock dike across the MRGO just south of its intersection with Bayou la Loutre (USACE 2012).

Figure 18.2-4: The MRGO and closure structure

18.2.3 Baptiste Collette Bayou

Baptiste Collette Bayou is a distributary of the Mississippi River that was federally authorized as a navigation channel by the Rivers and Harbors Act of 1968 (Figure 18.2-5). The channel was authorized to -14 feet Mean Low Gulf (MLG) with a bottom width of 150 feet; where the channel entered Breton Sound Basin, it was authorized at -16 feet MLG and 250 feet wide (USACE 2017). Plaquemines Parish Government completed a feasibility study in 2016 for the deepening and widening of Baptiste Collette Bayou. The purpose of the study was to investigate the economic benefits to the oil and gas industry and the Port of Venice/Plaquemines Parish. At this time the authorized dimensions have not changed.

Figure 18.2-5: Baptiste Collette Bayou

18.2.4 Local Channels and Waterways in the Breton Sound Basin

There are no federally maintained navigation channels or waterways within the Breton Sound Basin. The waterways located in the Basin are generally small, shallow bayous and canals dredged for the oil and gas industry. Bayou Terre Aux Boeufs in the Delacroix area is used by commercial fishermen (primarily crabs, oysters and shrimp) and has small facilities for seafood processing. West of the MRGO, Bayou la Loutre forms the boundary between the Breton Sound Basin and Pontchartrain Basin. The communities of Hopedale and Yscloskey are on the Pontchartrain Basin side of this boundary, but Bayou la Loutre serves as an important access point to the Breton Sound Basin for these communities.

18.3 RECREATIONAL NAVIGATION TRAFFIC

Recreational boating is common throughout much of the Breton Sound Basin. Canals and waterways commonly used by recreators near the prosed diversion site are shown in Figure 18.3-1 and include Reggio Canal, Manuel Canal, River aux Chenes and Bayou Terre aux Boeufs. Recreational boat use in the Mississippi River and Breton Sound Basin is estimated by the number of registered vessels and fishing licenses within the project area. Section 17.0

(Recreation and Tourism) provides more detailed information on recreational boating and fishing.

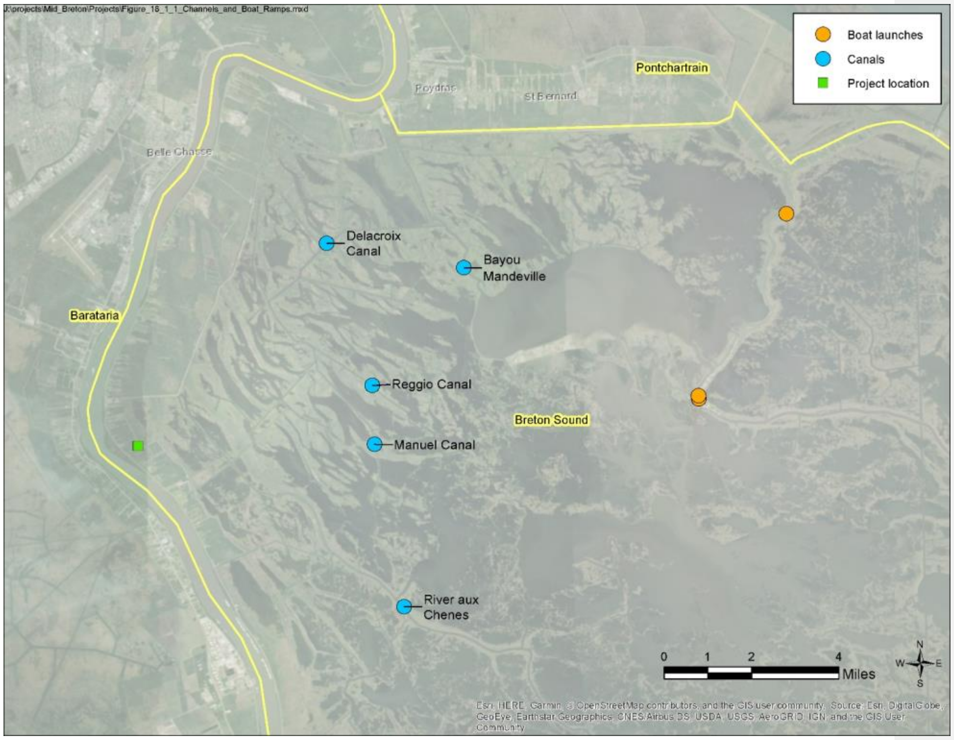


Figure 18.3-1 Canals used for Recreation Near the Project Site

18.3.1 Motorboat Registrations

Section 17.6 provides information on motorboat registrations for Plaquemines and St. Bernard parishes, the two parishes included in the project area. For the period 1988-2011, a total of 205,729 motorboats were registered in the two parishes, an average of 8,572 registrations per year. Motorboat registrations remained stable in Plaquemines Parish between 200 and 2011. In St. Bernard Parish, however, registrations decreased by approximately half in this period.

19.0 RECREATION AND TOURISM

19.1 INTRODUCTION

The project Study Area for recreation and tourism includes both Plaquemines and St. Bernard parishes. The varied landscape and waterways in the two-parish Study Area support a wide range of activities for outdoor recreationalists and tourists living in the region as well as for visitors coming from New Orleans and other locations. Recreational activities include fishing, hunting, wildlife watching, and boating. This section describes the recreational resources within the Study Area, including an overview of the regulatory environment and trends in recent activity levels. Where available, recreation data presented in this section are derived from site-specific data; parish-level data are used when site-specific data are not available.

19.2 RECREATION SITES

The Study Area includes a wide variety of recreation sites, including protected or designated lands (referred to as recreation areas), public fishing access points, boat launches, marinas, and hunting areas (see Figure 19.2-1). Tables 19.2-1 and 19.2-2 provide descriptions of the recreational lands and facilities in the Study Area. While recreation may occur on private and other lands outside of the Study Area identified on the map and in the tables, the map highlights those areas designed to provide outdoor recreational opportunities for the public. See Section 13 for information regarding commercial fishing areas, including oyster grounds, in the Study Area.

Recreational fishing in the Study Area includes fishing for oysters, shrimp, crab, crawfish, and various finfish species. Popular inshore salt water finfish species include red drum (red fish) and seatrout (weakfish) (USDOI 2013). Freshwater systems such as ponds, lakes, canals, and marshes host freshwater finfish species for recreational fishing, including sunfish, bass, and catfish.

The Study Area contains many sites accessible for fishing, including 18 with boat ramps. Of the 18 sites with boat ramps, seven are located on the east side of the Mississippi River and 11 sites with boat ramps on the west side of the Mississippi River. In addition, there are two Wildlife Management Areas (WMAs) and two National Wildlife Refuges (NWRs) with restricted fishing, one state park, and one National Historical Park and Preserve (Table 19.2-2).

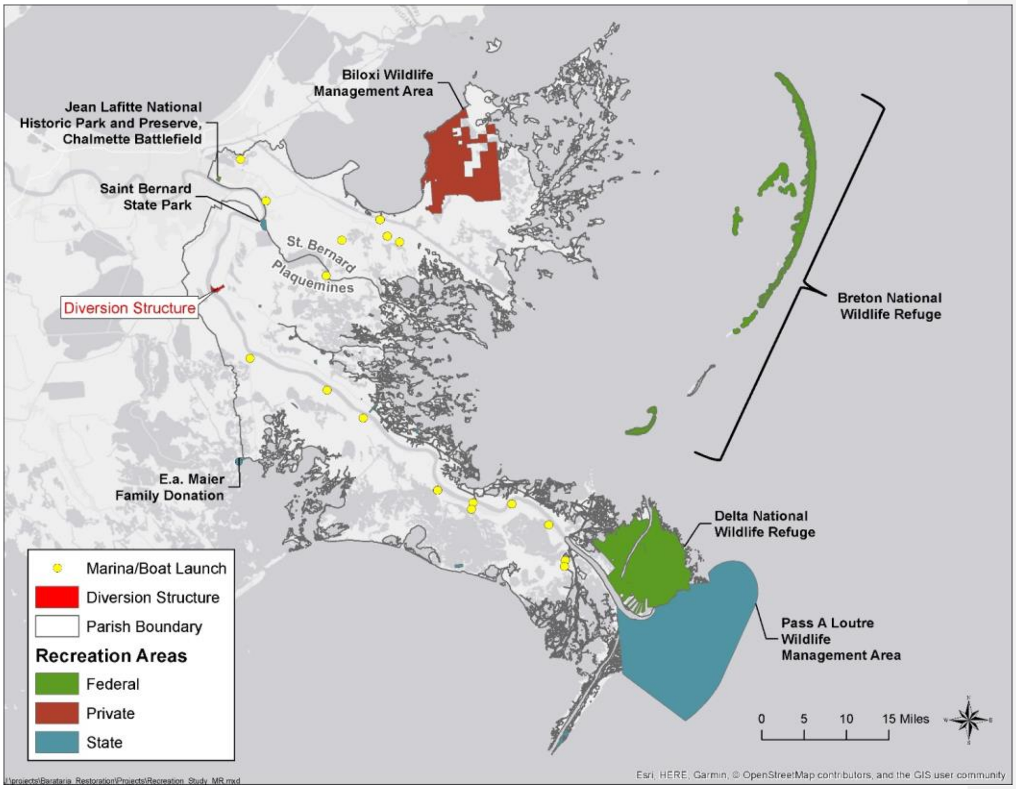


Figure 19.2-1. Map of Recreation Resources in the Two-Parish Study Area.

Table 19.2-1
Recreational Areas in the Study Area

Managing Agency	Site Name	Parish	Facilities/Activities Description	Annual Visitation	Size (acres[a])
Federal					
U.S. Fish & Wildlife Service	Delta National Wildlife Refuge	Plaquemines	Boating, restricted fishing, hunting, wildlife watching	9,000	50,000
U.S. Fish & Wildlife Service	Breton National Wildlife Refuge	St. Bernard	Boating, restricted fishing, wildlife watching	3,000	1,100
National Park Service	Chalmette Battlefield (part of Jean Lafitte National Historic Park and Preserve)	St. Bernard	Historic sites, battlefield, educational activities	50,000 - 65,000	143
State					
LDWF	Pass-a-Loutre Wildlife Management Area	Plaquemines	Restricted fishing, boat ramps, restricted hunting	N/A	115,000
LDWF	Biloxi Wildlife Management Area	St. Bernard	Restricted fishing, boat ramps, restricted hunting	N/A	115,000
Louisiana Department of Culture, Recreation and Tourism	St. Bernard State Park	St. Bernard	No boat ramps, pool on site as well as campgrounds and nature trail	60,000	358

Sources: LDWF 2018a; National Park Service 2011; Louisiana Department of Culture, Recreation and Tourism 2016.

Table 19.2-2
Recreational Fishing and Boating Access Facilities in the Study Area

Site Name	Waterbody	Closest Town	Facilities / Activities Description
Plaquemines Parish			
West of the Mississippi River, Plaquemines Parish			
Delta Marina	Adam's Bay	Empire	Marina and boat ramp
Joshua's Marina	Bay Pomme D'or	Buras	Marina and boat ramp
Bayou Log Cabins	Lake Judge Perez	Lake Hermitage	Boat ramp
Riverside Marina	Mississippi River	Buras	Boat ramp
Myrtle Grove Marina	Mississippi River	Myrtle Grove	Marina and 2 boat ramps
Happy Jack's Marina	Mississippi River	Port Sulphur	Boat ramp
Fort Jackson	Mississippi River	Venice	Boat ramp
Cypress Cove Marina	West Bay	Venice	Marina and 2 boat ramps
Venice Marina	West Bay	Venice	Marina and 3 boat ramps
Yellow Cotton Marina	Yellow Cotton Bay	Yellow Cotton	2 boat ramps
West Pointe a la Hache Marina	Grand Bayou	Pointe a la Hache	Boat ramp
East Side of Mississippi River, St. Bernard Parish			
Hopedale Marina	Bayou la Loutre	Hopedale	Marina and boat ramp
Serigne's Boat Launch	Bayou Terre aux Beoufs	Delacroix	Multiple boat ramps
Delacroix Pier and Boat Launch	Bayou Terre aux Beoufs	Delacroix	Boat launch, fishing pier, and
De Pope's Boat Launch	Violet Canal	Chalmette	Boat ramp
Reggio Marina	Reggio Canal	Reggio	Multiple boat ramps and launches
Campo's Marina	Mississippi River Gulf Outlet	Shell Beach	Marina and boat ramp
Pip's Launch	Bayou la Loutre	Hopedale	Boat ramp
Gulf Outlet Marina Boat Launch	Lake Borgne	Chalmette	Marina and boat ramp

Table 19.2-2
Recreational Fishing and Boating Access Facilities in the Study Area

Site Name	Waterbody	Closest Town	Facilities / Activities Description
Sources: NOAA, Gulf of Mexico Data Atlas, 2013			

19.3 RECREATIONAL FISHING

19.3.1 Regulatory Environment

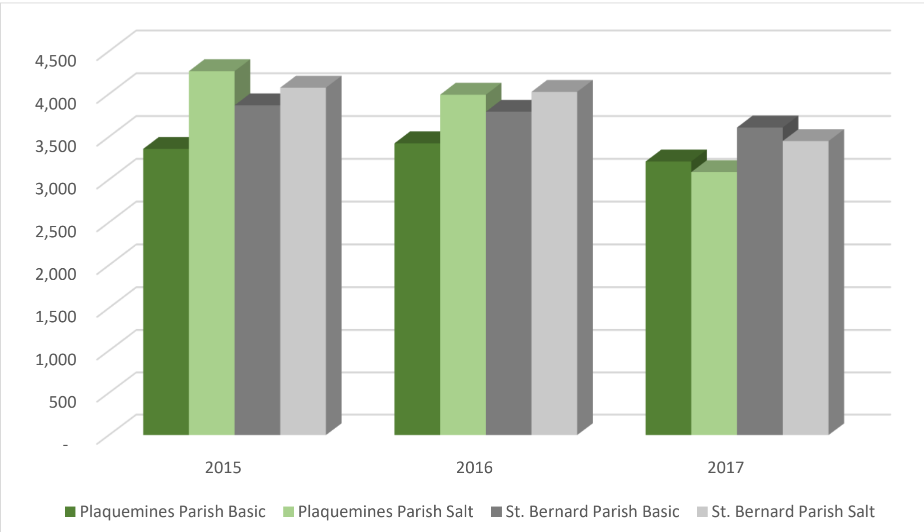
Regulations governing fishing are discussed in Section 13.0 Commercial Fishing. Fishing on LDWF-administered lands, such as WMAs, wildlife refuges, and habitat conservation areas, requires a license. Regulations are specific to each area. The Study Area completely or partially includes two LDWF-administered lands: Pass-a-Loutre WMA and Biloxi Wildlife Management Area. Federally managed lands such as the Breton and Delta NWRs maintain additional fishing regulations; both wildlife areas require compliance with LDWF fishing regulations in addition to area-specific locations, season, and time restrictions (USFWS 2018a).

19.3.2 Participation in Recreational Fishing

LDWF license sales data from 2015 to 2017 provides a measure or proxy of potential participation in recreational fishing among those living in the Study Area and across the state (LDWF 2018c). It should be noted that people fishing in Plaquemines and St. Bernard parishes does not necessarily indicate that the fishing licenses were purchased in these parishes; fishing licenses can be purchased from anywhere in the state.

Salt water fishing license holders are also required to buy the basic fishing license, which enables the license holder to fish in both fresh water and salt water. Most of the licensed recreational anglers are engaged in salt water fishing activities. There are also a number of lifetime licenses that can be purchased. The LDWF data are provided for both residents and non-residents; in 2016 and 2015, resident license sales accounted for approximately 80% of total basic fishing license sales and 65 to 75% of salt water recreation fishing license sales The number of non-residential saltwater licenses sold in 2017 was 20,303 (LDWF 2018c). .

Basic recreational fishing license sales in 2017 in Plaquemines and St. Bernard parishes accounted for 1.3% of statewide basic fishing license sales, while salt water recreation fishing license sales in the two parishes accounted for 2.1% of state-wide salt water fishing license sales. Proximate parishes, specifically Jefferson and Lafourche, have considerably more recreation fishing license sales, approximately eight and four times higher sales, respectively, than in Plaquemines and St. Bernard parishes (LDWF 2018c), which is consistent with their relatively higher populations. In general, recreational salt water fishing licenses have declined in the Study Area, while basic license sales have remained relatively stable.

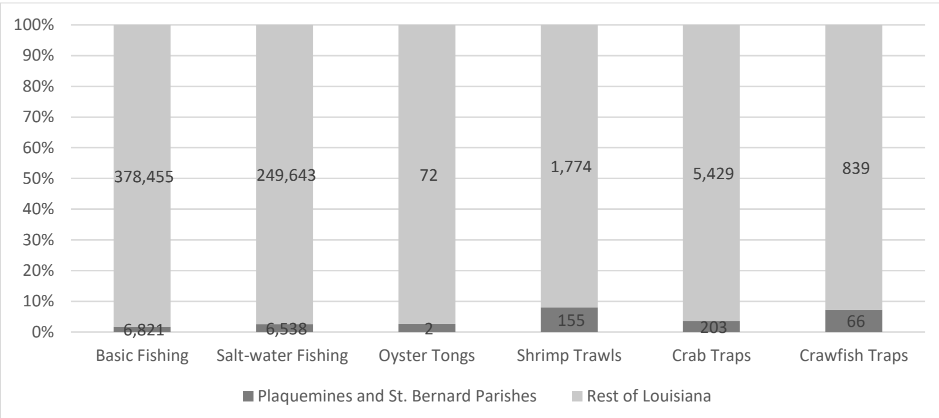


Source: LDWF 2018c

Figure 19.3-1. Annual saltwater and basic fishing license sales by parish for 2015, 2016, and 2017

Recreational fishing activities, including oystering, shrimping, and crabbing, occur in the Study Area, with shrimp trawling as the most prevalent type of license sold, accounting for 8.7% of shrimp trawling license sales in the state (see Figure 19.3-2). According to the 2016 Oyster Fisheries Management Plan, recreational oyster harvest likely accounts for less than 0.1% of the overall oyster harvest in Louisiana (Banks et al. 2016). The Study Area accounts for 2 and 3% of basic and salt water fishing licenses in the state, respectively. License sales for crab traps and crawfish traps account for 4 and 8% of these recreational license sales in the state, respectively.[13]

[13] Because finfish fishing does not require specific gear licenses, the LDWF license sales data cannot be used to quantitatively examine recreational fishing for finfish species in the Study Area.



Source: LDWF 2018c

Figure 19.3-2. Number of recreation license sales in the Study Area and state in 2017

NOAA's Marine Recreational Information Program (MRIP) provides information on recreational fishing in the Study Area. Table 19.3-1 summarizes the estimated number of recreational fishing trips in the two parishes between 2010 and 2016. As evidenced by these data, recreational fishing was low in 2010, likely due to area closures precluding recreational fishing following the DWH oil spill.

Table 19.3-1
MRIP Estimated Recreational Fishing Trips by Parish, 2010-2016[a]

Parish	2010	2011	2012	2013	2014	2015	2016	Annual Average
Plaquemines	310,189	569,549	297,765	418,570	348,963	309,847	351,780	372,381
St. Bernard	311,568	366,846	457,171	327,989	228,474	232,428	267,875	313,193

Source: NOAA NMFS 2017.
[a] The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends. Louisiana ceased participation in NOAA's MRIP as of January 1, 2014, potentially affecting 2014-2016 estimates. Values for 2017 and beyond are not available because MRIP survey has been discontinued.

In addition to license sales and fishing trip estimates, indicators of the importance of recreational fishing within the Study Area are available at the community level. NMFS has developed a suite of Fishing Engagement and Reliance Indices at the community level, which aim to capture the importance of recreational fishing to coastal communities (Jepson and Colburn 2014). Table 19.3-2 presents information on the two indices for the coastal communities that fall within the Study Area and are included in the dataset. It should be noted that the communities on the east bank of the Mississippi River south of the proposed Mid-Breton Sediment Diversion (Breton) and the communities within and north east of Breton Sound Basin are not included in the table due to lack of U.S. Census data for these communities. The indices include (Jepson and Colburn 2013):

- Recreational Fishing Engagement: absolute measure of the presence of recreational fishing activity based on estimated fishing trips from the MRIP site survey for recreational fishing. High rank indicates more engagement.
- Recreational Fishing Reliance: presence of recreational fishing in relation to the population of a community. High rank indicates increased reliance.

Table 19.3-2
Recreational Fishing Engagement and Reliance Indices by Coastal Community, 2014[a]

Coastal Community	Recreational Fishing Engagement	Recreational Fishing Reliance
Plaquemines Parish – West Bank of Mississippi River (all communities are south of Mid-Breton Sediment Diversion project except Belle Chasse)		
Belle Chasse	Low	Low
Boothville	Low	Low
Venice	High	High
Buras	Medium	Medium High
Empire	Medium	Medium High
Port Sulphur	Medium	Low
St. Bernard Parish – East Bank of Mississippi River (north of Mid-Breton Sediment Diversion)		
Chalmette	Medium	Low
Meraux	Low	Low
Violet	Low	Low

Source: NOAA. 2018. Recreational Fishing Engagement and Reliance Indices data for Louisiana Shoreline Communities for 2014. Provided via email dated April 12, 2018 from Michael Jepson, NOAA to IEc.

[a] High index indicates higher vulnerability.

19.3.3 Regional Impacts of Recreational Fishing Activities

The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation estimated that 825,000 individuals participated in 18 million days of recreational fishing activities in Louisiana in 2011 (including residents and non-residents). These anglers spent approximately

$1.0 billion on trip-related expenditures and equipment within the state. This equates to approximately $1,205 per angler including spending on fishing equipment, as well as approximately $38 per fishing day for trip-related expenses, such as boating costs, bait, food, and lodging (USDOI 2013).

NOAA Fisheries reported that there were 2.4 million angler trips in 2015 in the state of Louisiana. Regional economic models are tools that allow analysts to determine how a single stimulus, such as spending related to an angler trip, trigger additional spending between interrelated sectors in the regional economy. This is known as the “ripple effect” or “multiplier effect.” For example, NOAA Fisheries has estimated the economic impact of recreational fishing expenditures in Louisiana. Overall, at the state level, recreation fishing activities support $1.4 billion in economic activity, $508 million in income, and over 11,000 jobs in 2015 (NOAA Fisheries 2015).

19.4 RECREATIONAL BOATING ACTIVITIES

The Study Area provides recreational boaters ample opportunity to access Breton Sound Basin waters, as presented in Table 19.4-1. Recreational boating may include touring, fishing, watersports, and swimming, and includes for-hire charter boat fishing activities. LDWF requires that all motorboats operating in state waters must be registered with LDWF.

According to LDWF, all motorized vessels and watercraft that are used in Louisiana water must register with the state. Motorboat registrations by parish from 1988 to 2011 (including both commercial and recreational) are summarized in Table 19.4-1. The Study Area accounts for 3% of state average annual motorboat registrations. In addition, many other visitors with boats in other locations travel to recreate in the Study Area. From 1988to 2011, over 205,000 motorboats were registered with LDWF in Plaquemines and St. Bernard parishes, with an annual average of approximately 8,600 motorboat registrations (LDWF 2018c). As shown in Table 19.4-1, St. Bernard Parish has about 1,000 higher boat registrations than Plaquemines Parish on average over the 24-year period. In 2011, Plaquemines and St. Bernard parishes accounted for 3,937 and 2,702 registrations, respectively. Between 2000 and 2011, the number of motor boat registrations remained fairly stable in Plaquemines Parish, while the number of registrations in St. Bernard Parish declined by approximately 50% (LDWF 2018c).

Table 19.4-1
Motorboat Registrations by Parish, 1988-2011[a]

Parish	Average Annual	1988-2011 Total	Percent of Registrations in State
St. Bernard	4,772	114,532	2%
Plaquemines	3,800	91,197	1%
Two-Parish Total	**8,572**	**205,729**	3%
State Total	**314,255**	**7,542,119**	100%

Source: LDWF 2018c.

a. The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends. Annual averages were calculated over the years 1988-2011.

Another form of recreation in the Study Area is for-hire charter fishing. Charter fishing is a prevalent activity in Plaquemines and St. Bernard parishes. Notable communities in Plaquemines Parish where charter companies are located include Venice, Buras, Empire, and Pointe à la Hache. Notable communities in St. Bernard Parish where charter companies are located include St. Bernard, Delacroix, and Hopedale.

LDWF license statistics data provide estimates of charter fishing activity. Charter fishing licenses include a three-day charter passenger license, which permits license holders to salt water fish with a licensed guide in a charter vessel in state waters, and the three-day charter skiff license, which permits license holders to salt water fish in a licensed charter skiff under the direction of a charter operation, but not with a guide, in state waters (LDWF 2018b). According to the LDWF license statistics data, average annual number of charter fishing license sales between 2010 and 2017 were greater in Plaquemines Parish (426) than in St. Bernard Parish (77). The vast majority of these licenses sales are associated with three-day passenger charter licenses. There has been considerable variation in the annual number of license sales over time; for example, in 2017, there were 38 and 21 charter licenses sold in Plaquemines and St Bernard parishes, respectively, while in 2016, there were 31 and 17 sold (LDWF 2018c).

19.5 HUNTING

In 2011, there were a total of 277,000 hunters in Louisiana (both residents and non-residents above the age of 16) who spent a total of 5.2 million days hunting. Of these 277,000 hunters, 78% hunted game (for example deer, turkey), 34% hunted small game (for example squirrel, rabbits), and 40% hunted migratory birds (for example ducks, geese). Resident hunters accounted for 91% of all hunters in Louisiana in 2011 (USDOI 2013).

19.5.1 Regulatory Environment

The minimum license requirement to hunt ungulates or wild birds in Louisiana is a basic hunting license. This minimum requirement applies to both residents and non-residents above the age of 16. Hunting certain animals or using specific hunting equipment may require an additional special license; special licenses are required to hunt deer, turkey, bobcat, and migratory waterfowl. Trapping, bow-hunting or hunting with primitive firearms also requires an additional special license (LDWF 2018d).

Land managed by the LDWF includes WMAs, wildlife refuges, and habitat conservation areas (LDWF 2018e). Hunting on any land managed by LDWF requires a WMA Hunting Permit. In 2011, 36% of hunters in Louisiana (both residents and non-residents above the age of 16) hunted on public land and 75% hunted on private land (USDOI et al. 2013). Most of the marshlands in Plaquemines and St. Bernard parishes are privately owned; the Delacroix Corporation and Biloxi Marsh Lands (who leases its lands to the Biloxi WMA for management) are notable land owners in the Study Area, who lease their lands for waterfowl hunting and fishing. .

19.5.2 Hunting Participation

Table 19.5-1 presents the most popular types of hunting licenses purchased in the Study Area and a comparison to Louisiana as a whole. The most popular types of licenses obtained or purchased were the Migratory Bird Harvest Information Program (HIP) Certification (required to hunt migratory birds), combination hunting and fishing licenses, and the basic hunting license.

The next largest types of licenses purchased in Plaquemines and St. Bernard parishes were for big game and duck licenses. In addition, lifetime licenses can also be purchased from the state, which do not require any annual renewal or fees. The Study Area accounts for 4.5% of trapping license sales in the state.

Table 19.5-1
Number of Hunting and Trapping Licenses by Type, 2017

Type of License	Number of Licenses Sold			Two-Parish Percent of State Total
	Plaquemines Parish	St. Bernard Parish	Two-Parish Total	
HIP Certification[a]	1,047	903	1,950	0.9%
Combo Hunt and Fishb	785	908	1,693	1.3%
Basic Hunt	905	851	1,756	1.1%
Big Game	422	414	836	0.7%
Duck	591	533	1,124	1.9%
WMA Hunting Permit	126	147	273	0.7%
Primitive Firearms	49	92	141	0.5%
Bow	78	94	172	0.6%
Turkey	17	16	33	0.3%
Trapping	41	53	94	4.5%

Source: LDWF 2018c.

a. The HIP Certification is required for all migratory bird hunters.

b. The combination licenses can be used in lieu of a Basic Hunting License and contain additional special licenses such as Big Game Licenses and Louisiana Duck and Turkey Stamps.

The parish where a license is sold does not necessarily indicate where the hunting activity occurs. A direct link to location of hunting activity is animal tags. In Louisiana, tags are mandatory for deer and turkey hunting (LDWF 2018e). After a successful hunt, the hunter must tag the animal, record the date and parish of the kill, and validate the tag.

According to the Louisiana Deer Report 2016-2017, Plaquemines and St. Bernard parishes were not in the top 20 total harvest parishes or in the top 20 harvest per acre parishes in Louisiana (LDWF 2017). The top deer hunting parishes in Louisiana in 2016-2017 were outside of the Breton Sound Basin, Barataria and Mississippi River Basins (LDWF 2017). Overall, deer or turkey hunting activity within the Study Area is very limited.

Waterfowl hunting is an important recreational activity in Plaquemines and St. Bernard Parish. The most fourth most popular hunting permit across the two parishes is the Louisiana

Duck (waterfowl) permit, with 1,124 licenses sold in 2017 (LDWF 2018c). According to the 2010 Survey of Louisiana Waterfowl Hunters, Plaquemines Parish was the fourth parish for the one most hunted in by waterfowl hunters in Louisiana out of 65 parishes, and St. Bernard's Parish was tied with several other parishes for 13th (LDWF 2011). Pass-a-Loutre Wildlife Management Area in Plaquemines Parish, a popular waterfowl hunting area, hosts between 40,000 and 60,000 recreational users each year (Louisiana Conservationist, 2016).

LDWF has established regulations governing the harvest of wild populations of alligators and alligator eggs and raising and propagation of farmed alligators. Approximately 81% of Louisiana's coastal alligator habitats are privately owned. These properties must individually apply for an allotment of alligator harvest tags from LDWF. Alligator tags are allotted by parish on a tag-per-number of acres basis. Tag allotment for a particular area is determined by area-specific factors such as prior harvest statistics and habitat and biological assessments.

Hunters may also harvest alligators on public lands through a lottery process (LDWF 2018). An alligator hunting license is required for hunting on private or public land (LDWF 2017). Alligator hunting is managed by LDWF in some WMAs in the Study Area. In Pass-a-Loutre WMA, 350 commercial tags and 27 recreational lottery tags were issued to alligator hunters in the 2015 season. Overall in the 2015 lottery alligator harvest program, 349 hunters harvested a total of 897 alligators in 45 public areas throughout the state (LDWF 2016). Statewide, during the 2015 wild season, a total of 35,410 alligators were harvested by 3,109 licensed alligator hunters.

In addition to hunting, alligator ranching activity occurs within the Study Area. As of January 2016, there were 55 licensed farmers in Louisiana with farm inventories totaling 807,986 alligators; Plaquemines Parish is home to alligator farms as of December 2015 (LDWF 2016).

19.5.3 Regional Economic Impacts of Hunting

Approximately 277,000 hunters spent $709 million in Louisiana in 2011. These direct expenditures amounted to $2,385 per hunter for equipment and included around $58 per hunting day on trip-related expenses (USDOI 2013). A separate study additionally considered the multiplier effects of migratory bird hunting in 2004, finding a total economic contribution of $107.5 million and over 1,300 jobs, as well as $34.2 million in earnings (Richardson and Scott 2004). Another study estimated the regional economic contribution of alligator harvests, supporting $109 million in sales, 748 jobs, and $5.7 million in state and local tax revenues (Southwick 2008).

19.6 WILDLIFE WATCHING, INCLUDING BIRDING

Wildlife watching is a very common activity in the Study Area. The USFWS estimated that in 2011, over one million individuals (state residents and non-residents) participated in some form of wildlife watching in Louisiana, which is more than participated in recreational fishing or hunting in the state (USDOI et al. 2013). One study estimated that wildlife viewing activity supported $63.4 million in economic activity, approximately 794 jobs and provided $20.4 million in labor earnings in 2003 (Richardson and Scott 2004).

Bird watching is a particularly popular activity. Within the Study Area, a number of birding spots exist throughout Breton Sound Basin and the Mississippi River delta. Twenty-three species of seabirds and shorebirds frequent the Breton National Wildlife Refuge and 13 species nest on the various islands. USFWS reports that the most commonly observed type of birds among non-resident bird watchers are waterfowl and birds of prey. Songbirds and other waterbirds are also popular among bird watchers (USDOI et al. 2013).

19.7 VISITATION TO NON-GOVERNMENTAL PROTECTED AREAS

As described in Table 19.2-1 and shown in Figure 19.2-1, the Study Area includes a number of areas that are designated for conservation purposes by state and federal agencies. This section describes these public lands and provides a brief description of the visitation to these areas.

19.7.1 National Wildlife Refuges and Wildlife Management Areas

The Study Area includes two NWRs that are managed as part of the Southeast Louisiana Wildlife Refuges complex. The two refuges in the Study Area include:

- The Delta NWR, managed by the USFWS, was established in 1935 under the authority of the Migratory Bird Conservation Act to provide sanctuary and habitat for wintering waterfowl. According to the Refuge's 2008 Comprehensive Conservation Plan, management objectives for the Delta NWR also include protecting endangered and threatened coastal fish and wildlife species, providing quality outdoor recreation opportunities for visitors, and managing, restoring, and conserving marshland and coastal wetland habitat (USFWS 2008). Located in the birdfoot delta, the Delta NWR comprises close to 48,800 acres of marsh and open water in Plaquemines Parish. Access to the NWR requires crossing and navigating the Mississippi River by boat. Approximately 9,000 visitors visit the refuge annually for boating, bird watching, fishing, and hunting activities (USFWS 2018b).
- Breton NWR, which is managed by the USFWS, was established in 1904 by President Roosevelt and is the second –oldest refuge in the National Refuge system. The Refuge consists of a sixty mile long crescent of barrier islands located in the Gulf of Mexico south of Gulfport, Mississippi and east of New Orleans. The Refuge is accessible only by boat or floatplane. No regular commercial boat transport is available but charters can be arranged. Most waterborne visitors depart from either the Mississippi Gulf Coast or Venice, Louisiana. The islands of Breton NWR (except for North Breton Island) were designated as the Breton Wilderness, part of the National Wilderness System, in 1975. North Breton Island was excluded because an oil facility (now gone) was located on that island. The NWR comprises close to 1,100 acres in Plaquemines and St. Bernard parishes. The objectives of the Refuge are to provide sanctuary for nesting and wintering seabirds, to protect and preserve the wilderness character of the islands, and to provide sandy beach habitat for a variety of wildlife species. Approximately 3,000 annual visitors travel to the Refuge for boating, bird watching, photography, and fishing activities (USFWS 2018c).

The Study Area includes the following two LDWF WMAs:

- Pass-a-Loutre Wildlife Management Area. This is a 115,000-acre WMA located in Plaquemines Parish. LDWF reports that hurricane damage and subsidence have contributed to the conversion of vegetated marsh areas to large ponds at this site. This WMA allows fishing and hunting on a restricted basis and includes boat ramps (LDWF 2018a).
- Biloxi Wildlife Management Area. This WMA is owned by Biloxi Marsh Lands Corporation and leased to and managed by LDWF. The 36,000-acre WMA is located

in St. Bernard Parish. This WMA allows fishing, boating, hunting, trapping, and birding. There are specific regulations for some of these recreational activities (LDWF 2018a).

19.7.2 National and State Parks

One Louisiana state park is located in the Study Area. St. Bernard State Park is a popular park located adjacent to the Mississippi River in St. Bernard Parish in Braithwaite. The recreational area includes 51-campsites, a nature trail, and a water playground (Louisiana Department of Culture, Recreation, and Tourism 2019). Annual visitation to this park is approximately 60,000. The Chalmette Battlefield, part of the Jean Lafitte Historical Park and Preserve, is located on the east bank of the Mississippi River in Chalmette. The National Park Service (NPS)-managed site includes historic sites and battlefield and educational activities. The size of the Chalmette Battlefield site is 143 acres and hosts from 50,000 to 65,000 visitors per year (NPS 2011).

19.7.3 Non-Governmental Protected Areas

There are no known protected areas owned by non-governmental or private organizations that are used for public recreation that are located in the Study Area.

20.0 LAND BASED TRANSPORTATION

20.1 INTRODUCTION

Roads are essential to the movement of people and commodities. This section describes the existing road infrastructure in portions of Plaquemines and St. Bernard parishes and the surface transportation network in the vicinity of the proposed project construction footprint.

20.2 ROADS

Louisiana HWY 39 follows the eastern bank of the Mississippi River southward to Bohemia and represents the western boundary of the Breton Sound Basin. Along the northern and eastern side, LA HWY 46 and LA HWY 300 run parallel to one another. At the town of Reggio, LA HWY 300 turns south toward Delacroix and LA HWY 46 continues eastward to Yscloskey. LA HWY 46 ends at Yscloskey, where LA HWY 624 continues eastward to Hopedale (Figure 18.2-1).

LA HWY 39 and LA HWY 46 serve as the primary hurricane evacuation routes in the area. These highways both lead to New Orleans and eventually to US HWY 90 and Interstate 10.

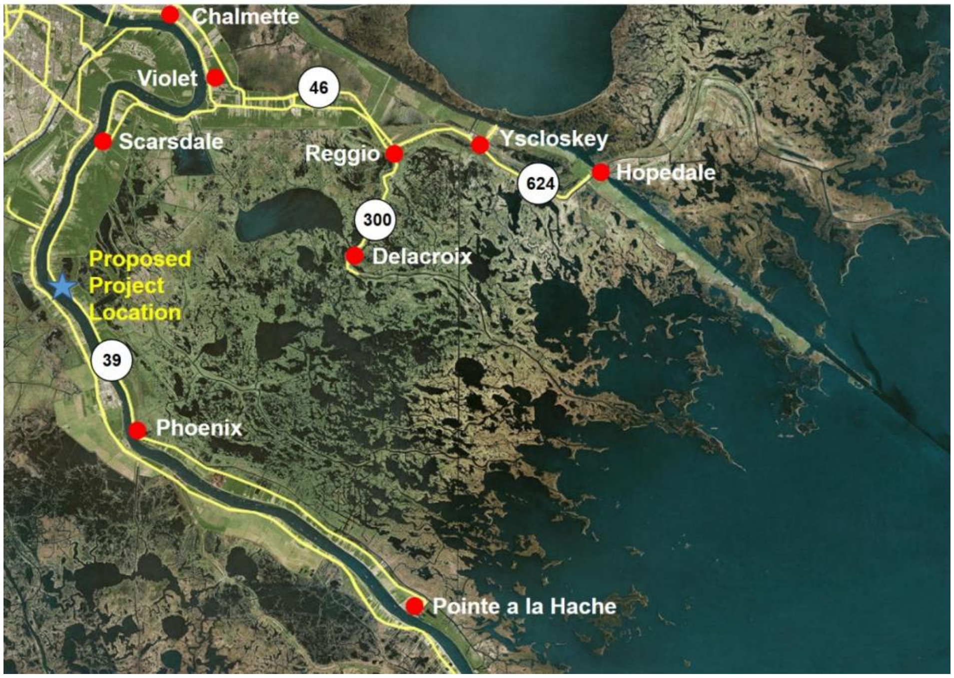


Figure 20.2-1: Major roads in and around the Breton Sound Basin (DOTD 2019)

The Louisiana Department of Transportation and Development (DOTD) provides classifications for roads in Louisiana. These classifications are then subdivided to differentiate rural and urban settings. Table 20.2-1 provides the DOTD road classifications for the four highways within and surrounding the Breton Sound Basin (DOTD 2017b). Note that road classifications change from “urban” to “rural” when the road in question transitions from the area protected by the HSDRSS system to areas outside this system.

Table 20.2-1
LA DOTD Road Classifications

Highway	Within HSDRSS System	Outside HSDRSS System
LA HWY 39	Major Collector (rural)	Principal arterial (urban)
LA HWY 46	Major Collector (rural)	Minor Arterial (urban)
LA HWY 300	Local (rural)	Major Collector (urban)
LA HWY 624	Minor Collector (rural)	n/a

Source: DOTD 2017b

The four major highways within and surrounding the Breton Sound Basin have relatively low traffic volumes. DOTD estimates Annual Average Daily Traffic (AADT) across the state and updates these estimates regularly. The proposed project construction footprint crosses LA HWY 39 in the area of Wills Point. Greenwood, located 2.52 miles north of the proposed project construction footprint, had an estimated 2015 AADT of 1,331 (Table 20.2-2, DOTD 2015). The closest data point south of the proposed project construction footprint is 8.55 miles south at Phoenix, where 2015 AADT was estimated at 616. In general, the southernmost areas along LA HWY 39 see the least traffic. The northernmost point included here is in Chalmette, which is within the HSDRSS system and is directly adjacent to New Orleans. 2015 AADT was estimated to be 41,278 in Chalmette.

Table 20.2-2
LA 39 AADT within the Breton Sound Basin

Mile Point	Location	Distance & Direction from Proposed Project	AADT	AADT Data year
45.93	Chalmette	22.07 miles north	41,278	2017
31.93	Scarsdale	8.07 miles north	2,092	2015
26.39	Greenwood	2.53 miles north	1,331	2015
15.31	Phoenix	8.55 miles south	616	2015
4.98	Pointe a la Hache	18.88 miles south	234	2015

Source: DOTD 2017a, 2015

AADT estimates for LA HWY 46, LA HWY 300, and LA HWY 624 show similar trends as those for LA HWY 39. As data collection points proceed east and south (i.e., away from New Orleans) AADT estimates decrease. The first data point on LA HWY 46 taken within the HSDRSS system is in Violet and shows a four-fold increase from the nearest data point outside the levee system (Table 20.2-3, DOTD 2017a).

Table 20.2-3
AADT for Other Highways within the Breton Sound Basin

Highway	Mile Point	Location	2017 AADT
LA HWY 46	13.51	Violet	10,321
LA HWY 46	23.15	Reggio	2,696
LA HWY 46	27.57	Yscloskey	1,472
LA HWY 300	7.06	Reggio	2,412
LA HWY 300	0.85	Delacroix	447
LA HWY 624	0.25	Hopedale	1.128
Source: DOTD 2017a			

21.0 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

21.1 INTRODUCTION

The affected environment for Hazardous, Toxic, and Radioactive Waste (HTRW) resource consists of potentially contaminated soils, groundwater, and surface water areas within the project area which includes the proposed project construction footprint. A desktop Phase I Environmental Site Assessment was performed following the process defined in the American Society for Testing and Materials (ASTM) E1527-13 Standard Practice for Environmental Site Assessments (refer to Appendix B) to determine whether HTRW resources occur within the vicinity of the proposed construction footprint. The assessment consisted of a review of recent and historic aerial photographs and regulatory agency database information (Geo Search, LLC 2019 a). A site reconnaissance was not conducted to review the general setting and exterior conditions of the subject property as part of this assessment.

This section also discusses the potential for encountering oil and gas infrastructure within the vicinity of the proposed construction footprint and briefly describes (in a qualitative fashion) the potential for encountering buildings or structures impacted by asbestos-containing materials (ACMs) and metals-based paints.

21.2 RECOGNIZED ENVIRONMENTAL CONDITIONS IN THE PROJECT AREA

The Phase I Environmental Site Assessment was performed to identify recognized environmental conditions (RECs) within the project area. A REC is defined as “the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property” (ASTM 2013).

In addition, CRECs and HRECs are also to be considered under the standard. A CREC is defined as: *A recognized environmental condition resulting from a past release of hazardous substances or petroleum products that has been addressed to the satisfaction of the applicable regulatory authority, with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls* (ASTM 2013).

An HREC is defined as: *A past release of any hazardous substances or petroleum products that has occurred in connection with the property and has been addressed to the satisfaction of the applicable regulatory authority, meeting unrestricted use criteria established by a regulatory authority, without subjecting the property to any required controls* (ASTM 2013).

21.2.1 Historical Aerial Photography and Topographic Map Review

Aerial photographs were obtained to examine the historic usage of the project area dating back to 1952 through 2015 (GeoSearch 2019b). Review of the aerial photographs revealed no areas of concerns (refer to Appendix B, Attachment C). Topographic maps from 1891 through 1955 were also reviewed and showed a railroad line passing through the proposed construction footprint. The railroad line was east of LA HWY 39 and was indicated as “abandoned” by 1955. It should be noted that railroad lines, in general, frequently exhibit soils contaminated by arsenic (as a result of herbicide application) and Benzo(a) pyrene equivalents (as the result of leaching of treated cross-tie timbers). Excavating and construction in railroad rights-of-way would be expected to involve impacts from these constituents. Therefore, the former railroad line is considered an REC.

21.2.2 Regulatory Agency Records Review

To provide a more comprehensive review than is required by ASTM E1527-13, a search of federal and state databases was performed out to a radius of one mile from the proposed project construction footprint boundary. This expanded database search, obtained from GeoSearch (2019a), is provided in Appendix B, Attachment B. Table 21.2-1 summarizes the primary databases that were searched, the search results, and the search radius. No sites were located within any of the search radii, and the one unlocatable site was identified based on the information provided and was determined to be beyond the one-mile maximum radius (GeoSearch 2019a).

21.2.3 Oil and Gas Infrastructure

Review of the USEIA database did not identify any active gas or oil wells in the immediate vicinity of the proposed project construction footprint. The Alliance Oil and Gas Field is located south of the project construction footprint and across the Mississippi River in the Barataria Basin. Appendix B, Attachment A shows the locations of active oil and gas wells relative to the proposed construction footprint within the Breton Sound Basin.

21.2.4 Buildings with Potential ACMs and Metals-Based Paints

The proposed construction footprint comprises a low-density residential and agricultural area, with multiple existing buildings. The proposed construction footprint contains approximately 16 residential, agricultural, or storage-type structures, all of which are relatively small (generally less than 7,500 square feet). Review of aerial photographs indicates that more than half of these buildings (approximately 12) were built prior to 1980 and could therefore be expected to contain ACMs or metals-based paints (primarily lead-based). If these materials are expected to be encountered in buildings that are planned for demolition as part of the proposed project, they are required to be properly surveyed, tested, and abated prior to the demolition activities. An asbestos survey would be required by a licensed asbestos inspector to determine the presence or absence of ACMs prior to renovation or demolition of buildings. Metals-based paints also have special removal requirements.

21.2.5 Summary

Based on the findings of the Phase I Environmental Site Assessment, one REC, a former railroad line present from the 1890s through the 1950s, was identified within the one mile radius from the proposed project construction footprint boundary. Former railroad rights-of-way have the potential for soil impacts due to contamination. No additional HREC or CREC were identified during this Phase I Environmental Site Assessment Investigation. The survey of the project construction footprint from the images on Google Earth showed an aboveground storage tank (AST) at a residence on the east side of LA HWY 39 towards the south end of the proposed construction footprint boundary This AST is not on any database reviewed and is not likely a REC. Based on the data available this AST is not considered an 'Environmental Condition' for the proposed project.

Table 21.2-1
Summarized Results of Database Review

Database	**Acronym**	**Locatable**	**Unlocatable**	**Search Radius (miles)**
FEDERAL LISTING				
Standard Environmental Records				
Emergency Response Notification System	ERNSLA	0	**1**	TP/AP
Federal Engineering Institutional Control Sites	EC	0	0	TP/AP
Land Use Control Information System	LUCIS	0	0	TP/AP
RCRA Sites with Controls	RCRASC	0	0	TP/AP
Resource Conservation & Recovery Act – Generator	RCRAGR06	0	0	0.1250
Resource Conservation & Recovery Act – Non-Generator	RCRANGR06	0	0	0.1250
Brownfields Management System	BF	0	0	0.5000
Delisted National Priorities List	DNPL	0	0	0.5000
No Longer Regulated Resource Conservation & Recovery Act Non-Corracts TSD Facilities	NLRRCRAT	0	0	0.5000
Resource Conservation & Recovery Act – Non-Corracts Treatment, Storage & Disposal Facilities	RCRAT	0	0	0.5000
Superfund Enterprise Management System	SEMS	0	0	0.5000
Superfund Enterprise Management System Archived Site Inventory	SEMSARCH	0	0	0.5000
National Priorities List	NPL	0	0	1.0000
No Longer Regulated Resource Conservation & Recovery Act Corrective Action Facilities	NLRRCRAC	0	0	1.0000
Proposed National Priorities List	PNPL	0	0	1.0000
Resource Conservation & Recovery Act – Corrective Action Facilities	RCRAC	0	0	1.0000
Resource Conservation & Recovery Act – Subject to Corrective Action Facilities	RCRASUBC	0	0	1.0000

Table 21.2-1
Summarized Results of Database Review

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
Additional Environmental Records				
Aerometric Information Retrieval System / Air Facility Subsystem	AIRSAFS	0	0	TP/AP
Enforcement and Compliance History Information	ECHO R06	0	0	TP/AP
Facility Registry System	FRSLA	0	0	TP/AP
Hazardous Materials Incident Reporting System	HMIRSR06	0	0	TP/AP
Integrated Compliance Information System (Formerly Dockets) Pollutant Discharge Elimination System	ICIS	0	0	TP/AP
National Pollutant Discharge Elimination System	NPDESR06	0	0	TP/AP
PCB Activity Database System	PADS	0	0	TP/AP
Permit Compliance System	PCSR06	0	0	TP/AP
Toxic Substance Control Act Inventory	TSCA	0	0	TP/AP
Toxics Release Inventory	TRI	0	0	TP/AP
Alternative Fueling Stations	ALTFUELS	0	0	0.2500
FEMA Owned Storage Tanks	FEMAUST	0	0	0.2500
Historical Gas Stations	HISTPST	0	0	0.2500
Integrated Compliance Information System Drycleaners	ICISCLEANERS	0	0	0.2500
Mine Safety and Health Administration Master Index File	MSHA	0	0	0.2500
Mineral Resource Data System	MRDS	0	0	0.2500
Open Dump Inventory	ODI	0	0	0.5000
Surface Mining Control and Reclamation Act Sites	SMCRA	0	0	0.5000
Uranium Mill Tailings Radiation Control Act Sites	USUMTRCA	0	0	0.5000
Department of Defense Sites	DOD	0	0	1.0000
Former Military Nike Missile Sites	NMS	0	0	1.0000
Formerly Used Defense Sites	FUDS	0	0	1.0000
Formerly Utilized Sites Remedial Action Program	FUSRAP	0	0	1.0000
Record of Decision System	RODS	0	0	1.0000
STATE (LA) LISTING				
Standard Environmental Records				
Sites with Controls	IC	0	0	TP/AP
No Longer Reported Underground Storage Tanks	NLRUST	0	0	0.2500
Underground Storage Tanks	UST	0	0	0.2500
Approved Hurricane Debris Dump Sites	ADS	0	0	0.5000

Table 21.2-1
Summarized Results of Database Review

Database	Acronym	Locatable	Unlocatable	Search Radius (miles)
Historical Leaking Underground Storage Tanks	HLUST	0	0	0.5000
Leaking Underground Storage Tanks	LUST	0	0	0.5000
Solid Waste Landfills	SWLF	0	0	0.5000
Voluntary Remediation Program Sites	VRP	0	0	0.5000
Confirmed and Potential Sites Inventory	CPI	0	0	1.0000
Additional Environmental Records				
Asbestos Demolition and Renovation Notification Projects	ASBESTOS	0	0	TP/AP
Clandestine Drug Laboratory Locations	CDL	0	0	TP/AP
Listing if Louisiana DEQ Liens	LIENS	0	0	TP/AP
Spills Listing	SPILLS	0	0	TP/AP
Waste Tire Generator List	WASTETIRE	0	0	TP/AP
Dry-cleaning Facilities	DCR	0	0	0.2500
Recycling Facilities	RCY	0	0	0.5000
Waste Pits	WP	0	0	0.5000

22.0 REFERENCES

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