3.0 AFFECTED ENVIRONMENT

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3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

The purpose of the Affected Environment chapter is to describe the physical, biological, chemical, and human environments in areas likely to be impacted by the proposed Project as they exist or in accordance with the most recent available data. A historical context is provided for resources such as hydrology and hydrodynamics in order to provide a snapshot of these resources when they were fully connected to the Mississippi River. Resources likely to be impacted (directly, indirectly, or cumulatively) by the No Action and Action Alternatives are described in detail (such as surface water, aquatic resources, and commercial fishing), while other environmental resources within the Project area unlikely to be impacted receive brief summary (such as groundwater use; air quality; and hazardous, toxic, and radioactive waste [HTRW]). This approach complies with USACE's NEPA Implementation Procedures for the Regulatory Program (33 CFR Part 325, Appendix B) and 40 CFR 1502.15, which states:

> Affected environment. The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The description shall be no longer than is necessary to understand the effects of the alternatives. Data and analyses in a statement shall be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced. Agencies shall avoid useless bulk in statements and shall concentrate effort and attention on important issues. Verbose descriptions of the affected environment are themselves no measure of the adequacy of an environmental impact statement.

3.1.1 Project Area

The Project area is defined by the boundaries of the Barataria Basin and the Lower Mississippi River watersheds. These watersheds are identified by USGS as the East Central Louisiana and Lower Mississippi River Hydrologic Units (Hydrologic Unit Codes [HUCs] 08090301 and 08090100, respectively) (USGS 2017c) (see Figure 3.1-1). The Barataria Basin (HUC 08090301) is roughly triangular in shape, with Bayou Lafourche forming its western boundary, the west bank of the Mississippi River forming its northern and eastern boundaries, and a chain of barrier islands and the margin of the Mississippi River birdfoot delta forming the southeastern boundary. The Barataria Basin is built on a foundation of clays, silts, sands, and other sediments with freshwater swamp, freshwater to saline marshes[12], barrier islands, natural levees, and former distributary channels of the Mississippi River (Coleman et al. 1998). The Lower

[12] Marshes (a type of emergent wetland) and swamps (a type of forested wetland) are the dominant wetland types in the Project area. Wetlands are defined and described in greater detail in Section 3.6 Wetland Resources and Waters of the U.S.

Mississippi River watershed (HUC 08090100) is defined as the Mississippi River itself and the birdfoot delta.

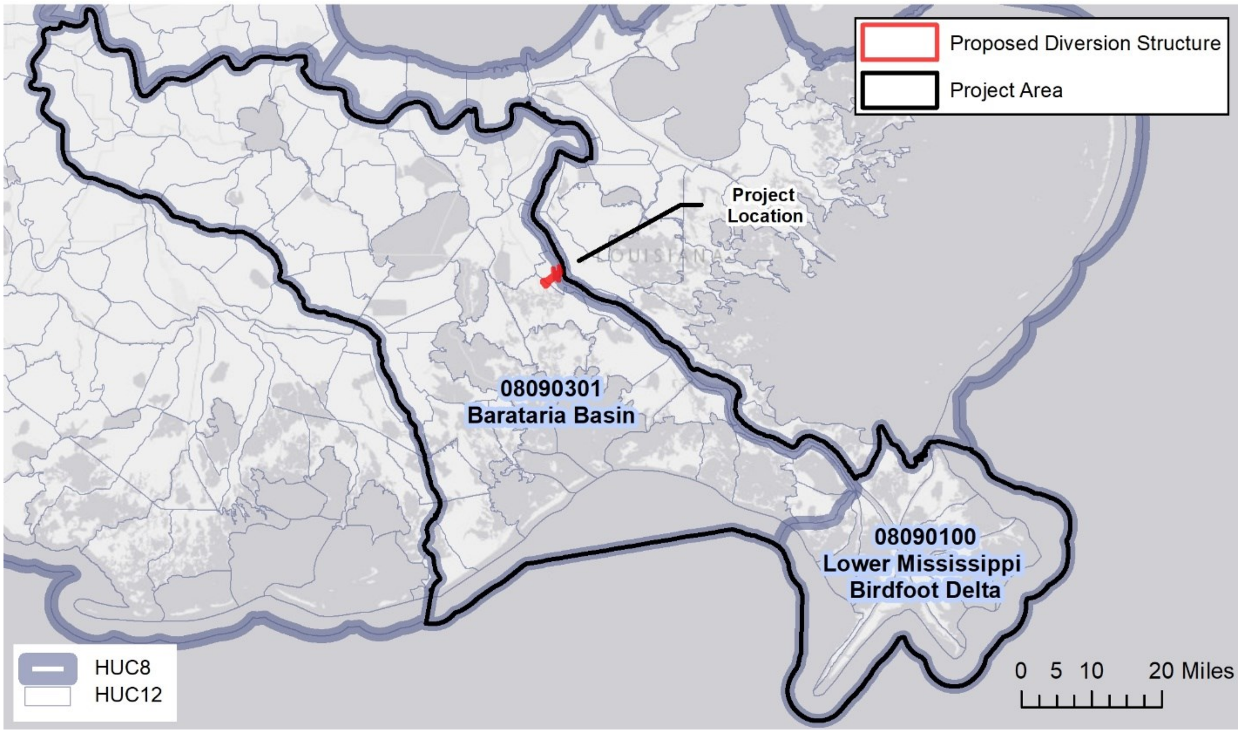


Figure 3.1-1. Map of Project Area Boundaries and Watersheds within the Project Area.

The Project area includes all or portions of 10 Louisiana parishes. Table 3.1-1 shows the number of acres of each parish in the Project area. Active construction and operation of the proposed Project, including the proposed diversion structure and outfall area, would occur in Plaquemines and Jefferson Parishes.

Table 3.1-1
Parish Acreages in Project Area

Parish	Acres
Lafourche	646,096
Plaquemines	592,161
Jefferson	263,286
St. Charles	238,566
St. James	115,576
Assumption	72,593
St. John the Baptist	72,292
Orleans	20,438
Ascension	11,654
St. Bernard	2,891

The location of the proposed Project is on the west bank of the Mississippi River at RM[13] 60.7 AHP near Myrtle Grove (see Figure 1.1-2 in Chapter 1). The proposed Project outfall area**,** which is where sediment and fresh water would be dispersed into the Barataria Basin during Project operations, includes freshwater, intermediate, and brackish wetlands degraded due to a combination of many natural and human-induced processes outlined in this chapter. Project features shown in Chapter 2, Figure 2.8-1, including the proposed Project diversion structure, intake structure, and outfall area, are referenced throughout this chapter to provide a location context for descriptions of the affected environment. The term "immediate outfall area" refers to the area in the basin that would encompass the proposed Project outfall transition feature, barge access channels for delivery of construction materials, beneficial use placement areas, and marsh terrace outfall features (see Figure 2.8-1 in Chapter 2).

3.1.2 Physiographic Setting

The Project area is located within the southern portion of the Mississippi Alluvial Plain, a sub-province of the Atlantic Coastal Plain (Vigil et al. 2000, Hunt 1967), which follows the Mississippi River south from Illinois through Missouri, Arkansas, Tennessee, Mississippi, and Louisiana, ending at the Gulf of Mexico (Omernik 1987). This sub-province is dominated by the Mississippi River. The Mississippi-Missouri River system drains water and the associated sediment load from the entire central portion of the U.S. The northern portion of the Mississippi Alluvial Plain sub-province is known as the Mississippi Embayment, a low-lying geologic basin filled with fluvial sediments deposited by the river between the Cretaceous period and present-day. The river has occupied its current channel for the last 1,320 years (McFarlan 1961; Saucier 1963, 1994; Weinstein and Gagliano 1985; Törnqvist et al. 1996).

The southern portion of the Mississippi Alluvial Plain sub-province is known as the Mississippi River Delta. The delta, as we know it today, is geologically modern and most surficial sediments were deposited by the Mississippi and Atchafalaya Rivers during the Holocene epoch, beginning about 7,000 years ago (Turner et al. 2018). The main channel of the Mississippi River is dynamic, with delta lobes forming from sediment deposition in the Gulf of Mexico and delta switching occurring approximately every 1,000 to 1,500 years over the last 7,000 years (Roberts 1997; Day et al. 2007; Blum and Roberts 2012). The Mississippi River's modern active delta, known as the Plaquemines-Balize delta, or birdfoot delta, extends farthest into the Gulf of Mexico in a large middle lobe. The Project area is located primarily within the deltaic coastal marshes including, and to the west of, this currently active lobe (Daigle et al. 2006). Portions of the Project area also overlap the more-inland swamps and Holocene meander belts that form the margins of these marshes. In this document, references to the Mississippi River Delta describe the area encompassed by the current Mississippi

[13] RM markers for the Mississippi River start at RM 0.0 at Head of Passes, where the main stem of the river branches off into the birdfoot delta at its mouth in the Gulf of Mexico. Mile markers upriver from Head of Passes are labeled AHP and mile markers downriver from Head of Passes are labeled BHP.

River, its historic inactive lobes, and the currently active birdfoot delta. The Project area comprises only the central portion of the broader Mississippi River Delta.

In developing the Louisiana Comprehensive Wildlife Conservation Strategy (Louisiana Department of Wildlife and Fisheries [LDWF] 2015), the LDWF and the Nature Conservancy developed a system of ecoregions specific to the State of Louisiana, based on similarities in physiography. The Barataria Basin comprises parts of two ecoregions, the Mississippi River Alluvial Plain ecoregion and the Gulf Coast Prairies and Marshes ecoregion (LDWF 2005a). The Mississippi River Alluvial Plain includes all or parts of Assumption, St. James, Ascension, St. John the Baptist, St. Charles, Jefferson, Orleans, and Plaquemines Parishes in the basin as well as St. Bernard Parish. Terrestrial (upland) habitats in the Barataria Basin associated with this ecoregion include primarily agriculture/cropland/grassland, some hardwood mixed forest, and live oak natural levee forest. The Mississippi River Alluvial Plain is, as its name implies, rich in alluvial sediments and is associated with primarily bottomland hardwood forests, as well as freshwater swamps and other forested wetlands.

The Gulf Coast Prairies and Marshes ecoregion in Louisiana includes the coastal portion of the Barataria Basin. This ecoregion includes all or portions of St. Charles, St. John the Baptist, Jefferson, Plaquemines, and Orleans Parishes in the basin. Barrier islands, live oak natural levee forest, coastal dune grasslands, and agriculture/ cropland/grassland habitats are typical of this ecoregion (LDWF 2005a). The coastal marsh areas are comprised of salt, brackish, intermediate, and fresh marshes. Other plant communities associated with the Gulf Coast Prairies and Marshes ecoregion are the cypress and cypress-tupelo swamps, coastal live oak-hackberry forests (cheniers) of the southwest coast, live oak natural levee forests of the southeast coast, and some bottomland hardwood forests.

Physical features characterizing the Barataria Basin include natural and artificial levees, bays, lakes, bayous, coastal beaches, barrier islands, forested wetlands, and marshes, which occur across gradients of both elevation and salinity. The upper most extent of the Barataria Basin is at Donaldsonville, Louisiana (Conner and Day 1987). Water flows through a system of lakes and bayous, from Lac des Allemands in the Upper Barataria Basin, to Lake Salvador via Bayou des Allemands, south into Little Lake via Bayou Perot, and then into Barataria Bay (see Figure 3.1-2). The lower portion of the basin is a bar-built estuary with shallow water, sand bars, and a low-tide, low-energy coast (Conner and Day 1987). The barrier islands between the bay and the Gulf of Mexico moderate the effects of marine influences and storms in the basin. In addition to the natural waterways, the GIWW, which bisects the basin from northeast to southeast below Lake Salvador, and the Barataria Waterway, which extends from below Lake Salvador to Barataria Bay, are the primary navigation channels that cross through the basin.

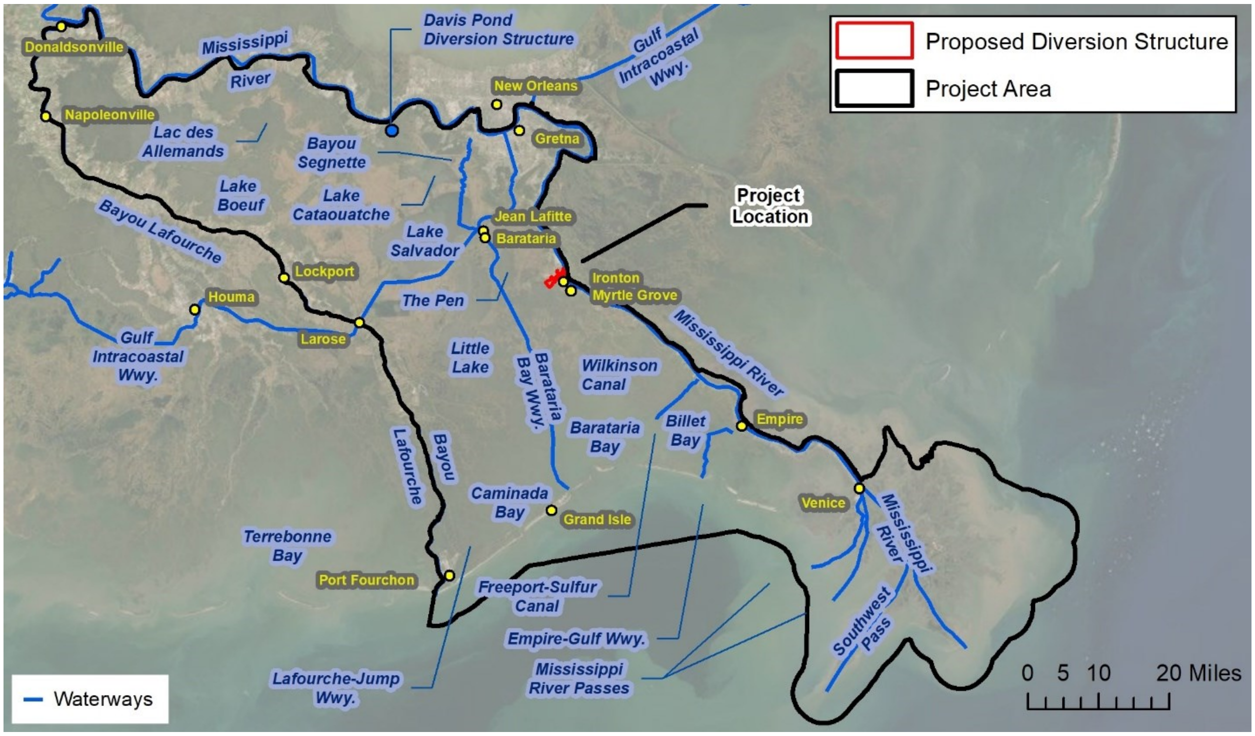


Figure 3.1-2. Major Waterbodies in the Project Area, with Key Towns and Landmarks.

3.1.3 Climate

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 degrees Fahrenheit (°F) (25.4 degrees Celsius [°C]) and 59.1°F (15.1°C), 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 cyclones, which by definition include tropical storms and hurricanes. In the Gulf of Mexico, tropical storms have wind speeds between 39 miles per hour (MPH) and 73 MPH, while hurricanes have wind speeds greater than 73 MPH. An annual average of 0.7 tropical cyclones of tropical storm strength (of which 0.3 were hurricanes) hit the Louisiana coast between 1851 and 2010. A hurricane is expected to make landfall in Louisiana every 2.8 years (Roth 2010). More recent hurricanes to make landfall in the Project area in southeast Louisiana include Hurricane Isaac (2012), Hurricane Zeta (2020), and Hurricane Ida (2021). 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). In August 2021 Hurricane Ida made landfall at the southwestern corner of the Project area with maximum wind speeds of almost 150 MPH; storm surge reached between 9 and 12 feet in Barataria Bay. Hurricane Ida caused catastrophic damage in southeast Louisiana and thousands of buildings (particularly in Lafourche and Jefferson parishes) were damaged. Overall, damage in Louisiana is estimated at $55 billion (Beven et al. 2022). Since 1895, the average temperature in the U.S. has increased by about 1.3°F 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 the 1960s and 1970s during which time the temperature in Louisiana dropped by almost 2°F, and a subsequent steady increase in temperature to the present (Kunkel et al. 2013; Frankson and Kunkel 2017). 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 (Frankson and Kunkel 2017). Average annual temperatures in the Project area are projected to increase by between 2.5°F and 5.5°F by 2099 (Kunkel et al. 2013).

Summer precipitation in Louisiana is projected to decrease, but only by an amount that is smaller than natural variations. Drought intensity is likely to increase due to higher temperatures that would increase the loss of soil moisture during dry periods (Frankson and Kunkel 2017). Hurricane wind speeds, rainfall intensity, and storm surge height and strength are also projected to increase (Carter et al. 2014). Changes in wind speed and direction would continue to impact saltwater intrusion on the freshwater marshes. Wetland loss is addressed in Section 3.6.2 in Wetland Resources and Waters of the U.S.

The risk of sea-level rise and increased flood risk is high in coastal Louisiana, particularly in low-lying areas. Sea-level rise and subsidence have 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 impact 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, low-income communities, some communities of color, and people with chronic illnesses. Climate change impacts on these populations include damage to essential infrastructure, poor air and water quality, heat, extreme weather, and mental health stress (U.S. Global Change Research Program [USGCRP] 2018).

3.1.4 Overview and History of the Project Area

The Mississippi River drains about 40 percent of the lower 48 U.S. states (Bahr et al. 1983), and has occupied its current channel for approximately the last 1,320 years (Conner and Day 1987). Since the 1800s, the Lower Mississippi River has been extensively modified for navigation and flood control, isolating the river from the adjacent floodplain and delta complexes.

3.1.4.1 Mississippi River

The Mississippi River Delta is the result of approximately 7,000 years of sediment accretion from the Mississippi River drainage basin. Tremendous fluvial (riverine) deposits from the entire Mississippi River drainage basin were deposited as the river changed course numerous times over thousands of years, forming an extensive sequence of overlapping delta lobes. As a delta lobe was abandoned, a new delta lobe formed (Hatton et al. 1983) (see Section 3.2.1.1 Historical Context for more information about delta lobes in the Project area). Periods of seaward delta building alternated with periods of land loss and sea-level rise. River sediments were deposited at river mouths and into adjacent areas via overbank flooding, crevasse formation, and older distributaries (Day et al. 2007). As a result of these processes, a landscape of lakes and bayous, distributaries, wetlands, and low upland ridges formed. The Mississippi River Delta is subject to subsidence, defined as the downward movement of the earth's surface relative to a datum such as sea level, at rates that vary across the delta. Subsidence is generally the result of multiple processes acting to produce the observed rate, including both natural and human-induced subsidence processes (Morton et al. 2006, Dokka 2011).

Wetland loss along coastal Louisiana accounts for approximately 37 percent of the estuarine marsh loss and 90 percent of the total wetland loss in the continental U.S. (Couvillion et al. 2017, Day et al. 2016). Land loss in the Mississippi River Delta is primarily attributable to entrapment of sediment by upstream reservoirs (Yuill et al. 2009) and by levee construction, which prevents water and suspended sediment from nourishing the surrounding wetlands. The volume of introduced sediment no longer offsets the loss of soil volume due to compaction of previously deposited sediments. The deficit, combined with the increased rate of sea-level rise since delta formation, means that a significant area of wetlands are being submerged (Blum and Roberts 2009). Subsidence increases saltwater intrusion, which kills freshwater marsh vegetation, thereby limiting the amount of peat produced and the amount of land created. See Section 3.6.2.2 Causes of Wetland Loss for further details.

3.1.4.2 Barataria Basin

The Barataria Basin is located between the abandoned Lafourche and Plaquemines delta complexes that were deposited by the Mississippi River before it changed course to its present location, where it has deposited the Plaquemines-Balize modern birdfoot delta. The Barataria Basin was an active sublobe of the St. Bernard delta complex known as the Bayou des Familles – Bayou Barataria branch.

One of the first accounts of Louisiana's fisheries abundance was by Pierre le Moyne d'Iberville in 1699, prior to European settlement, who described vast offshore oyster reefs, islands forming from huge drift trees, and schools of white shrimp in what is now the Barataria-Terrebonne estuarine system (Condrey et al. 2008). Early accounts also identified a coastline advancing into the sea, with four distributaries of the Mississippi River resulting in plumes of fresh water that extended more than 6 miles into the Gulf of Mexico during spring floods (Condrey et al. 2008, Day et al. 2021). The input of river waters into the estuarine system was recognized in the early 1900s as being beneficial to fisheries, with the Mississippi River Basin later described as the center of production for white shrimp, as well as for blue crab and oysters (Gunter 1952, Caffey and Schexnayder 2002). The construction of levees subsequently limited the input of Mississippi River waters to the estuarine basins, which negatively impacted system productivity (Viosca 1927). The reduction in freshwater input also facilitated saltwater intrusion into the estuarine basins, which damaged oyster reefs in the lower basins but also allowed for the expansion of oyster populations into more interior areas (Van Sickle 1976). The early 1900s also saw a rise in reports in the loss of individual oyster reefs due to both general increases in salinities attributed to the river levees and from sporadic but significant input of fresh water from crevasses and spillways (Gunter 1952).

Construction projects designed primarily for flood control disrupted the hydrologic connection between the Barataria Basin and the Mississippi River (Conner and Day 1987), isolating the basin from freshwater and sediment inputs, which also altered coastal processes that historically maintained coastal wetlands. The first levee on the Mississippi River began construction in 1717, with levees gradually expanding until about 1880 when the rate of construction increased. By 1904, three of the four main distributaries of the Mississippi River had been severed (Gunter 1952). Alterations to the basin included the dam built at the connection between Bayou Lafourche and the Mississippi River in 1902 (Day et al. 2007, Meade and Moody 2010, Day et al. 2016), levee construction along the Mississippi River following the Great Flood of 1927, construction of the GIWW and the Barataria Bay Waterway in the 1930s, the construction of the Old River Control Structure in 1962 to divert flow from the Red and Mississippi Rivers into the Atchafalaya River, and the construction of canals in the 1960s and 1970s for oil and gas exploration (Day et al. 2000, Bass and Turner 1997). These construction projects altered the hydrologic connectivity, disrupted salinity gradients, and reduced sediment input, ultimately resulting in extensive wetlands loss and barrier island erosion in the Barataria Basin and the larger delta complex. See Section 3.6.2.2 in Causes of Wetland Loss for a more detailed overview of the causes of wetland loss in the basin, including the construction of risk reduction levees.

Freshwater inputs in the basin are now limited primarily to precipitation and runoff from the Upper Barataria Basin and diversion (and similar) projects constructed along the Mississippi River, as discussed i in Appendix U Summary of Select Natural and

Man-made Diversions in Southeastern Louisiana. Vertical land accretion now occurs as a result of deposition of sediments from storm events, eroding marshes, and waterbottoms (Conner and Day 1987, Madden et al. 1988). Land loss in the Barataria Basin from 1932 to 2016 resulted in a net loss of 276,036 acres, accounting for 29.1 percent of the land area in the basin (Couvillion et al. 2017). Along coastal barrier islands of Louisiana, historical and long-term loss rates average about 8.9 feet per year (Kindinger et al. 2013). Since the 1990s, several studies, under varied agencies and authorities, have explored the concept of diverting fresh water, sediments, and nutrients from the river to the Barataria Basin (see Section 1.2.2.1 Previous Studies) to address impacts to the system from natural (for example, sea level rise, subsidence) and human (for example, levees, canals) causes; these prior works have led to the consideration of the proposed MBSD Project.

Already stressed by land loss and ecosystem change, the aquatic and terrestrial resources in the Barataria Basin were further impacted by the DWH oil spill.

3.1.4.3 DWH Oil Spill

On April 20, 2010, the DWH mobile drilling unit exploded, caught fire, and eventually sank in the Gulf of Mexico, resulting in a massive release of oil from the Macondo well, causing loss of life and extensive natural resource injuries. Initial efforts to cap the well following the explosion were unsuccessful, and for 87 days after the explosion, the well continuously and uncontrollably discharged oil and natural gas into the northern Gulf of Mexico. By the time the well was capped, the resulting ecological impact was unprecedented in scale: the spill released an estimated 139 million gallons of oil into the Gulf of Mexico ecosystem and created a surface oil slick as large as the State of Virginia (DWH NRDA Trustees 2016a).

The DWH oil spill occurred within the northern Gulf of Mexico ecosystem where ecological resources and habitats are closely linked: energy, nutrients, and organisms move between habitats in this region, such that injuries to one habitat or species can have cascading impacts across the entire ecosystem (DWH NRDA Trustees 2016a). As part of the injury assessment for the DWH oil spill, the Trustees documented injuries to species including shrimp, fish, shellfish, birds, and marine mammals. These injuries ranged from decreased growth rates to reproductive effects and mortality. Many of these injured species depend on the nearshore marsh and estuarine habitats exemplified by those in the Barataria Basin for one or more of their life stages.

3.2 GEOLOGY AND SOILS

3.2.1 Geology, Topography, and Geomorphology

3.2.1.1 Historical Context

The Project area is located within the central portion of the Mississippi River Delta, bounded by current and former courses of the Mississippi River. During the Late Wisconsin glacial advance approximately 26,000 to 19,000 years ago, continental ice accumulation caused the sea level to lower 400 feet beneath its present level. As a result, the shoreline was as far as 100 miles south of its present position, at the present-day continental shelf margin (Kolb and van Lopik 1958). Lowered sea level led to entrenchment of gulfward-flowing streams and their tributaries into the newly exposed Pleistocene Prairie Formation. Entrenchment of the ancestral Mississippi River into the Prairie Formation formed an alluvial valley with branching tributaries approximately 10 to 25 miles wide. This valley trended southeast across the deltaic plain from near Houma to Grand Isle on the eastern edge of the Barataria Basin (May et al. 1984).

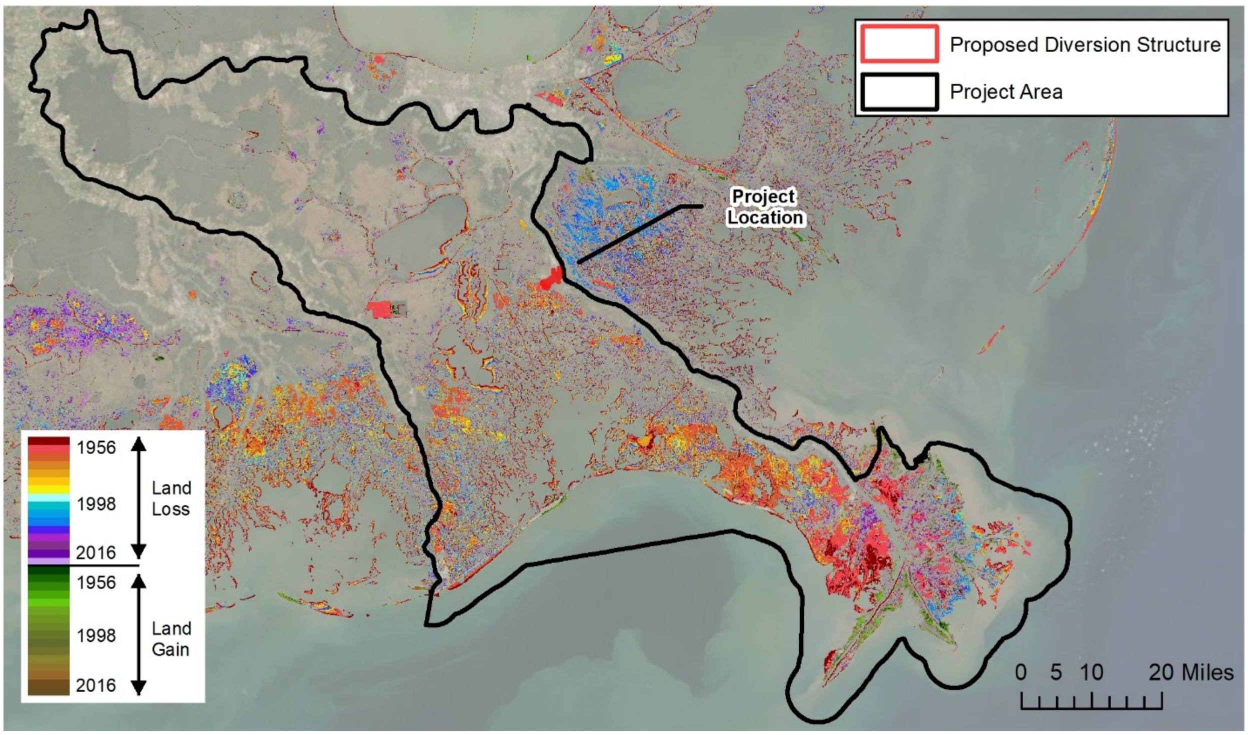
Between 17,000 and 8,000 years ago, sea level began to rise rapidly, at 0.5 inches/year (12 millimeters/year), as a result of glacial melting (Sweet et al. 2017). As sea level rose, glacial outwash of sands and gravel were deposited in a braided stream environment in the entrenched valley. The rate of sea-level rise slowed about 7,000 years ago (Turner et al. 2018), filling the incised valleys with sediment and transforming the Lower Mississippi River back to a meandering system (Blum and Roberts 2012). About 5,700 years ago, sea level was 6 to 10 feet (2 to 3 meters) lower than present and the rate of relative rise slowed to 0.1 to 0.2 inch/year (3 to 5 millimeters/year) (Blum and Roberts 2012; Otvos 2008; Otvos and Giardino 2004; Otvos 2005). The Mississippi River began building a series of lobate deltas in a gulfward direction, displacing Gulf waters that had extended up the Mississippi River alluvial valley.

Beginning approximately 3,600 years ago, the Project area received sediments from Mississippi River deltas related to the St. Bernard, Lafourche, and, most recently, the Plaquemines-Balize modern delta complex. The result of deltaic deposition in the Project area is a thick sequence of fine-grained deltaic deposits overlying substratum and Pleistocene deposits (May et al. 1984). These deposits reach a maximum thickness of over 300 feet at the mouth of the present Mississippi River and in the ancestral valley near Grand Isle. This is much thicker than in ancestral deltas, which were deposited in shallower water (Kulp et al. 2005). The delta complexes and their associated lobes overlap each other throughout much of the Project area, contributing to the complexity of the geologic setting. Each delta lobe was abandoned when the river mouth filled with sediment and the river switched to shorter, steeper routes to the Gulf. Sediments at the abandoned river mouth began to subside and erode, with sediments being reworked into islands and moved alongshore. This sequential construction and abandonment of individual delta lobes is part of a normal delta cycle (Roberts 1997; Van Beek and Gagliano 1984). As such, a normally functioning delta typically includes both one or more active delta lobes, as well as older, abandoned delta lobes with lower sediment loads.

Historically, Mississippi River channel migration, crevasses, and overbank flooding deposited sediment, fresh water, and nutrients in the Barataria Basin, building land and sustaining wetland habitats. However, levees and Mississippi River channelization have altered natural fluvial interaction and sediment transport from the river into the basin, removing the source of sediment and fresh water that built and maintained the wetlands relative to subsidence and sea-level rise. See a more detailed discussion about how levees and Mississippi River channelization have contributed to wetland loss in the basin in Section 3.6.2.2 Causes of Wetland Loss. See Section

3.4.1.1 Sea-Level Rise and Subsidence for more detail about subsidence in the Project area.

Between 1932 and 2016, land area in the Barataria Basin declined from approximately 947 to 671 thousand acres and in the Mississippi River Delta from approximately 167 to 75 thousand acres (Couvillion et al. 2017). Figure 3.2-1 depicts land area change within the Project area from 1932 to 2016. Wave and current-driven erosion are the dominant processes contributing to ongoing land loss along the barrier islands, headlands, and exposed bay and lake rim margins of the Project area, while submergence mainly from the actions of flooding, excavation of oil and gas canals, substrate compaction, and subsidence are the primary contributors of land loss in the interior marshes of the basin (Penland et al. 1990).



Source: Couvillion et al. 2017

Figure 3.2-1. Land Area Change in Project Area (1932 to 2016).

3.2.1.2 Existing Conditions

Surficial geologic conditions in the Project area consist of a network of abandoned distributaries and their associated natural levees separated by swamps, interdistributary marshes, lakes, and bays. The surface is generally characterized by a sequence of Holocene-aged natural levee, point bar, marsh, interdistributary, prodelta, and nearshore Gulf deposits overlying substratum and Pleistocene-age deposits (HDR Engineering 2014a). Natural levees are approximately 5 feet in elevation and composed mainly of oxidized silts and silty clays that are well drained, have low water content, and medium to stiff consistency. Natural levee deposits are approximately 10 to 20 feet thick at the Mississippi River and become thinner towards the west. Subsurface point bar deposits near the river are predominantly silt, silty sand, and sand, with clays common in the upper portion, and are approximately 120 feet thick. They form on the inside ("point") of a bend in the river channel where water velocity slows and allows sediment load to settle out. Marsh deposits are approximately 10 feet thick and composed of very soft organic clays and peat with relatively high water content and low strength. Interdistributary deposits form when floodwaters overtop natural levees or are carried inland by wave action or currents from river mouths. The sediments settle out in vegetated marshes or shallow ponds within the interdistributary lowland. Interdistributary deposits consist of very soft, saturated gray clays that are highly bioturbated (disturbed by living organisms) and contain some silt laminae. Shell fragments and minor amounts of organic debris are commonly distributed throughout the interdistributary sequence, which is approximately 40 feet thick. Some zones of intradelta deposits are found within the interdistributary deposits. Intradelta deposits form at the mouth of an advancing delta and consist primarily of clean sands and silty sands with some silts and are 10 to 20 feet thick. Beneath the interdistributary deposits are prodelta deposits characterized by massive, homogeneous clays with medium consistency. Silt laminations and shell fragments are rare. Prodelta deposits are approximately 60 feet thick. Nearshore Gulf deposits are approximately 5 feet thick and are composed of silty sand and sand deposits with shell fragments that represent an erosional surface that formed on top of the Pleistocene surface as sea level was rising. The top of the Pleistocene surface is located at approximately -125 feet in elevation. These deposits consist of over-consolidated stiff to very stiff clay with sand and silt lenses and low water content (May et al. 1984, HDR Engineering 2014a).

To characterize the distribution of sediments in the mid-basin, sediment cores were collected at 25 stations in the basin (Bentley at al. 2015). Results of the study showed that existing sediments in the mid-basin have the following grain size distribution:

- from ground surface to a depth of 30 inches (75 centimeters): 25 percent sand (larger than 63 microns in size), 58 percent silt (3.9 to 63 microns), and 17 percent clay (smaller than 3.9 microns); and
- from ground surface to a depth of 39 inches (100 centimeters): 22 percent sand, 59 percent silt, and 18 percent clay (Bentley et al. 2015).

The study also found that the uppermost 5 feet (1.5 meters) of sediment samples taken within the mid-basin had a high organic content; deeper than that, the mineral-rich sediments had only a scattering of highly organic sediments.

Groundwater is at or near the surface where the proposed Project diversion structure would be located. At this location, shallow groundwater levels are maintained below the surface by a system of forced drainage in which water is pumped from drainage ditches into the Barataria Basin. Point bar, intradelta, and nearshore Gulf deposits are likely hydrologically connected to the Mississippi River, and the water level in these deposits is influenced by river stages.

3.2.2 Faults

A fault is a surface or zone along which there has been ground displacement. Growth faults are a type of normal fault associated with sedimentation. They developed in the underlying Pleistocene and older basement soils due to the weight of overlying sediment deposited as the Mississippi River Delta progressed southward (Gagliano et al. 2003a). The Louisiana Geological Survey identified two surface fault traces to the west of the Project area near Bayou Lafourche (Heinrich et al. 2010). Armstrong et al. (2014) found deep subsurface fault planes that were generally about 2 miles deep and 5 to 7 miles wide that were mapped in seismic surveys in the southeastern edge of Barataria Bay and in Breton Sound. They projected where these deep faults might be if they extended to the surface, with one north of Port Sulphur and two near Empire. They noted that the amount of surface displacement of these projected fault traces, if any, was unknown.

Fault movement is driven by several processes (Gagliano 2005a): sediment loading, compaction, isostatic adjustment, migration of salt diapirs that change pressure gradients on existing fault zones or create new ones, gravity slumping related to river delta expansion onto inclined strata, and tectonic movement. Shock waves from distant earthquakes have also triggered movement along local faults, which in turn may cause a secondary earthquake (Gagliano 2005b). Modern fault movement may also be caused by oil and gas withdrawal (Morton et al. 2003). Salt domes are associated with many of the faults in southeastern Louisiana, but are absent or rare in the Project area. Although faults are sometimes associated with earthquakes, the USGS estimates that peak ground accelerations of less than 2 percent of gravity would occur in the vicinity of the Project area (USGS 2014). Therefore, the risk of strong ground shaking associated with Project-area faults is very low (HDR Engineering 2014b).

3.2.3 Mineral Resources

The mineral resources of the Project area are subdivided into non-fuel mineral resources and oil and gas resources, described separately below. While limited non-fuel mineral resource extraction takes place within the Project area, the extraction of oil and gas resources dominate the region and the Project area in terms of extraction facilities, infrastructure, and economic importance.

3.2.3.1 Non-Fuel Mineral Resources

Non-fuel mineral resources within the Project area consist primarily of construction sand excavated from upland mines and borrow pits in the Project area (USGS 2013, 2017a, 2017b). Based on a review of aerial photographs and USGS topographic maps and databases, the only active sand mines or borrow pits in the Project area include three facilities 20 to 25 miles north of the location proposed for the Project diversion structure along the west bank of the Mississippi River in the vicinity of Westwego and Avondale, Louisiana (USGS 2013, 2017a, 2017b).

In addition to traditional sand mines and borrow pit operations, there are a number of USACE-approved, privately owned and government-furnished borrow pit locations for supplying clay for Greater New Orleans HSDRRS projects. Thirty-three of these sites lie within the Project area, primarily in the uplands that form the rim of the Barataria Basin and on the natural levees of the Lower Mississippi River (USACE 2012b). Of these, the Phillips 66/Alliance and Midway Cattle Ranch borrow pits are within the vicinity of the location proposed for the Project diversion structure.

In addition to onshore sand mining and borrow pits, channel bars in the Lower Mississippi River are increasingly being used as sand resources (Allison and Nittrouer 2004, Khalil and Finkl 2009, Nittrouer and Viparelli 2014), particularly as borrow areas for coastal restoration projects. The Bayou Dupont projects (BA-39 and BA-164) are examples of marsh creation projects with in-river borrow areas located within the Project area.

While salt/halite, sulfur, and phosphates are also produced in coastal Louisiana, no currently active mines or production facilities exist within the Project area. Abandoned salt and sulfur mine locations exist in the Project area, the closest of which being the Lake Hermitage Dome subsurface sulfur mine approximately 9 miles southeast of the location proposed for the Project diversion structure.

3.2.3.2 Oil and Gas Resources

Oil and gas production is one of the most significant industries throughout Louisiana and the surrounding region. The Barataria Basin and Mississippi River Delta in particular have a long history of extensive oil and gas production, transportation, and processing. The Project area is the location of extensive historical and ongoing onshore oil and gas production and associated wells, pipelines, and collection infrastructure as well as pipelines and infrastructure associated with the transportation of oil and gas from offshore to onshore processing facilities.

Per review of the Louisiana Department of Natural Resource (LDNR) Strategic Online Natural Resources Information System (SONRIS), there are 184 oil and gas fields in the Barataria Basin and the Lower Mississippi River Delta that are entirely or partially within the Project area (see Figure 3.2-2). The location proposed for the Project diversion structure directly overlies the Lafitte oil field and is approximately 1 mile immediately south of the Alliance oil field. SONRIS data also indicate that the Project area contains 22,364 oil and gas wells (LDNR 2017a). Table 3.2-1 summarizes the status of the oil and gas wells in the Project area. The Project area also contains thousands of miles of oil and gas pipelines. A review of publicly available pipeline data from the National Pipeline Mapping System (U.S. Department of Transportation [USDOT] 2017), the U.S. Energy Information Administration (USEIA 2017), and the USGS (1999) indicate that over 2,600 miles of crude oil, petroleum product, and natural gas pipelines are located in the Project area.

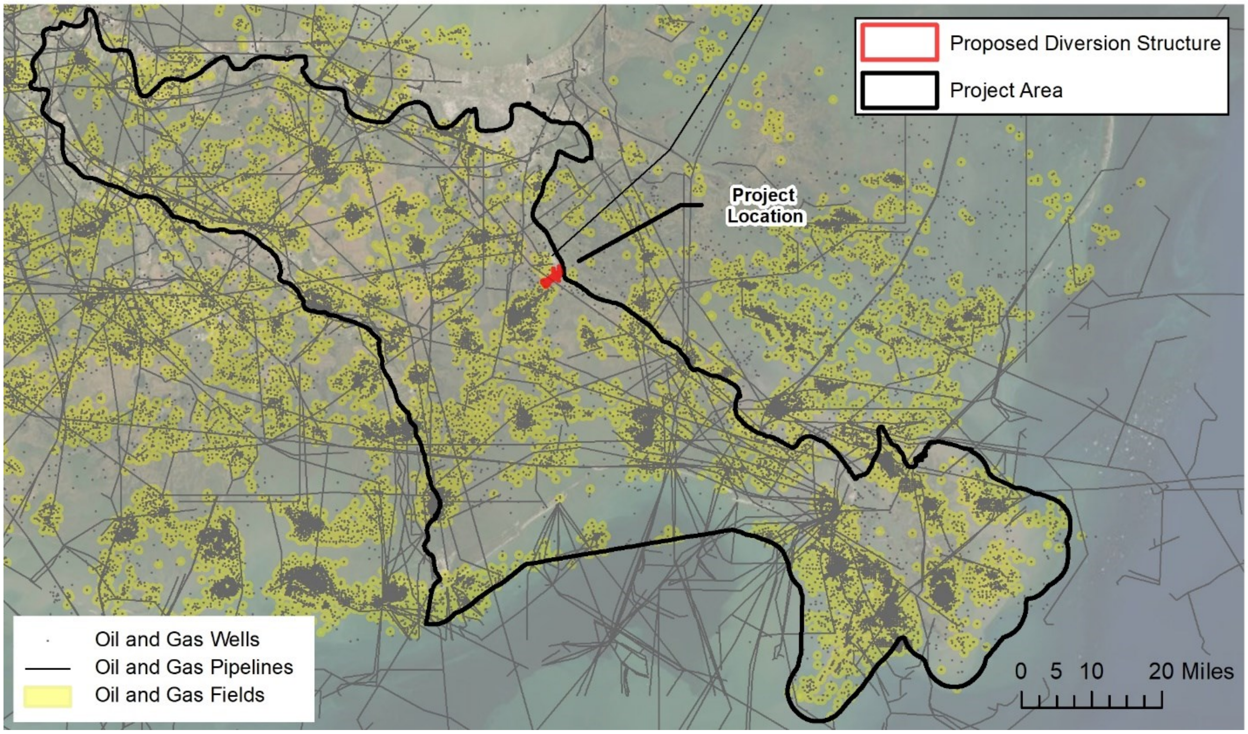


Figure 3.2-2. Map of Oil/Gas Fields, Wells, and Pipelines within the Vicinity of the Location Proposed for the Project Diversion Structure.

The Shell Delta Crude Nairn-Norco 20-inch crude oil pipeline transits the immediate outfall area of the location proposed for the Project diversion structure (USDOT 2017). Approximately 1 to 1.5 miles north of the Project footprint is the Alliance Refinery, which, per the NPMS (USDOT 2017), is served by a network of oil and gas pipelines, including:

- Shell Delta Crude Alliance Refinery 16-inch-diameter Lateral crude oil pipeline;
- Plains Pipeline Cam crude oil pipeline;
- Colonial Pipeline non-Highly Volatile Liquid product pipeline;
- American Midstream Lafitte natural gas pipeline;
- American Midstream Lafitte Gloria Cros natural gas pipeline; and
- Phillips 66 Pipeline River Parish natural gas pipeline.

Table 3.2-1
Summary of Oil/Gas Wells in the Project Area by Well Status

Status	Count	Percent
Plugged and Abandoned	11,100	49.6%
Dry and Plugged	4,842	21.7%
Shut-In Productive-Future Utility	1,995	8.9%
Permit Expired	1,611	7.2%
Active-Producing	799	3.6%
Reverted to Single Completion	636	2.8%
Active-Injection	348	1.6%
PA-35 Temporary Inactive Well	335	1.5%
Shut-In Productive-No Future Utility	222	1.0%
Temporarily Abandoned Well	161	0.7%
Act 404 Orphan Well	107	0.5%
Unable to Locate Well	95	0.4%
Plugged Back-No Perforations	37	0.2%
Water	28	0.1%
Shut-In Dry Hole-Future Utility	22	0.1%
Permitted	9	<0.1%
Approval to Construct Injection Well	7	<0.1%
Shut-In Dry Hole- No Future Utility	4	<0.1%
Inactive Injection Well	2	<0.1%
Conversion to Oil/Gas Well	2	0.0%
Educational/Service Company	1	<0.1%
Shut-In Waiting on Pipeline	1	<0.1%
Source: LDNR 2017a		

3.2.4 Soils

Soils in the Project area formed in alluvial sediments from distributary streams of former Mississippi River deltas (Saucier 1974). Generally, 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 protected from flooding. The soils within the Project area were identified and assessed using the Soil Survey Geographic (SSURGO) database (USDA 2017) as provided by the U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS), as summarized below. Figure 3.2-3 depicts the primary soil series in the Project area. With the exception of three soil series found on natural levees of the Mississippi River and sandy ridges of barrier islands (the Commerce, Convent, and Felicity series), all soil series in the Project area are classified as hydric. Hydric soils are formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upperpart and support hydrophytic vegetation. The presence of hydric soils is one of three criteria used by the USACE to determine whether an area is classified as a wetland (USACE 1987; see Section 3.6 Wetland Resources and Waters of the U.S. for information about wetlands in the Project area).

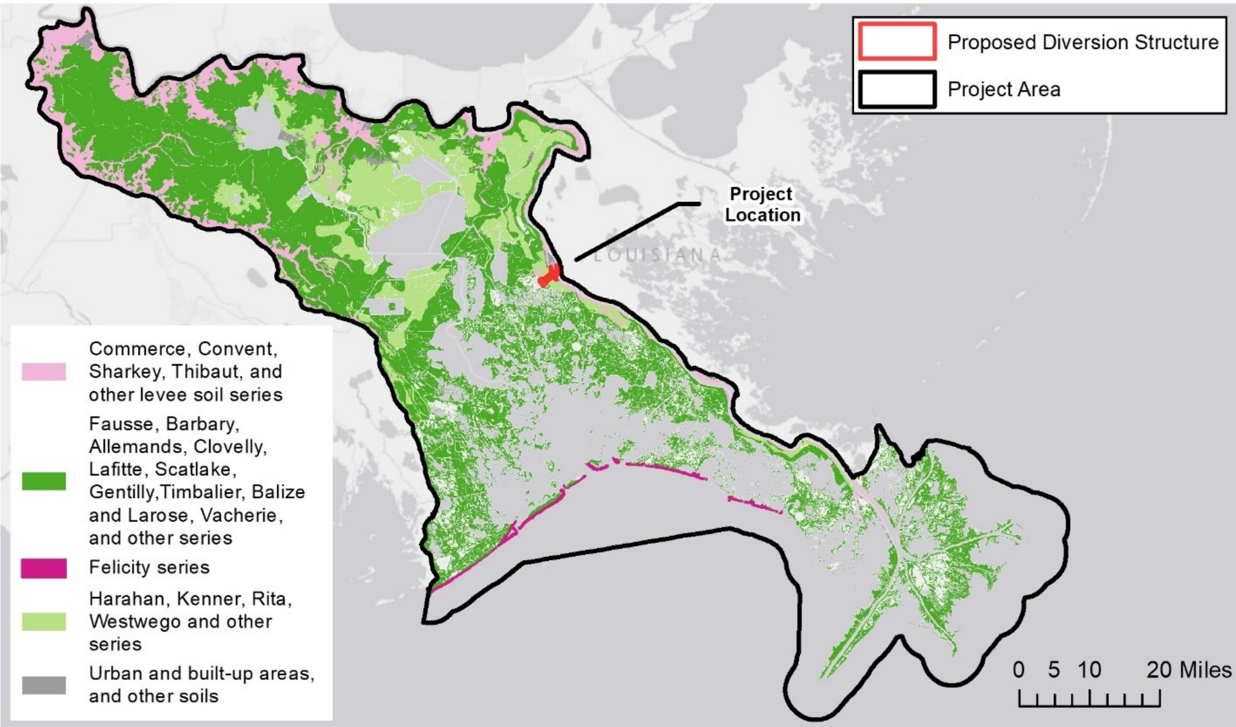


Figure 3.2-3. Map of Primary Soil Units in Project Area. Soils on the natural levees within the Project area that are protected from flooding or are rarely or occasionally flooded include Sharkey, Commerce, and Convent series. Soils on the natural levee at the location proposed for the Project diversion structure location belong to the Sharkey-Commerce unit.

Soils in the marshes and swamps of the Project area are frequently flooded and ponded, very deep and very poorly drained, with slopes less than 1 percent. These include Fausse, Barbary, Allemands, Clovelly, Lafitte, Scatlake, Gentilly, and Timbalier series.

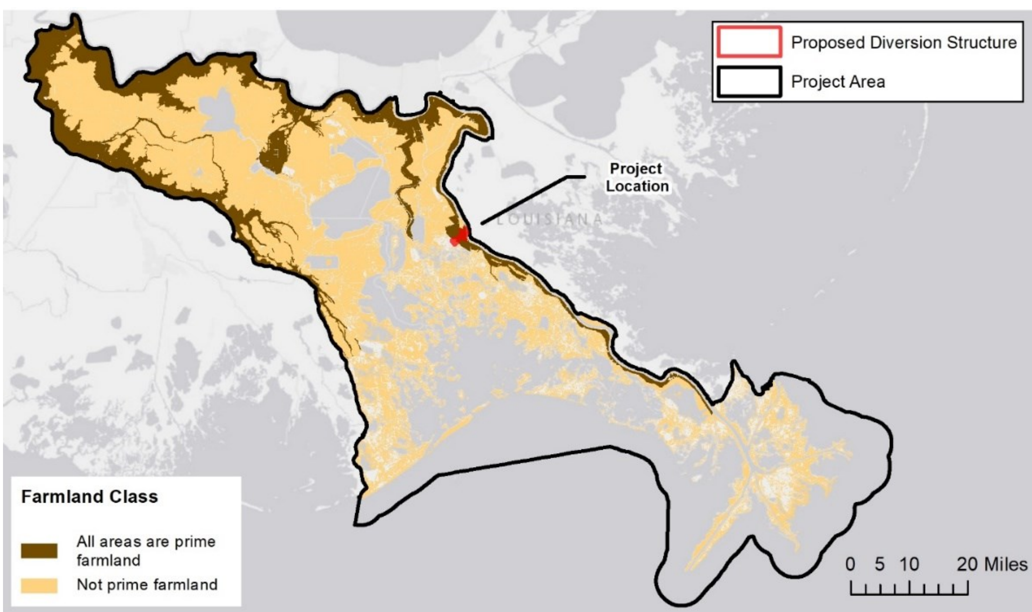
Soils in former marshes and swamps that have been drained and protected from flooding include Kenner, Harahan, Westwego, and Rita series. These soils are deep to very deep and poorly to very poorly drained with slopes ranging from 0 to 1 percent. Soils in the area of the location proposed for the Project diversion structure belong to the Harahan-Westwego-Rita unit.

Soils on sandy ridges that are occasionally flooded include the Felicity series. These soils formed in sandy coastal environments on level and nearly level areas adjacent to Gulf coastal beaches. They are found mainly at elevations of 5 feet or less and are subject to flooding during storm tides. Slopes range from 0 to 3 percent.

3.2.5 Prime Farmland

The Farmland Protection Policy Act of 1981 (FPPA) specifies that federal agencies must evaluate the impacts of any activities that could result in the conversion of designated prime or unique farmland, or farmland of statewide and 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. Unique farmland is defined as land other than prime farmland that is used for producing specific high-value food and fiber crops. 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.

The majority of land within the interior of the Project area is wetlands and is not classified as prime or unique farmland (see Figure 3.2-4). Areas along the inland margins of the Project area adjacent to the Mississippi River and Bayou Lafourche on higher-elevation natural levees or drained soils are classified as prime farmland. This includes the majority of the area of the location proposed for the Project diversion structure. Within the broader Project area, the SSURGO data (USDA 2017) describe 1.1 million acres of mapped non-water soil units. Of these, 277 thousand acres (25 percent) are classified as areas of prime farmland, and about 848 thousand acres (75 percent) are classified as not prime farmland.



Source: USDA 2017

Figure 3.2-4. Prime Farmland in the Project Area.

3.3 GROUNDWATER RESOURCES

3.3.1 Aquifers

The Project area is 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 (USGS 2003, Renken 1998). 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).

In the northwestern portion of the Project area, the Coastal Lowlands Aquifer System contains two freshwater aquifers, including the Mississippi River Alluvial Aquifer and the Chicot Equivalent Aquifer System, which comprise 10 percent and 11 percent, respectively, of the Project area (Smoot 1986, Louisiana Department of Transportation and Development [DOTD] 2009). Recharge occurs from rainfall over the aquifer surface, leakage from underlying aquifers, and locally from the Mississippi River (Stuart et al. 1994). The majority of the Project area does not have a major source of fresh groundwater (Smoot 1986).

Surface sediments in the Barataria Basin adjacent to the Mississippi River are generally connected hydrologically to adjacent waterbodies, and the groundwater level reflects the level of adjacent waterbodies (USACE 2004). As such, submarine groundwater discharge is a contributor to geochemical and hydrological fluxes within the deltaic plain (Kolker et al. 2013).

3.3.1.1 Sole Source Aquifers

The U.S. Environmental Protection Agency (USEPA) 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 (USEPA 2017a). There are no SSAs within the Project area. The nearest SSAs are the Southern Hills Regional Aquifer System and the Chicot Aquifer System, which are 9.1 miles north and 14.8 miles west of the Project area, respectively.

3.3.2 Groundwater Use

3.3.2.1 Groundwater Extraction

Surface water sources account for the majority of water withdrawals in the Project area, and groundwater withdrawal is minimal by comparison. Withdrawal rates for all parishes in the Project area are shown in Table 3.3-1. Most groundwater withdrawn in the Project area is associated with industry along the Mississippi River corridor (Sargent 2011).

Table 3.3-1
Groundwater Withdrawals, in Million Gallons per Day (Mgal/d)[a]

Parish	Public Supply	Industrial	Power Generation	Rural Domestic	Livestock/ Irrigation/ Aquaculture
Ascension	3.0	6.4	0.0	2.2	0.3
Assumption	0.0	8.6	0.0	0.2	0.3
Jefferson	0.0	2.2	4.9	0.0	0.1
Lafourche	0.0	1.1	0.0	0.0	3.0
Orleans	0.0	1.9	10.9	0.2	0.0
Plaquemines	0.0	0.0	0.0	0.0	0.0
St. Bernard	0.0	0.0	0.0	<0.1	<0.1
St. Charles	0.0	4.2	0.0	0.0	0.0
St. James	0.0	2.8	0.0	0.0	0.0
St. John the Baptist	3.9	9.5	0.0	0.1	0.0
Total / % of Total Project-Area Parish Use[b]	**6.9 / 10.5%**	**36.7 / 55.7%**	**15.8 / 23.9%**	**2.8 / 4.3%**	**3.7 / 5.6%**

Mgal/d = million gallons per day

[a] This table is adapted from Sargent 2011. The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends.

[b] Note that these totals are for the entirety of the listed parishes (not just the portions of the parishes found within the Project area).

3.3.2.2 Public and Private Water Supply Wells

Based on consultation with the Louisiana Department of Environmental Quality (LDEQ), there are no public drinking water wells in the Project area (LDEQ 2018a). The closest well identified in the vicinity of the proposed Project diversion structure is an irrigation well, approximately 0.5 mile south.

As of 2015, there were 414 active water wells within the Project area. These include 147 wells registered in the Mississippi River Alluvial Aquifer with an average well depth of 248 feet, 194 wells registered in the Chicot equivalent aquifer system with an average well depth of 295 feet, and 73 wells registered in areas with unknown aquifer designations and depths (LDNR 2017b).

3.3.3 Groundwater Quality

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). As explained in Section 3.3.1, the majority of the Project area (79 percent) is not associated with large freshwater aquifers (Renken 1998, USGS 2003).

The LDEQ runs an Aquifer Sampling and Assessment Program to monitor the quality of groundwater in Louisiana’s major freshwater aquifers. The program samples groundwater wells across 14 aquifers on a rotational basis every 3 years and presents the results in a triennial report. Under the Federal Safe Drinking Water Act, USEPA has established the primary Maximum Contaminant Level (MCL) for pollutants that may pose a health risk in public drinking water. A primary MCL is the highest level of a contaminant that USEPA allows in public drinking water. Secondary MCLs have also been set by USEPA, but are defined as non-enforceable guidelines for the taste, odor, or appearance of water (LDEQ 2009a, 2009b).

The LDEQ's 2009 triennial report (the most recent year for which data are available), indicates that the groundwater from the Mississippi River Alluvial Aquifer is very hard and of poor quality when considering taste, odor, or appearance, with 33 secondary MCLs exceeded in 19 wells. The primary MCL for arsenic was the only short-term or long-term health risk guideline exceeded; this exceedance occurred in six of the 23 wells sampled in this aquifer (LDEQ 2009b). The 2009 report indicates that the groundwater from the Chicot Equivalent Alluvial System is soft and of fair quality when considering taste, odor, or appearance guidelines, with 20 secondary MCLs exceeded in 10 wells. One primary MCL (arsenic) was exceeded in an industrial use well.

The LDNR's *Recommendations for a Statewide Ground Water Management Plan* provides a summary of known or potential adverse impacts on groundwater quality or availability in the major aquifer systems in Louisiana. Saltwater intrusion from the Gulf of Mexico was among the findings of concern cited in the report for the Mississippi Alluvial and Chicot Equivalent Aquifers (LDNR 2011).

The LDNR's Office of Conservation has the authority to regulate groundwater usage by designating an Area of Ground Water Concern, 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 Project area (LDNR 2018).

3.4 SURFACE WATER AND COASTAL PROCESSES

3.4.1 Overview

3.4.1.1 Sea-level Rise and Subsidence

Relative sea-level rise results from the combined effects of terrestrial subsidence and global sea-level rise. Subsidence is defined as the downward movement of the earth's surface relative to a vertical datum such as Mean Sea Level. Subsidence at any location is rarely due to one process, but is generally the result of multiple processes acting to produce the observed rate. In the Barataria Basin, natural subsidence processes include: compaction of Holocene sediments, which accounts for at least 60 percent of the total subsidence rate (Jankowski et al. 2017); glacial isostatic adjustment, in which the bulge that had been created around the ice sheet readjusts downward, contributing 0.02 inch (0.55 millimeter) per year to local relative sea-level rise (Gonzalez and Törnqvist 2006, Yuill et al. 2009); coastal land loss (Kolker et al. 2011); tectonics, including fault processes and the movement of salt diapirs (Gagliano 2007, Dokka 2006, Dokka et al. 2006, Dokka 2011); and downwarping due to the weight of the increased load of thick sediment deposits (Yuill et al. 2009).

Groundwater and oil and gas extraction have been identified as localized causes of subsidence (Morton et al. 2006, Kolker et al. 2011). The forced drainage of wetlands for agriculture, flood protection, or development results in lowering of the water table, which in turn causes accelerated surface consolidation and oxidation of organic material. Subsidence up to several feet has been documented in developed areas of Jefferson and Orleans Parishes, and large areas of coastal land loss are found associated with early failed land reclamation projects (Craig et al. 1979). Subsidence resulting from forced drainage is highly influenced by the thickness of organic-rich deposits in the subsurface (Zilkoski and Reese 1986, Jones et al. 2016). The thicker the organic deposits, the higher the subsidence potential. The area in the vicinity of the location proposed for the Project diversion structure is under forced drainage.

Gagliano et al. (2003a, b), Gagliano (2005c), and Yeager et al. (2012) identified faulting as a significant driver of tectonic subsidence in coastal Louisiana. For a discussion of faults, see Section 3.2.2 in Geology and Soils.

Compaction of Holocene deposits is considered the primary contributor to subsidence in the Mississippi River deltaic plain (Roberts 1985, Roberts et al. 1994, Törnqvist et al. 2008, Jankowski et al. 2017). Primary compaction occurs naturally as soil volume is reduced due to dewatering under the weight of overlying sediment. Previous studies suggest a strong relationship between rates of subsidence and the age, thickness, and character of Holocene deltaic deposits (Kuecher 1994, Roberts et al. 1994, Kulp 2000, Törnqvist et al. 2008). The highest rate of shallow sediment compaction occurs within the uppermost 16 to 33 feet (5 to 10 meters) and has a high degree of spatial and temporal variability within the Project area (Jankowski et al. 2017). In general, subsidence ranges are lower in the northern portion of the Project area where older, thinner Holocene deposits are found, and increase towards the coast where younger, thicker deposits characterize the area. Specifically, subsidence ranges for the Upper and Middle Barataria Basin are 0.1 to 0.4 inch (2 to 10 millimeters) per year and for the Lower Barataria Basin are 0.2 to 0.8 inch (6 to 20 millimeters) per year (Reed and Yuill 2016). Microbiological (for example, decay) and chemical (for example, oxidation) processes also contribute to net sediment compaction but over much longer periods of time (hundreds to thousands of years) (Yuill et al. 2009, van Asselen et al. 2009).

Local and regional subsidence processes coupled with global sea-level rise produce relative sea-level rise rates for a specific location. Global sea-level rise refers to the global fluctuations in sea level primarily driven by variations in the masses or volume of the oceans caused by melting of major ice caps and glaciers and expansion or contraction of sea water in response to temperature changes (Rovere et al. 2016). Tide gage records indicate global average sea level rose an average of 0.07±0.02 inch (1.9 ± 0.4 millimeters) per year over the period 1961 to 2009 (Church and White 2011).

Satellite altimetry records indicate that the average sea surface elevation in the Gulf of Mexico has increased at a rate of 0.13±0.02 inch (3.3 ± 0.4 millimeters) per year between 1993 and 2011 (Parris et al. 2012). The U.S. Interagency Sea Level Rise Task Force (Sweet et al. 2017) has developed six scenarios for future global mean sea-level rise in the United States through 2100, with a low (historical) rate of about 1 foot (0.3 meter) by 2100, an intermediate rate of 3.3 feet (1.0 meter) by 2100, and a high (worst-case physically possible) rate of 6.6 feet (2.0 meters) by 2100.

In Louisiana, due to the high rate of subsidence in shallow (16 to 33 feet [5 to 10 meters]) sediment, approximately 60 to 85 percent of the total subsidence is not included in tide gage measurements, which are anchored at an average of 75 feet (23 meters) below the surface (Nienhuis et al. 2017). The National Oceanic and Atmospheric Administration (NOAA) tide gage at Grand Isle measured a relative sea-level rise rate of 0.36 inch (9.1 millimeters) per year (1947 to 2016), but the Coastwide Reference Monitoring System (CRMS) sites measured a much higher rate of change between 1992 and 2011: 0.47 ± 0.33 inch (12.0 ± 8.3 millimeters) per year as the average for all 274 Coastal Louisiana CRMS sites, and 0.52 ± 0.35 inch (13.2 ± 8.8 millimeters) per year as the average for the 185 Mississippi Delta Louisiana CRMS sites (Jankowski et al. 2017). General guidance on "Incorporating Sea Level Change in Civil Works Programs" can be found in the USACE Engineer Regulations 1100-2-8162.

In summary, regional geological processes and human alterations have caused subsidence throughout coastal Louisiana, particularly in the southern portion of the Project area. Due to these regional influences in combination with global sea-level rise, water levels are projected to continue rising.

3.4.1.2 Coastal Zone Regulatory Setting

The Coastal Zone Management Act (CZMA) calls for the effective management, beneficial use, protection, and development of the nation's coastal zone and promotes active state involvement in achieving those goals. To reach those goals, the CZMA requires participating states to develop management programs that demonstrate how those states will meet their obligations and responsibilities in managing their coastal areas. In Louisiana, the LDNR, Office of Coastal Management (OCM) administers the Coastal Zone Management Program (LDNR 2017c). The inland boundary of the Louisiana Coastal Zone was most recently delineated in the 2012 Regular Session of the Louisiana Legislature with the passage of House Bill 656 (Act 588); the Louisiana Coastal Zone consists of all or part of 20 coastal parishes. The proposed Project area is located entirely within the 2012 Louisiana Coastal Zone (LDNR 2017d).

The Coastal Barrier Resource Act (CBRA), as amended, designated relatively undeveloped coastal barriers along the coast of the U.S. and its territories as part of the John H. Chafee Coastal Barrier Resources System (CBRS). The purposes of the CBRA are "to minimize the loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources associated with the coastal barriers along the Atlantic and Gulf Coasts . . ." (16 USC 3501[b]). Under this act, federal expenditures and federal financial assistance are prohibited in units of the CBRS, except for emergency life-saving activities or under certain exceptions. Units within Louisiana (S01-S08 and LA07) are specifically excluded from the prohibition on federal expenditures when those expenditures combat shoreline erosion. The USFWS is the primary authority tasked with its implementation. The Project area encompasses four CBRS units and one otherwise protected area along its southern margin (USFWS 2017a; see Figure 3.4-1). These include:

- Bastian Bay Complex (S01) from Sandy Point to Lanaux Island;
- Bay Joe Wise Complex (S01A) from Bastian Island to Quatre Bayou Pass;
- Grand Terre Island Unit (S02), including the Grand Terre Islands to Fort Livingston;
- Caminada Unit (S03) from Elmer's Island to Bayou Fourchon; and
- Grand Isle Unit (LA-04P), an otherwise protected area including Fort Livingston and Grand Isle State Park.

Federally funded or financially assisted activities occurring within a CBRS unit are subject to a consistency analysis by the USFWS. Activities can be found to be consistent with CBRA per exemption 16 USC 3505(a)(6)(A) for "Projects for the study, management, protection, and enhancement of fish and wildlife resources and habitats, including acquisition of fish and wildlife habitats, and related lands, stabilization projects for fish and wildlife habitats, and recreational projects."

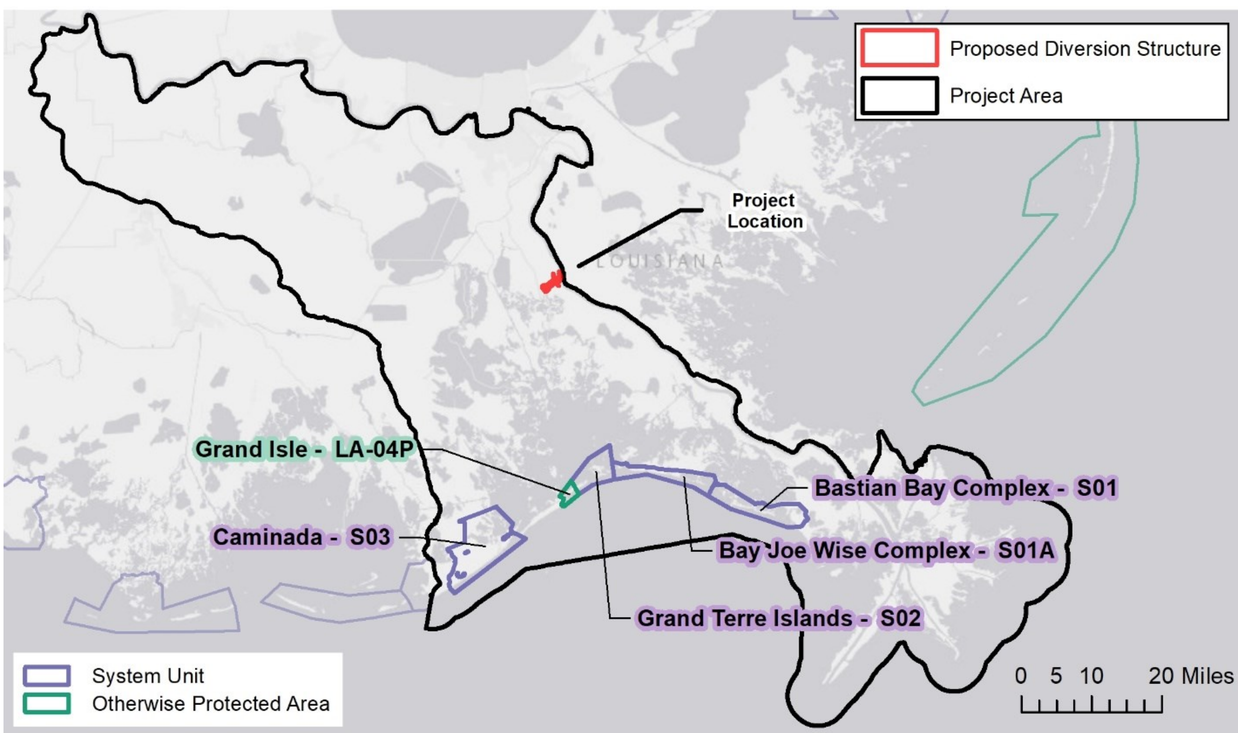


Figure 3.4-1. Coastal Barrier Resources System Units in the Project Area.

3.4.1.3 Watershed Characterization

The Project area is defined by the boundaries of the Barataria Basin and the Lower Mississippi River watersheds identified by USGS as the East Central Louisiana and Lower Mississippi River Hydrologic Units (HUCs 08090301 and 08090100, respectively) (USGS 2017c) (see Figure 3.1-1). The majority of the Barataria Basin consists of low-relief coastal bays, lakes, and deltaic marshes between Bayou Lafourche and the Mississippi River within the East Central Louisiana watershed. Surface waters in the East Central Louisiana watershed are largely influenced by estuarine and oceanic waters of the Gulf of Mexico. The flow of fresh surface water into the Barataria Basin has been reduced due to the construction and maintenance of flood control levees along the Mississippi River and other modifications explained in Section 3.1.4 Overview and History of the Project Area. A more detailed discussion about the causes of wetland loss in the Barataria Basin, including the construction of risk reduction levees, is provided in Section 3.6.2.2 in Wetland Resources and Waters of the U.S. At present, diversion projects introduce a small amount of water from the Mississippi River into the basin. See Section 3.4.2.4 Tides, Currents, and Flow for more details about existing diversion projects.

The Lower Mississippi River watershed above Venice consists only of the river channel itself and adjacent levees. Below Venice, the watershed widens to include the coastal bays, passes, levees, and deltaic marshes of the river delta, which still receives the flow of fresh surface water from the Mississippi River. Some portions of the flow of the Mississippi River within the birdfoot delta have been diverted for marsh creation and restoration projects, as described in Section 3.4.2.4 Tides, Currents, and Flow. Surface water flow in the Lower Mississippi River watershed is generally dominated by the Mississippi River itself except during very low river flows, during which time it is influenced more by estuarine and oceanic waters of the Gulf. Each of these HUCs is further subdivided by the USGS into finer sub-basins, as depicted in Figure 3.1-1.

3.4.1.4 Waterbodies in the Project Area

The Barataria Basin is delineated by the natural levees that were formed by Bayou Lafourche and the Mississippi River. A chain of barrier islands separates the basin from the Gulf of Mexico. In the northern half of the basin several large lakes occupy the lower lying areas approximately half-way between the ridges. The southern half of the basin consists of tidally influenced marshes connected to a large bay system behind the barrier islands.

Waterbodies within the Barataria Basin include numerous lakes (Lac des Allemands; Lakes Boeuf, Cataouatche, Salvadore, and Little Lake), Caminada Bay, and Barataria Bay (see Figure 3.1-2). In addition, the USACE maintains federal navigation channels in the Project area. These include the Mississippi River, the GIWW, the Barataria Bay Waterway, and Bayou Lafourche (see Section 3.21 Navigation for information about federal navigation channels in the Project area).

3.4.2 Hydrology and Hydrodynamics

3.4.2.1 Historical Context

The Mississippi River is a massive river, draining over 768 million acres covering parts of 31 states and two Canadian Provinces (Alexander et al. 2012). As described in Section 3.1.4 Overview and History of the Project Area, the Barataria Basin was an active sublobe of the St. Bernard delta complex and lies between the natural levees that were formed by Bayou Lafourche and Bayou des Familles (Frazier 1967, LDWF 2015c). The basin was supplied with fresh water, sediment, and nutrients from the Mississippi River, through both a direct connection to the river and seasonal flooding. The primary connection between the Barataria Basin and the Mississippi River—Bayou Lafourche—was closed off in 1904 when a dam was built across the head of Bayou Lafourche in Donaldsonville, cutting off all flow from the Mississippi River (Van Heerden et al. 1996). Continued channelization of the main channel of the Mississippi River and increasing levee heights during the 1930s and 1940s further isolated the Barataria Basin from fresh water and sediment carried by floodwaters that historically overflowed into the wetlands (Alexander et al. 2012, Conner and Day 1987). See Section 3.6.2.2 for a more detailed discussion about how levees and the channelization of the Mississippi River have contributed to wetland loss in the Barataria Basin.

3.4.2.2 Bed Elevations

Elevation data for dry land is termed topography and for land below the water surface is termed bathymetry or “bed elevations” (referenced to the North American Vertical Datum of 1988 [NAVD88]). Figure 3.4-2 shows the bed elevations of Barataria Basin for the current Delft model version 3 (Sadid et al. 2018). Elevations in the area are highest along the Mississippi River Levee and lowest in navigation channels. See Section 3.21 Navigation for information about navigation channel depths in the Project area.

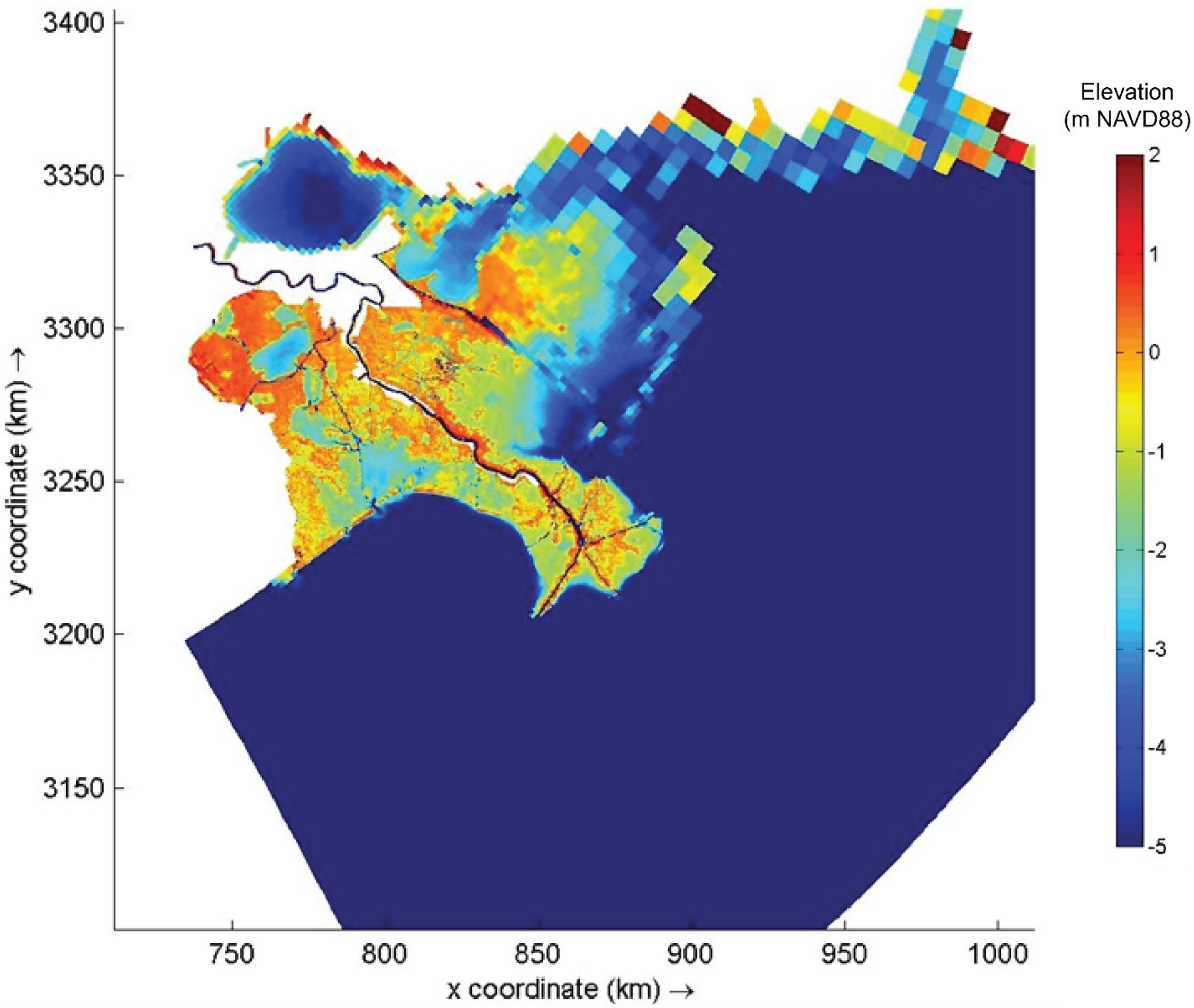


Figure 3.4-2. Barataria Basin Model Grid Bed Elevations from the Delft Model Version 3. Figure is adapted from Sadid et al. 2018. Elevations are in referenced to NAVD88.

Elevations in Lac des Allemands, which covers about 12,000 acres, range from -6 to -10 feet (see Figure 3.4-2, Meselhe et al. 2015). The two primary waterbodies in the center of the basin are the 15,000-acre Lake Salvador and 8,000-acre Lake Cataouatche (see Figure 3.4-2). The latter is the receiving body for the Davis Pond Freshwater Diversion Project outfall. Bed elevations for both lakes also range from approximately -6 to -10 feet NAVD88 (Meselhe et al. 2015).

Extending south from the GIWW to the Gulf of Mexico, the Barataria Basin contains numerous bayous and open water. The largest areas of open water are Little Lake and Barataria Bay. From Lake Salvador, water flows through Bayous Perot and Rigolettes into Little Lake and then into Barataria Bay. Elevations of Little Lake and Barataria Bay are approximately -3 to -6 feet, with Bayou St. Denis and Grand Bayou with areas at -21 feet (OCS 2017). The Barataria Bay Waterway runs between The Pen and Bayou Rigolettes, past Little Lake, and through Barataria Bay (see Figure 3.4-2). It is a major conveyance channel and acts as a conduit for saltwater intrusion. Survey cross-sections conducted in 2011 showed that most of the land elevations in this region were about 1 to 2 feet (T. Baker Smith 2011). The deepest portions of the Barataria Basin are at the passes between the barrier islands separating Barataria Bay from the Gulf of Mexico. Barataria Pass, between Grand Isle and Grand Terre Island as shown in the NOAA chart 11358, has depths over 80 feet (OCS 2017). Other passes, like Caminada Pass and Quatre Bayou Pass, have depths near 20 feet.

3.4.2.3 Water Levels

Water levels in the Barataria Basin are influenced by tides from the Gulf of Mexico, wind, and rainfall. Figure 3.4-3 shows that high winds in Grand Isle on June 21, 2017, increased water surface elevation by almost 2 feet. This effect has been well documented throughout the Louisiana coast (for example, Moeller 1993, Walker 2001, and Li et al. 2010), and occurs primarily when winds are blowing from the south or southeast as they "stack up" water in the basin. Northerly or westerly winds have the opposite effect and lower water levels in the Barataria Basin by effectively pushing water out of the basin towards the Gulf.

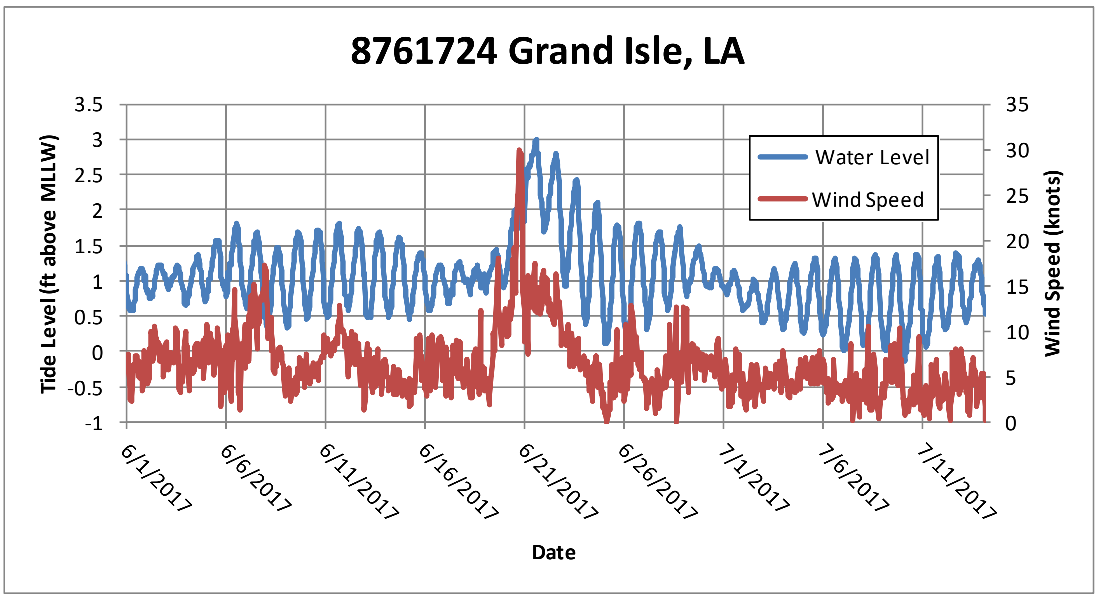


Figure 3.4-3. Water Level and Wind Speed at the Grand Isle, LA Station. USGS gages and CRMS stations throughout the Barataria Basin report daily or hourly water levels, most of which are referenced to the NAVD88 datum (USGS 2017d, CPRA 2017b). As shown in Table 3.4-1, average water levels within the Barataria Basin are generally about 1 foot.

3.4.2.4 Tides, Currents, and Flow

3.4.2.4.1 Tides

Tides are the cyclical rising and falling of water levels driven primarily by gravitational forces from the sun and moon. The tide is diurnal in the Barataria Basin. The tidal signal in the Barataria Basin is most pronounced near the Gulf of Mexico and less pronounced farther north. The tidal signal also propagates up the Mississippi

River, where the tidal range is often around 1 foot or more at Belle Chasse. A comparison of the mean tidal ranges reported at the NOAA Grand Isle station (8761724), the Hackberry Bay station near the center of the basin (8761819), and the Lafitte station near the GIWW (8761899) demonstrates the general decrease in tidal ranges farther into the basin (see Table 3.4-1).

Table 3.4-1
Summarized Water Levels within the Barataria Basin

Agency	Station Number	Station Name	Datum	Average Water Level	Max Water Level	Min Water Level	Mean Tide Range
NOAA	8761724	Grand Isle LA	Local	6.6 ft	--	--	1.0 ft
NOAA	8761819[a]	Texaco Dock, Hackberry Bay	Local	3.4 ft	--	--	0.9 ft
NOAA	8761899[a]	Lafitte, Barataria Waterway	Local	3.2 ft	--	--	0.3 ft
USGS	73802516	Barataria Pass at Grand Isle	NAVD88	0.8 ft	1.5 ft[b]	0.1 ft[b]	--
USGS	7380330	Bayou Perot at Point Legard	NAVD88	1.2 ft	1.5 ft[b]	01.0 ft[b]	--
USGS	2.951E+12	L. Cataouatche at Whiskey Canal	NAVD88	1.2 ft	1.4 ft[b]	1.09 ft[b]	--
CRMS	176	--	NAVD88	0.34 ft	2.9 ft	-2.4 ft	--
CRMS	276	--	NAVD88	0.7 ft	3.4 ft	-0.1 ft	--
CRMS	3617	--	NAVD88	0.6 ft	3.1 ft	-1.6 ft	--
CRMS	181	--	NAVD88	0.3 ft	2.7 ft	-1.6 ft	--
CRMS	3136	--	NAVD88	0.6 ft	2.3 ft	-0.9 ft	--

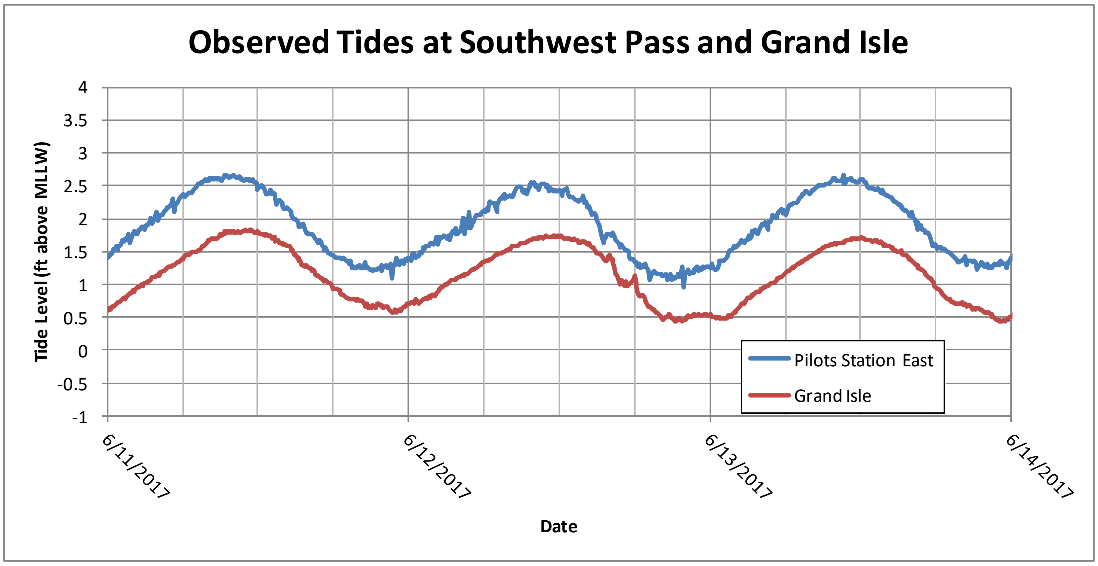
Source: CPRA 2017b

[a] These two NOAA Stations have been replaced with USGS stations that continue to monitor water levels in NAVD88 at these locations.

[b] Average, minimum, and maximum water levels estimated for CRMS and USGS stations for all available data during the period of record. Note that the period of record varies by station, with start years ranging from 2000 to 2012 for USGS and CRMS stations.

3.4.2.4.2 Currents

Currents within the Barataria Basin are generally characterized by fresh water flowing from Lac des Allemands and the Davis Pond Freshwater Diversion Project south towards the Gulf of Mexico, and salt water driven northward by tides from the Gulf into Barataria Bay. The Atchafalaya River (outside of the Project area to the west) flow also strongly influences the region via the GIWW, which intersects Lake Salvador and Bayou Perot (see Figure 3.1-2). The tidal signal in the Gulf generally acts as a wave sweeping counterclockwise (Gouillon et al. 2010) and can be observed from data from NOAA Stations about 40 miles apart: the Grand Isle station and the Pilots Station East, Southwest Pass (CO-OPS 2017) station. Figure 3.4-4 shows the tidal signal at both stations in June 2017. The high tide reaches Southwest Pass (in the birdfoot delta) one to two hours before it reaches Grand Isle (see Figure 3.1-2). This phasing difference combined with the narrow openings between the barrier islands can induce local variations in circulation as the tide propagates through the passes. Throughout the rest of the basin, currents are more complicated and influenced by a variety of local factors. Wind-forced fluctuations in the currents also commonly recur on 3- to 10-day timescales from about October through April in Barataria Basin.



Source: CO-OPS 2017

Figure 3.4-4. Observed Water Levels at NOAA Stations at Southwest Pass (8760922) and Grand Isle (8761724).

3.4.2.4.3 Flow

The present-day Barataria Basin receives fresh water mainly through rainfall and the Davis Pond Freshwater Diversion Project (LDWF 2015c). Due to the hydrologic modifications in and adjacent to the Mississippi River, most of the Mississippi River fresh water, nutrients, and suspended sediment loads are discharged into the Gulf of Mexico and off the continental shelf in a plume. There is currently very little freshwater influence from the Mississippi River plume to the Barataria Basin, except when river stages are high, winds are blowing from the southwest, and the longshore current cycles the western part of the plume around to the barrier islands (Schiller et al. 2011).

The Mississippi River plume is the largest source of fine sediment and nutrients, as well as fresh water and saltwater mixing in the northern Gulf of Mexico. Satellite data have shown that the size of the plume ranges from 174 to 2,973 square miles (450 to 7,700 square kilometers), with the size depending on the magnitude of river discharge (Walker and Rouse 1993). While the nutrient-rich waters of the plume fuel food web and fishery production in the northern Gulf, they also lead to over-eutrophication and hypoxic bottom waters west of the Mississippi River birdfoot delta (Rabalais et al. 2002). See Section 3.5.2 Ambient Water Quality, Including Salinity in Surface Water and Sediment Quality for additional information about hypoxia in the northern Gulf of Mexico near the Project area.

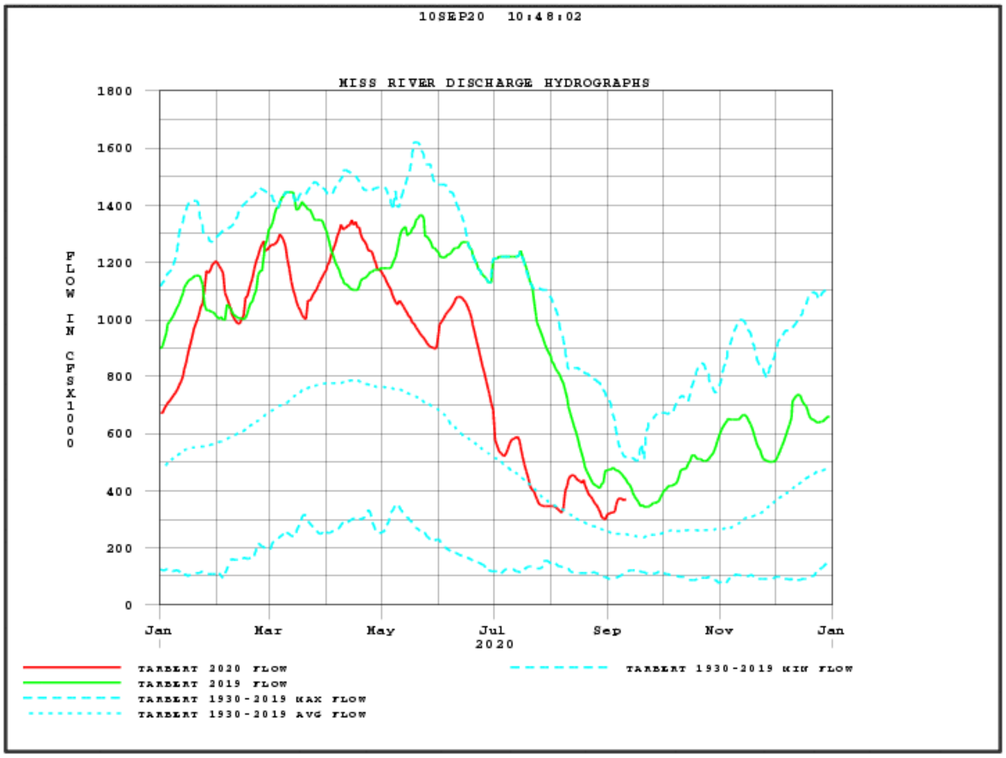
In the drier, upper reaches of the basin, rainfall flows as sheetflow (shallow overland flow) to small streams and bayous, then to Lac des Allemands, and eventually to Lake Salvador and Barataria Bay. Storms and associated rainfall and wind events impact circulation within the basin. Increased rainfall at the Upper Barataria Basin can raise local water levels and produce faster-moving streams with greater flows. Increased water levels in the Upper Barataria Basin set up a north to south flow that pushes fresh water out towards the Gulf. An onshore wind can "stack up" water in the basin, increasing water levels and flooding the marshes. An offshore wind can push water out of the basin, draining the marshes. Local wind effects can produce local cells of circulation based on water level differences and flows induced by wind drag (Reed 1995).

Water flow in the Mississippi River is subject to similar atmospheric factors. The Mississippi River extends over 2,300 miles and includes more than 20 locks and dams. The southern 1,100 miles of the river are free flowing, with no locks or dams. Several major tributaries, such as the Ohio and Tennessee Rivers, add to the river flow. Farther downstream at the Old River Control Structure in Vidalia, Louisiana, flow from the Red and Mississippi Rivers is diverted down the Atchafalaya River. During periods of extremely high flow, water may also be released through the Morganza and Bonnet Carré spillways.

The Davis Pond Freshwater Diversion Project, opened in 2002, operates intermittently to divert up to 10,000 cfs from the Mississippi River into Lake Cataouatche (CPRA 2016a). The project is currently operated to maintain seasonal average salinities at established gages in the basin (see Chapter 4, Section 4.5 Surface Water and Sediment Quality for additional information about the Davis Pond Freshwater Diversion Project). A small portion of Mississippi River water is diverted within the birdfoot delta by uncontrolled river diversion projects for marsh creation and restoration, such as the West Bay Diversion and the Delta Wide Crevasses Project.

During low flow periods in the Mississippi River, the tidal signal from the Gulf is evident in the river as far upstream as the Bonnet Carré Spillway at RM 126.9 AHP. During low flow periods, the tidal range at the Belle Chasse station at RM 76 AHP is 1.0 foot or more.

The USACE Tarbert Landing gage, immediately downriver from the Old River Control Structure at RM 306 AHP, has a flow record dating back to 1930. Here, the Mississippi River flows exhibit an annual cyclical pattern, with an average peak flow of nearly 800,000 cfs in April and a minimum of 200,000 cfs in September. The maximum and minimum observed flows are over 1.6 million cfs and 100,000 cfs, respectively (see Figure 3.4-5). Local weather patterns, such as high winds, also affect water stages in the Mississippi River.



Source: USACE 2020

Figure 3.4-5. Mississippi River Flow at the Tarbert Landing Gage.

The salt water in the Gulf of Mexico is denser than the fresh water flowing in the Mississippi River. During low flow periods, the Gulf's salt water migrates upstream along the bottom of the river underneath less dense fresh water. This poses risks for municipal water intakes along the Lower Mississippi River. As a mitigation measure for deepening the river channel to 45 feet, during extreme low water conditions, the USACE constructs a temporary sand sill (called a saltwater sill) at RM 65 AHP to block the saltwater wedge from migrating upriver. Since deepening the channel to 45 feet, the sand sill has been constructed three times (1988, 1999, and 2012) in order to mitigate for the increased duration and extent of saltwater intrusion above RM 64 AHP (USACE 2018i).

3.4.2.5 Sediment Transport

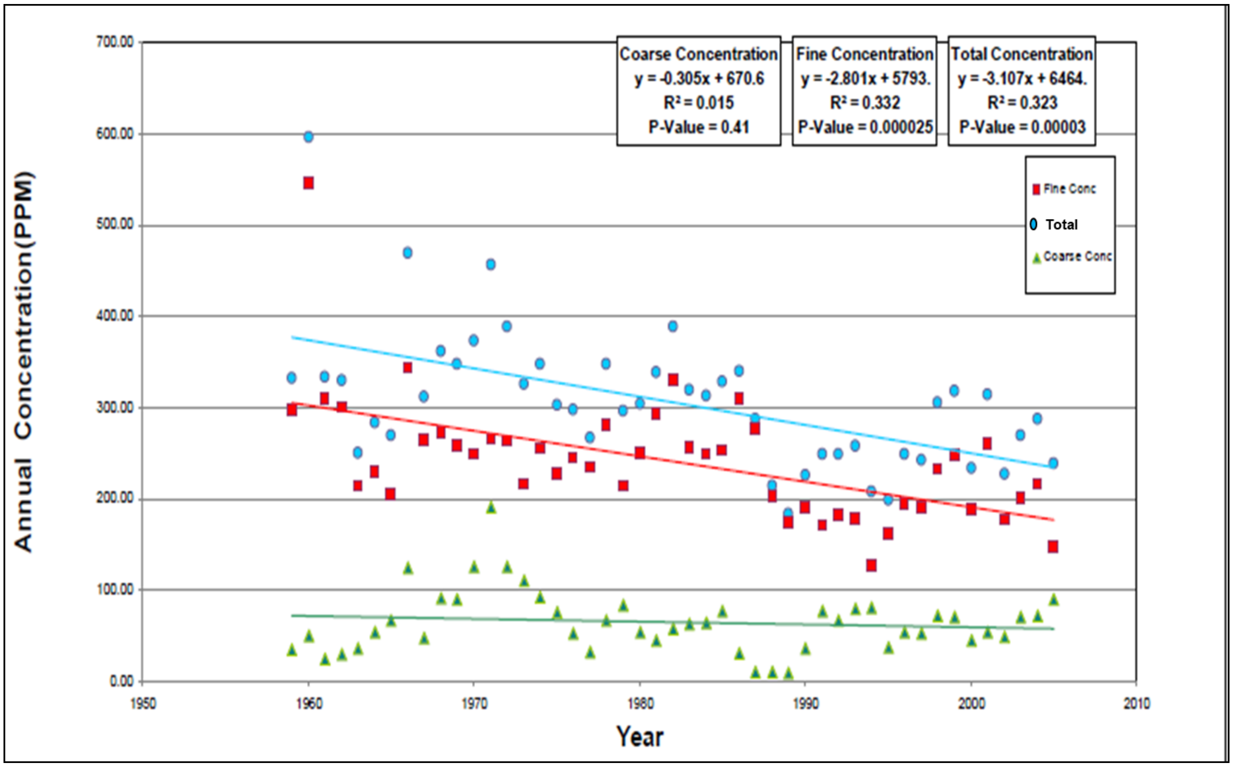
3.4.2.5.1 Historical Context

The amount of sediment carried down the Mississippi River has substantially decreased in the past 100 years due to a variety of factors including sediment trapping at upstream dams, the construction of river bank revetments, the construction of the levees following the 1927 flood, and soil-conservation programs (Thorne et al. 2008). The river formerly carried over 400 million tons of sediment annually, but a more than 50 percent reduction in annual sediment load has occurred since the early 1900s (Keown et al. 1986, Milliman and Syvitski 1992, Alexander et al. 2012). Currently, much of this reduced sediment load is either trapped in the river basin by existing dams, settles out in the navigation channel, or is discharged into the Gulf of Mexico. Navigation channel entrainment structures, such as jetties, are maintained within the birdfoot delta to move the remaining river sediment into the Gulf of Mexico (National Academies Press 2011). The present Mississippi-Atchafalaya combined sediment load is approximately 190 million tons per year. Below the Old River Control Structure, the amount of sediment transported by the main channel of the Mississippi River was estimated as 124 million tons per year (Horowitz et al. 2001, Horowitz 2006). With the virtual elimination of overbank floodplain deposition, coastal wetlands are not receiving enough sediment to offset erosion and subsidence (see Section 3.6 Wetland Resources and Waters of the U.S. for additional information about wetland loss in the Project area).

3.4.2.5.2 Existing Conditions

The total sediment load of the Mississippi River is comprised of finer-grained silt and clay particles (moving as suspended load) that are distributed evenly through the water column and heavier, coarse-grained sand (moving as bed load and suspended load) that is concentrated nearer the bottom of the water column. Figure 3.4-6 shows the annual average concentrations of fine-grained, coarse-grained, and total measured suspended sediments from 1959 to 2005 at the Tarbert Landing gage. Fine-grained sediments are defined as those with grain sizes of 63 microns or smaller, and coarse-grained sediments are those with grain sizes larger than 63 microns (Thorne et al. 2008). Trend lines shown in Figure 3.4-6 show that the concentration of total suspended sediments has decreased over this time period, and that the reduction in total sediments is driven by the reduction in fine sediments. Thorne et al. (2008) suggested some caution in using this estimate given large gaps in the available data, uncertainties associated with early measurements of sediment load, and other factors.

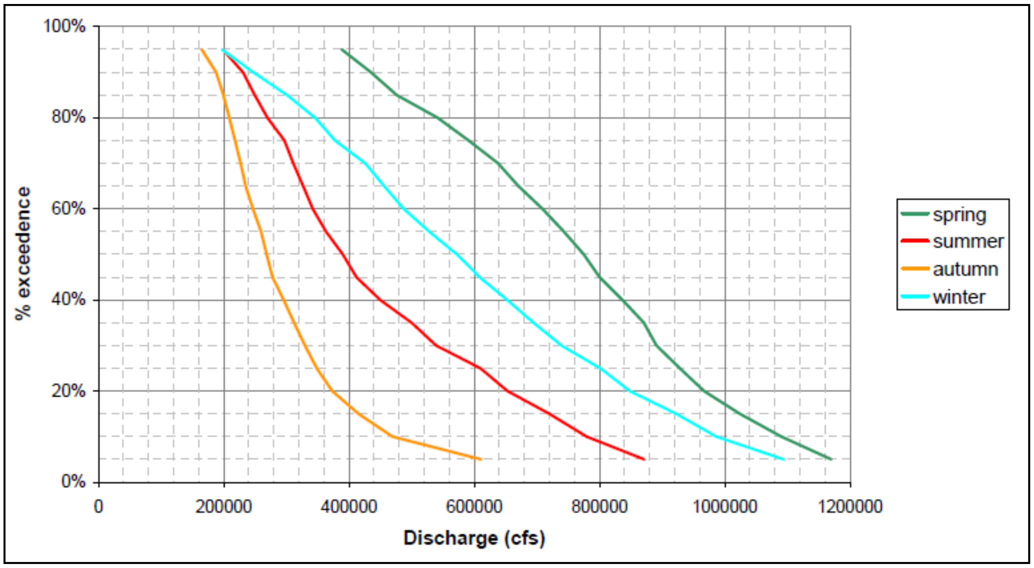
Meade and Moody (2010) analyzed water discharge and sediment samples at several stations in the Missouri River and along the Lower Mississippi River as far north as the Tarbert Landing station from 1940 through 2007 to demonstrate a more complex relationship between water discharge, sediment supply, and construction projects that alters the river’s hydrology. The authors demonstrated that the reduction rate of the total annual sediment supply at Tarbert Landing was highest (with an estimated loss of 15 million metric tons per year) from 1950 through 1968, a time period when construction of bank revetment and dikes in the Lower Mississippi River was active. However, the authors showed that from 1968 through 2007 the overall annual sediment reduction was much more gradual, with the rate estimated as a loss of 1.1 million metric tons per year. Additionally, from 1968 through 2007, there was no apparent relation between mean annual sediment concentration and mean annual discharge at Tarbert Landing (Meade and Moody 2010). More recently, Little and Biedenharn (2014) stated that for both total and coarse sediment concentrations, no significant trends were observed from the 1990s to present. Little and Biedenharn (2014) also identified that the four anomalously low sand (coarse sediment) concentration data points shown between 1986 and 1989 in Figure 3.4-6 resulted from the use of a sampling method that resulted in sand being under-represented.



Source: Thorne et al. 2008

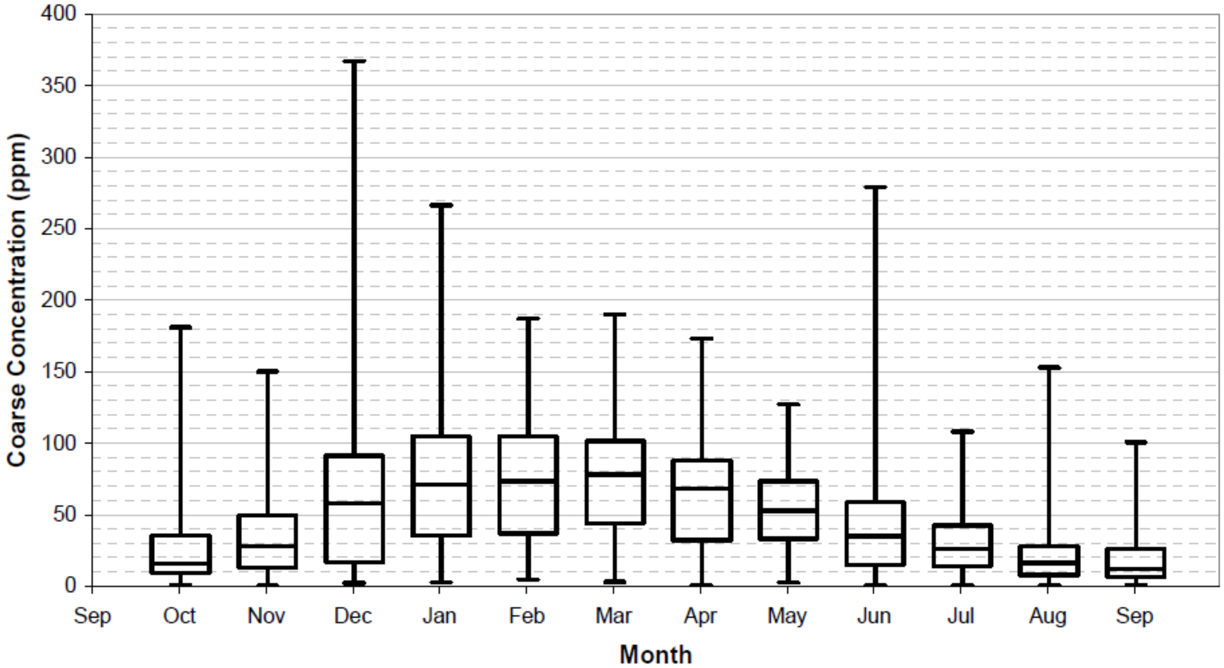
Figure 3.4-6. Tarbert Landing Annual Total (Blue), Fine (Red) and Coarse (Green) Sediment Concentrations from 1959 to 2005.

Higher river flows suspend and contain more coarse-grained sediments (larger than 63 microns in diameter) that are important in delta building, as they are heavier and settle out faster when water flow slows down or stops. Monthly sediment measurements at Tarbert Landing (see Figure 3.4-8) show that concentrations of coarse-grained sediments are highest in the winter and spring when flows are highest. Variability is also high in the monthly concentrations of coarse-grained sediments suspended within the river, as shown by the maximum concentration bars compared to the median concentrations (see Figure 3.4-8).



Source: Thorne et al. 2008

Figure 3.4-7. Seasonal Flow Duration Curves at Tarbert Landing from 1963 to 2005 Showing the Range in Mississippi River Discharge by Season. Percent exceedance on the y axis indicates the percent of the time when the discharge was equal to or higher than the discharge on the x axis. For example, the river flow only reached 600,000 cfs or greater 5 percent of the time from 1963 to 2005 for autumn, and was 160,000 cfs or greater 95 percent of the time.



Source: Thorne et al. 2008

Figure 3.4-8. Boxplots Showing Monthly Variation in Concentrations of Coarse-grained Sediments at Tarbert Landing from 1963 to 2005. Plots show the minimum (lowest bar around 0), the 25th percentile (low box), the median (middle of box), 75th percentile (high box), and maximum (highest bar) for the month.

In shallow waters of the Barataria Basin, sediment transport is primarily driven by wind and wave effects. Conner and Day (1987) described the sediment transport pattern as "…largely a storm-related phenomenon with sediments from other eroding marshes and bay bottoms being deposited." Wind-induced currents re-suspend bottom sediments and transport them around the basin. Waves, either from winds or vessel traffic, erode sediments from shorelines. During storms, the amount of sediment transported within the Barataria Basin is greatly increased (Madden 1988).

3.4.3 Stormwater Management and Drainage

The Project area includes a complex of levees, floodwalls, gate structures, and canals that were built to manage flood risks related to riverine and tidal flooding and storm surge. Areas surrounded by flood protection structures are generally low-lying, flat agricultural land, consisting of ridges with swale drains on each side to lower the water table for pasture-grazing. The swales are interconnected with terrace ditches that collect and drain along centralized channels to levee drainage channels (HDR Engineering, Inc. 2014a). Stormwater management is dependent upon forced drainage pumping. To facilitate drainage of the interior land, 78 drainage pump stations are located throughout the four-parish area of the HSDRRS (including Jefferson, Orleans, St. Bernard, and Plaquemines Parishes) to pump stormwater over the levees and into the Barataria Basin (USACE 2018i). The levees, floodwalls, floodgates, and pump stations authorized under HSDRRS are closely coordinated and operated among the USACE, parishes, and levee district non-federal sponsors (USACE 2018i).

3.5 SURFACE WATER AND SEDIMENT QUALITY

3.5.1 Water Quality Standards and Designated Uses

Section 303(d) of the 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 USEPA have established surface water quality standards 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. Eight 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, limited aquatic life and wildlife, drinking water supply, outstanding natural resource, and oyster propagation.

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 2020), a summary of the suspected causes and sources of impairment for impaired subsegments of the Mississippi River and Barataria Basin is provided below in Sections 3.5.1.1 and 3.5.1.2.

3.5.1.1 Mississippi River

The Mississippi River includes three subsegments in the Project area for which designated uses have been established (see Figure 3.5-1). Two of these (070401 and 070601), are listed by LDEQ as impaired for supporting their designated uses of fish and wildlife propagation and oyster propagation. The identified impairments in these waters include fecal coliform bacteria and dissolved oxygen (DO). The source of fecal coliform impairments is listed as marina/boating sanitary on-vessel discharges and unknown sources. The suspected source of impairment for DO is upstream sources (LDEQ 2020). Subsegment 070301, where the proposed Project diversion intake structure would be located is fully supporting its designated uses. Designated uses for this subsegment include swimming, boating, fishing, and drinking water supply (LDEQ 2020).

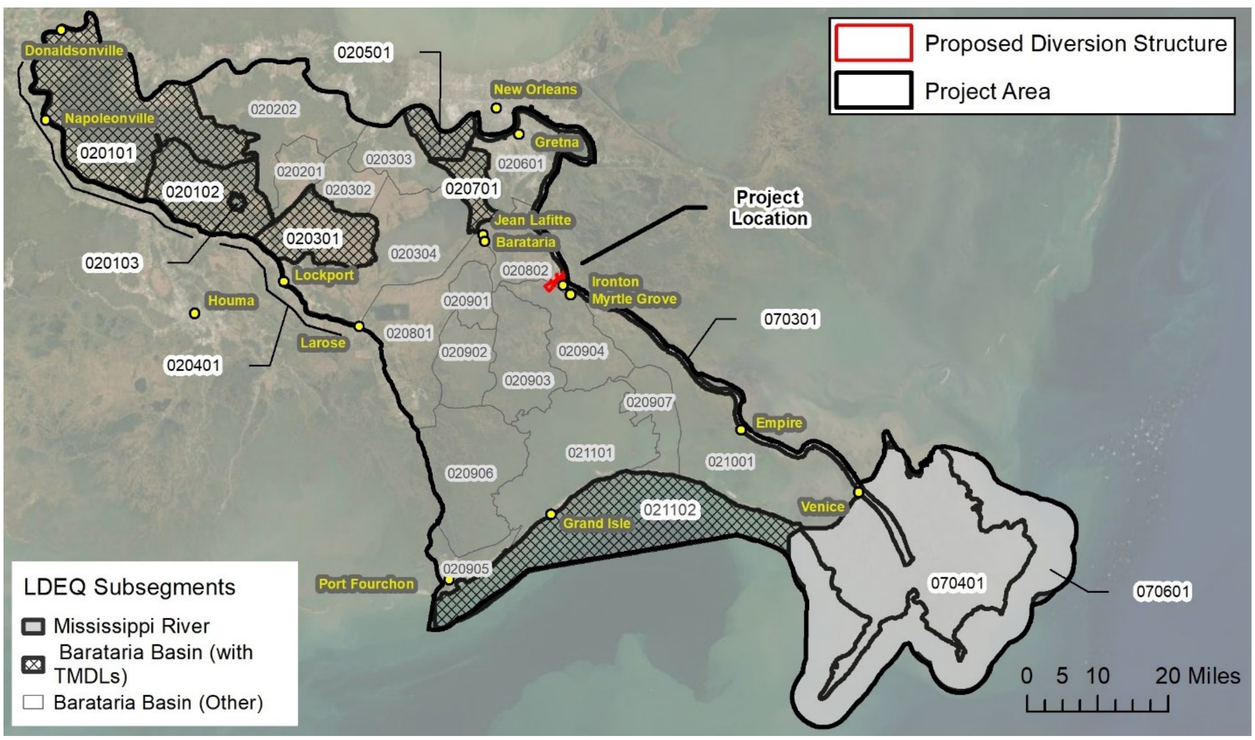


Figure 3.5-1. Mississippi River Water Quality Subsegments in the Project Area.

3.5.1.2 Barataria Basin

A total of 19 waterbody impairment combinations in 13 subsegments within the Barataria Basin are listed on the state's 2020 Clean Water Act Section 303(d) list as not supporting designated uses for primary contact recreation (swimming), fish and wildlife propagation, oyster propagation, and/or outstanding natural resource. The primary parameter of concern for the primary contact designation use is bacterial contamination (fecal coliform or Enterococci). The suspected bacterial sources for the Barataria Basin are waterfowl, on-site sewage treatment systems, and/or package sewage treatment plants.

LDEQ (2020) lists the suspected causes of the fish and wildlife propagation, oyster propagation and outstanding natural resource use impairments as fecal coliform or Enterococci, DO impacts from sewage treatment and other permitted discharges, nitrogen and phosphorus from landfills and golf courses, chloride and sulfate from forced drainage pumping, and turbidity from infrastructure runoff, water diversions, and natural sources. These impairments appear mostly in the upper portion of the basin, including areas north of Lake Salvador. In response to impaired water designations, LDEQ has received USEPA approval for eight TMDLs for subsegments within the Barataria Basin (see Table 3.5-1).

Table 3.5-1
LDEQ Generated TMDLs for Subsegments within the Barataria Basin

Subsegment Number	Subsegment Name	Parameter of Concern	Status
020501	St. Charles Canals and Bayous	Oxygen Demand	USEPA Approved
020301	Bayou des Allemands	Oxygen Demand	USEPA Approved
020101	Bayou Verret, Bayou Chevreuil, Bayou Citamon and Grand Bayou	Biochemical Oxygen Demand	USEPA Approved
020701	Bayou Segnette	Oxygen Demand	USEPA Approved
020102	Bayou Boeuf, Halpin Canal, and Theriot Canal	Biochemical Oxygen Demand	USEPA Approved
020103	Lake Boeuf	Biochemical Oxygen Demand	USEPA Approved
020401	Bayou Lafourche-From Donaldsonville to ICWW at Larose	Fecal coliform	USEPA Approved
021102	Barataria Basin Coastal Bays and Gulf Waters to the State 3-mile limit	Mercury in fish tissue	USEPA Approved

3.5.2 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 2018a), the LDEQ Ambient Water Quality Data Portal (LDEQ 2018b), and CPRA's CRMS (CPRA 2018a) (see Table 3.5-2). These data were collected at the water quality stations shown in Figure 3.5-2. Graphics are provided throughout this section to illustrate summary statistics generated from the data.

Table 3.5-2
Ambient Water Quality Data Used to Describe Project Area

Station ID	Station Description	Date Range	Data Evaluated
Mississippi River			
07374525 (USGS)	Mississippi River at Belle Chasse, Louisiana	1977 to 2017	Specific Conductance, Temperature, Flow, Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Atrazine, Chloride, Sulfate, Fecal Coliform
0322 (LDEQ)	Mississippi River west of Pointe a la Hache, Louisiana	1970 to 1998	Specific Conductance, Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
Barataria Basin – CRMS			
3985	Barataria	2008 to 2018	Temperature, Specific Conductance, Salinity
287	Barataria	2008 to 2018	Temperature, Specific Conductance, Salinity
4218	Barataria	2008 to 2018	Temperature, Specific Conductance, Salinity
220	Barataria	2008 to 2018	Temperature, Specific Conductance, Salinity
276	Barataria	2008 to 2018	Temperature, Specific Conductance, Salinity
6303	Barataria	2008 to 2018	Temperature, Specific Conductance, Salinity
4690	Barataria	2006 to 2018	Temperature, Specific Conductance, Salinity
224	Barataria	2006 to 2018	Temperature, Specific Conductance, Salinity
258	Barataria	2007 to 2018	Temperature, Specific Conductance, Salinity
176	Barataria	2006 to 2018	Temperature, Specific Conductance, Salinity
272	Barataria	2007 to 2018	Temperature, Specific Conductance, Salinity
164	Barataria	2006 to 2017	Temperature, Specific Conductance, Salinity
178	Barataria	2007 to 2017	Temperature, Specific Conductance, Salinity
172	Barataria	2007 to 2018	Temperature, Specific Conductance, Salinity
163	Barataria	2007 to 2018	Temperature, Specific Conductance, Salinity
162	Barataria	2007 to 2018	Temperature, Specific Conductance, Salinity
Barataria Basin – LDEQ			
0897	Little Lake south of Bayou Perot, Louisiana	2000 to 2016	Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
0907	Barataria Waterway south-southeast of Lafitte, Louisiana	2000 to 2017	Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
0909	Bayou Dulac west of Bay Sanbois, Louisiana	2000 to 2017	Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
3000	Barataria Bay in Lake Grande Ecaille, northwest of Grand Ecaille, Louisiana	2005	Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
4345	Pipeline canal at end of Rattlesnake Bayou, 0.25 mile SW Freeport Sulphur Canal	2012 to 2017	Total Nitrogen, Total Phosphorus, Dissolved Oxygen, Total Suspended Solids, Turbidity, Chloride, Sulfate, Fecal Coliform
Sources: USGS 2018a, CPRA 2018a, LDEQ 2018b			

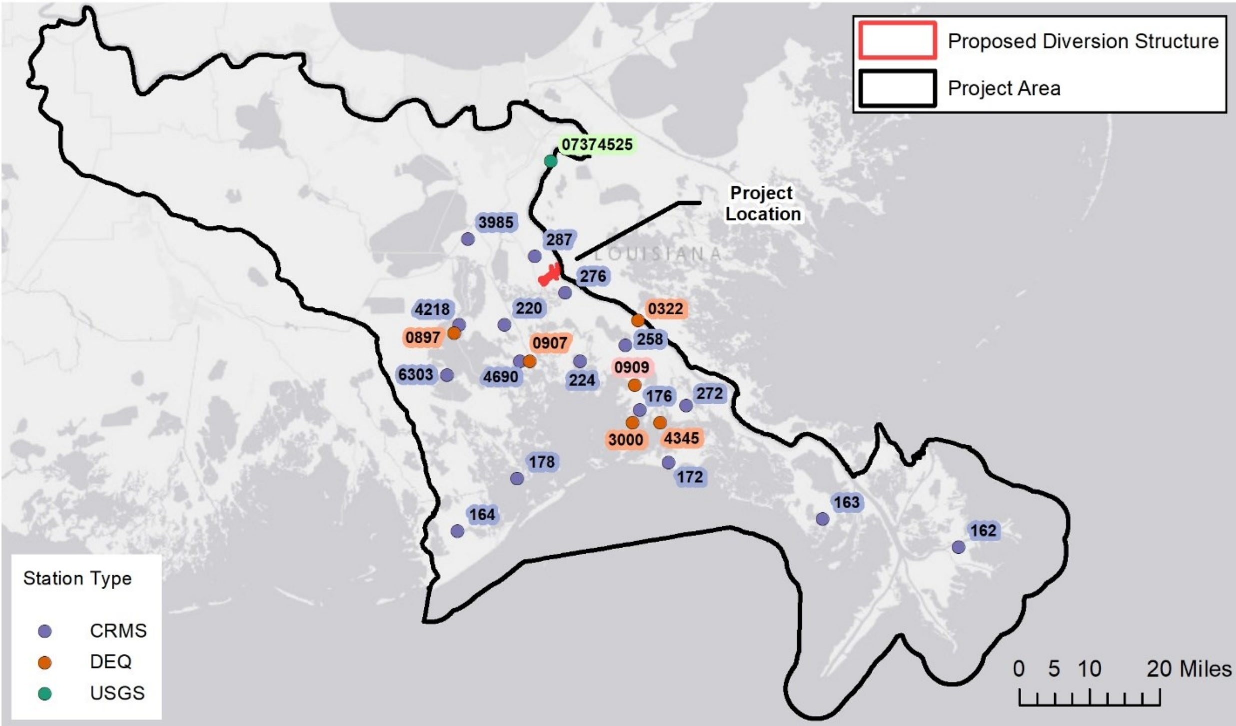


Figure 3.5-2. USGS, LDEQ, and CRMS Ambient Water Quality Stations Used for this Section.

3.5.2.1 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 frequently measured and useful water quality parameters, and it can be an indicator of salinity intrusion into freshwater 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.

Salinity data are not available from the Mississippi River stations, but specific conductance data are and can be correlated to salinity data. The correlation 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 3.5-3 provides a range of salinity values at 77°F (25°C) for corresponding specific conductance values.

Table 3.5-3 Specific Conductance versus Salinity at 77°F (25°C)		
Marsh Type	**Specific Conductance Range (µS/cm)[a]**	**Salinity Range (ppt)[b]**
Fresh	0 to 2,200	0 to 1
Intermediate	2,200 to 9,300	1 to 5
Brackish	9,300 to 29,300	5 to 18
Saline	29,300 to 46,200	18 to 30

Source: Cowardin et al. 1979
[a] microsiemens per centimeter
[b] parts per thousand

Specific conductance values in the Mississippi River at Belle Chasse upstream of the proposed Project diversion structure ranged from 259 to 709 microsiemens per centimeter (µS/cm) between 1977 and 2017, consistent with expected values for a freshwater system. The data indicate an overall pattern of lower values associated with higher average flow (see Table 3.5-4). Downstream of the location proposed for the Project diversion structure, the most recent long-term data available indicate that specific conductance in the Mississippi River at West Pointe A La Hache ranged from 225 to 640 µS/cm between 1971 and 1998. Based on Table 3.5-3, this would correspond with a salinity value of 0 to 1 part per thousand (ppt) (fresh water).

Table 3.5-4
Comparison of Mississippi River and Barataria Basin Temperature and Specific Conductance

Month	Mississippi River Average Flow[a] (cfs)	Monthly Average Temperature °F (°C)		Specific Conductance (µS/cm)	
		Mississippi River[a]	Barataria Basin[b]	Mississippi River[a]	Barataria Basin[b]
January	639,506	43 (6.6)	55 (13)	367	14,281
February	596,742	45 (7.1)	59 (15)	369	12,784
March	683,182	50 (10)	66 (19)	364	12,400
April	786,672	61 (16)	73 (23)	356	10,522
May	769,218	68 (20)	79 (26)	368	10,216
June	647,750	79 (26)	84 (29)	410	9,421
July	533,649	84 (29)	86 (30)	427	9,694
August	389,346	86 (30)	86 (30)	490	10,613
September	272,003	84 (29)	82 (28)	495	13,034
October	297,083	73 (23)	75 (24)	488	15,873
November	320,673	63 (17)	66 (19)	488	18,376
December	518,222	52 (11)	59 (15)	431	17,416

[a] USGS National Water Information System (NWIS) Belle Chasse Station, 1977 to 2017
[b] Selected CRMS stations monthly average data in the Barataria Basin, 2006 to 2018

In the Barataria Basin, specific conductance concentrations were evaluated using data from the CRMS stations shown on Figure 3.5-2 and described in Table 3.5-4. All available data collected between 2006 and early 2018 were reviewed. In aggregate, the Barataria Basin exhibits significantly higher specific conductance concentrations than the Mississippi River, consistent with expected values for a brackish to saline system. A correlation between seasonally increasing specific conductance concentrations and decreasing temperature is apparent in the Barataria Basin data (see Table 3.5-4).

A spatial gradient is also present in the basin, with fresher water in the upper reaches transitioning to more saline conditions in the southern area of the basin near the Gulf (see Figure 3.5-3). The exceptions are the two stations (163 and 162) located within the Mississippi River birdfoot delta, which are influenced by the river and exhibit much lower specific conductance concentrations. A monthly comparison of specific conductance between the Mississippi River and the Barataria Basin depict consistently fresher (less saline) conditions in the Mississippi River (see Table 3.5-4).

3.5.2.2 Salinity

Salinity is a measure of dissolved salt in the water column, which can be calculated from specific conductance and water temperature. As stated earlier, for stations in the Mississippi River, salinity values are not readily available; measurements are more frequently provided as specific conductance. Salinity concentrations correlate in a positive manner with both specific conductance (see Figure 3.5-4) as well as temperature. Consequently, salinity concentrations within the Barataria Basin follow the same general trends as the specific conductance data described in Section 3.5.2.1. The LDEQ has not adopted water quality standards for salinity.

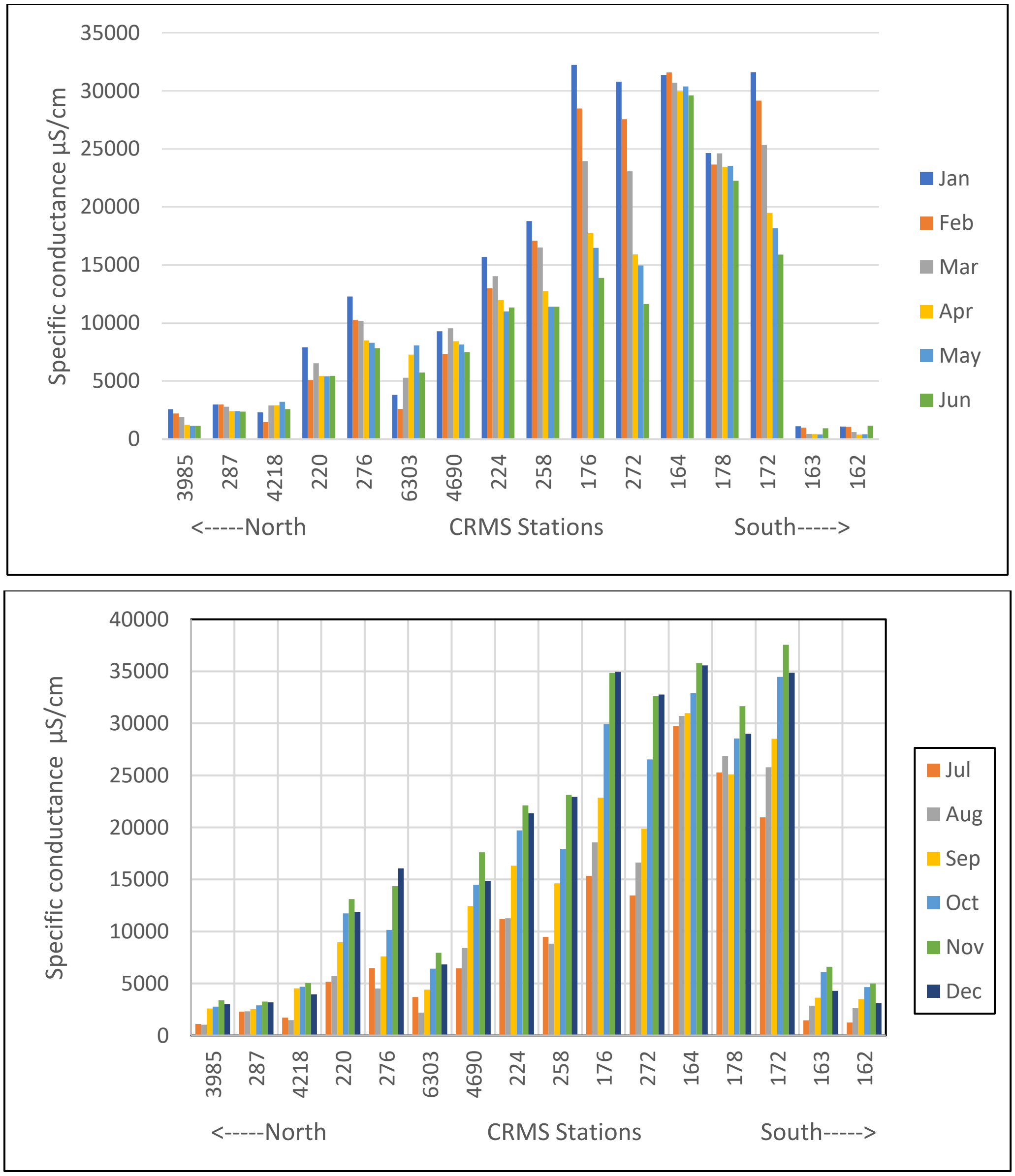


Figure 3.5-3. Monthly Specific Conductance Average (2006 to 2018) at Select Barataria Basin CRMS Sites.

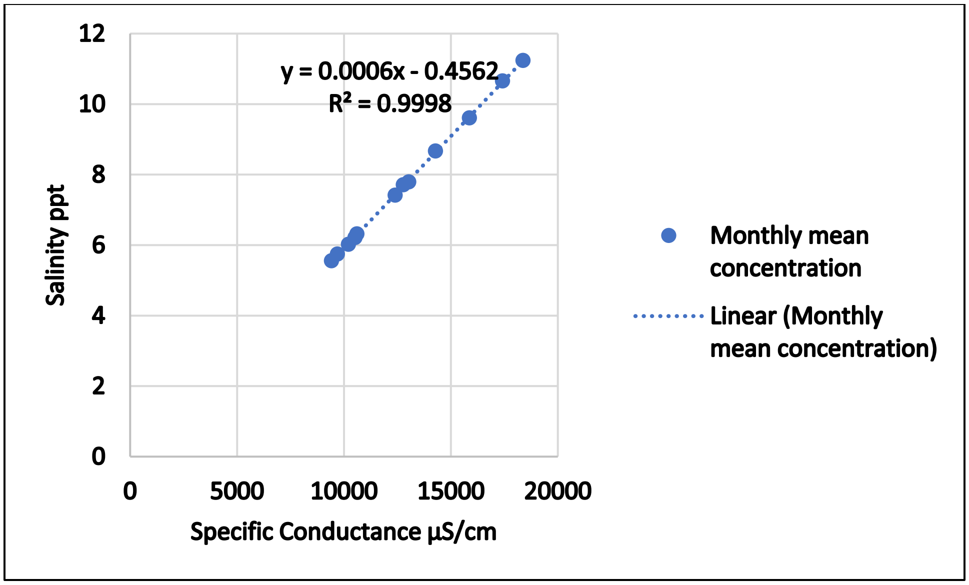


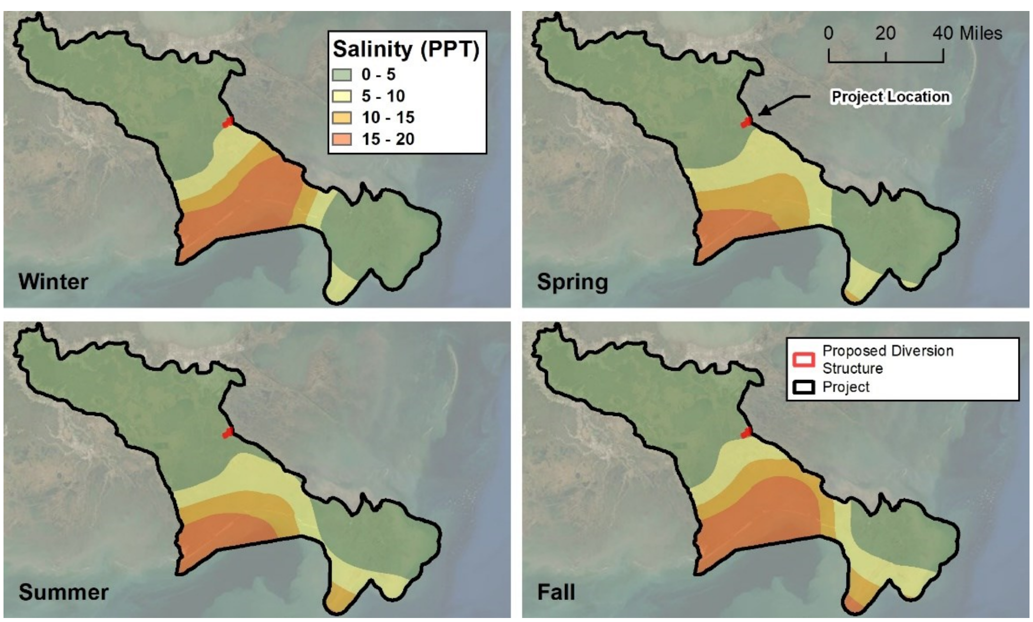
Figure 3.5-4. Correlation between Monthly Average Specific Conductance and Salinity (2006 to 2018) at Select CRMS Sites.

Annual average salinity at select CRMS stations in the Barataria Basin ranged from 7.7 to 11 ppt between 2006 and 2018, with lower values in the upper portions of the Project area. Similar to the specific conductance data in Section 3.5.2.1, the exceptions are the two stations located within the Mississippi River birdfoot delta, (Stations 162 and 163) which are influenced by the river and exhibit much lower-salinity concentrations (see Table 3.5-5). There is a substantial range in salinity concentrations at individual stations, indicating a highly dynamic system. Salinity concentrations are influenced by numerous factors, including seasonal rain events, Mississippi River discharge, other operating freshwater diversions, synoptic and seasonal timescale wind-forcing, and lunar tides. Figure 3.5-5 displays the seasonal average salinity variability spatially within the Project area. Salinity in the Project area is variable and generally ranges from fresh in the spring and summer to brackish in the fall and winter.

Table 3.5-5
Monthly Average Salinity (ppt) at Select Barataria Basin Stations[a]

CRMS Station (North to South)	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
3985	1.4	1.2	1.0	0.6	0.6	0.6	0.6	0.5	1.4	1.5	1.8	1.6
287	1.6	1.6	1.5	1.3	1.3	1.3	1.2	1.3	1.4	1.6	1.8	1.7
4218	1.3	0.8	1.6	1.6	1.8	1.4	0.9	0.8	2.6	2.6	2.8	2.2
220	4.5	2.8	3.7	3.0	3.0	3.1	2.9	3.2	5.2	6.8	7.6	6.9
276	7.1	5.9	5.8	4.8	4.7	4.4	3.6	2.5	4.3	5.8	8.4	9.5
6303	2.1	1.4	3.0	4.1	4.6	3.3	2.1	1.2	2.5	3.6	4.5	3.8
4690	5.3	4.2	5.5	4.8	4.7	4.3	3.7	4.9	7.3	8.5	10.5	8.7
224	9.2	7.5	8.2	6.9	6.3	6.6	6.5	6.5	9.7	11.8	13.3	12.9
258	11.3	10.2	9.8	7.4	6.6	6.6	5.5	5.0	8.5	10.6	14.0	14.0
176	20.2	17.6	14.5	10.5	9.7	8.1	9.0	11.0	13.8	18.6	21.9	22.1
272	19.2	17.0	14.0	9.3	8.7	6.7	7.8	9.8	11.9	16.3	20.4	20.5
164	19.6	19.7	19.1	18.6	18.9	18.4	18.5	19.1	19.3	20.6	22.6	22.5
178	15.1	14.4	15	14.3	14.3	13.5	15.4	16.5	15.3	17.7	19.8	18.0
172	19.8	18.1	15.5	11.7	10.8	9.4	12.6	15.8	17.6	21.7	23.9	22.0
163	0.6	0.5	0.2	0.2	0.2	0.5	0.8	1.6	2.0	3.5	3.8	2.4
162	0.6	0.6	0.3	0.2	0.2	0.6	0.7	1.5	1.9	2.6	2.8	1.7

[a] CRMS monthly average data in the Barataria Basin, 2006 to 2018



Source: Generated by GEC based on CPRA CRMS data

Figure 3.5-5. Generalized Seasonal Salinity Averages (2006 to 2018) at Select Barataria Basin CRMS Sites.

Turner et al. (2019) conducted monthly water quality sampling at 37 stations in the Barataria Basin for nutrients, salinity, and solids between 1994 and 2016. The sampled transect extended from Grand Isle northward to Bayou Chevreuil. In the study, salinity concentrations ranged from 0 to 21 practical salinity units (psu)[14], which are roughly equivalent to ppt. The study found that annual average salinity in the Barataria Basin slightly declined over the 22 years of sampling, and that the salinity in the basin is negatively correlated with the average annual discharge of the Mississippi River at Tarbert Landing, Louisiana. This trend in slightly decreased salinity over time is likely influenced by high river years in the later part of the dataset as well as discharge from the Davis Pond Freshwater Diversion (which began operations in 2002).

3.5.2.3 Temperature

Water temperature can directly affect biological activity and growth in aquatic plants and animals. 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 freshwater systems is 89.6°F (32°C), and the maximum criterion in estuarine and coastal waters is 95°F (35°C). Site-specific temperature criteria are included in LAC 33:IX.1123, Table 3 and apply to subsegment locations in the Project area (see LAC 33:IX.1123 for more details).

In Mississippi River subsegments 070301 and 070601, the maximum temperature criterion is about 90°F (32°C); in subsegment 070401, the maximum criterion is 95°F (35°C) (see Figure 3.5-1 for locations of these subsegments). Seasonal fluctuations in water temperature are evident with warmer temperatures during the summer months and cooler temperatures during the winter months. For example, the monthly average Mississippi River water temperature at Belle Chasse (subsegment 070301) ranged from 43.9°F (6.6°C) in January to 86°F (30°C) in August between 1977 and 2017 (see Table 3.5-4). LDEQ's 2016 Water Quality Integrated Report indicated that all three Mississippi River subsegments within the Project area meet the temperature standards criteria.

The maximum LDEQ water quality standards temperature criteria in all Barataria Basin subsegments within the Project area are either 90°F or 95°F (32°C or 35°C). Aggregate average water temperatures in the Barataria Basin between 2006 and 2018 ranged from 55°F (13°C) in January to 86°F (30°C) in July and August (see Table 3.5-4) and do not exceed the criteria. Cooler temperatures were evident during winter (December to February) compared to summer months (June to September). There is a substantial range in temperature at all CRMS sites, demonstrating the influence of

[14] Salinity is described in parts per thousand (ppt) or practical salinity units (psu). However, as ppt and psu are nearly equivalent, ppt is the identified unit of measure for this EIS, regardless of how a given study presents salinity values.

regional weather patterns on water temperature in the basin. A monthly comparison of water temperatures demonstrates consistently warmer temperatures in the Barataria Basin when compared with the Mississippi River. Turner et al. (2019) found the annual average temperature in the Barataria Basin at any station in his study to be about 70° to 72°F (21° to 22°C).

3.5.2.4 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 DO levels in the water column resulting in hypoxic conditions (low DO). 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.

Presently, Louisiana has narrative nutrient criteria (LAC 33:IX.1113.B.8), which states:

> "The naturally occurring range of nitrogen-phosphorous ratios shall be maintained. This range shall not apply to designated intermittent streams. To establish the appropriate range of ratios and compensate for natural seasonal fluctuations, the administrative authority will use site-specific studies to establish limits for nutrients. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters."

It is difficult to determine the naturally occurring range because many systems, including the Mississippi River and the Barataria Basin, were significantly impacted by anthropogenic sources of nutrients prior to the implementation of sampling programs. LDEQ is in the process of evaluating various stressor-response factors that may help inform development of numeric nutrient criteria, or numeric nutrient thresholds that could be used in the translation of the narrative nutrient criteria in accordance with USEPA guidance. As such, the below analyses make use of USEPA-generated sub-ecoregion reference condition metrics for total nitrogen (0.71 milligrams/liter[mg/L]) and total phosphorus (0.125 mg/L) for comparison to existing Mississippi River and Barataria Basin nutrient concentrations (USEPA 2001). It is important to note that these reference metrics provide a numerical value to compare the Mississippi River and the Barataria Basin nutrient concentrations and are not intended to be used to evaluate waterbody status relative to the current narrative nutrient criterion.

Average total nitrogen concentrations for the period of record for the Mississippi River upstream and downstream of the location proposed for the Project diversion structure and for the Barataria Basin, are summarized in Table 3.5-5. The most recent available long-term data from the Mississippi River at West Pointe A La Hache demonstrate significantly higher total nitrogen concentrations than observed at the Belle Chasse station, and total nitrogen concentrations at Belle Chasse are consistently higher than concentrations recorded within the Barataria Basin. Average total nitrogen concentrations in the Mississippi River exceed the USEPA ecoregional reference concentration of 0.71 mg/L in all months (see Table 3.5-6). Average concentrations in the Barataria Basin equal or exceed the ecoregional reference concentration in 10 of 12 months.

In the Mississippi River at Belle Chasse, higher total nitrogen concentrations were recorded during the summer months of May, June, July, and September (see Table 3.5-6). River flows are high in May and decline during June through September. Data from the Mississippi River at West Pointe A La Hache and the Barataria Basin exhibit higher total nitrogen concentrations during the winter months of November through March, which correspond to higher flows in the Mississippi River (see Section 3.4 Surface Water and Coastal Processes for further discussion about Mississippi River flows).

Table 3.5-6
Average Monthly Nutrient Concentrations in the Mississippi River[a,b] and Barataria Basin[c]

Month	Mississippi River at Belle Chasse Total Nitrogen (mg/L)	Mississippi River at Belle Chasse Total Phosphorus (mg/L)	Mississippi River at West Pointe A La Hache Total Nitrogen (mg/L)	Mississippi River at West Pointe A La Hache Total Phosphorus (mg/L)	Barataria Basin Total Nitrogen (mg/L)	Barataria Basin Total Phosphorus (mg/L)
January	3.7	0.3	11.0	0.2	1.4	0.1
February	3.6	0.3	12.0	0.2	1.4	0.1
March	3.3	0.3	11.0	0.2	1.2	0.5
April	3.4	0.3	10.0	0.2	1.0	0.1
May	4.2	0.3	8.0	0.2	0.9	0.1
June	3.9	0.3	7.2	0.2	0.8	0.1
July	4.9	0.4	7.2	0.2	0.7	0.1
August	3.2	0.3	7.0	0.2	1.0	0.1
September	4.9	0.3	6.9	0.2	0.9	0.1
October	3.0	0.3	7.6	0.2	1.0	0.1
November	3.8	0.3	9.8	0.1	1.2	0.1
December	3.5	0.4	11.0	0.2	1.2	0.2

[a] USGS National Water Information System (NWIS) Belle Chasse Station, 1977 to 2017
[b] LDEQ Ambient Monitoring Station 0322, 1972 to 1998
[c] LDEQ Ambient Monitoring Stations 3000, 0907, 0909, 0907, 0897, 4535, 2000 to 2017

A review of the raw data used to determine the monthly averages presented in Table 3.5-6 indicates that inorganic nitrate plus nitrite is the predominant form of nitrogen in the Mississippi River. In the Barataria Basin, Total Kjehldahl nitrogen (TKN), a predominantly organic form, is the dominant form of nitrogen. Turner et al. (2019) determined that an average of 83 percent of the total nitrogen at all stations in the Barataria Basin is in an organic form. Turner et al. (2019) found the highest inorganic nitrogen concentrations, which contribute to healthy plant growth, in the northern portion of the basin, with decreasing concentrations moving southward, although the total nitrogen concentrations did not follow a similar trend. In contrast to the Mississippi River, the Barataria Basin inorganic nitrogen concentrations are not always high enough to ensure continued plant productivity.

3.5.2.5 Phosphorus

Presently, Louisiana has narrative nutrient criteria (LAC 33:IX.1113.B.8), which states:

> "The naturally occurring range of nitrogen-phosphorous ratios shall be maintained. This range shall not apply to designated intermittent streams. To establish the appropriate range of ratios and compensate for natural seasonal fluctuations, the administrative authority will use site-specific studies to establish limits for nutrients. Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters."

As noted in the previous section, the below analysis makes use of a USEPA-generated sub-ecoregion reference condition metric for total phosphorus (0.125 mg/L) for comparison to existing Mississippi River and Barataria Basin nutrient concentrations (USEPA 2001). It is important to note that these reference metrics provide a numerical value to compare the Mississippi River and the Barataria Basin nutrient concentrations and are not intended to be used to evaluate waterbody status relative to the current narrative nutrient criterion. 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.

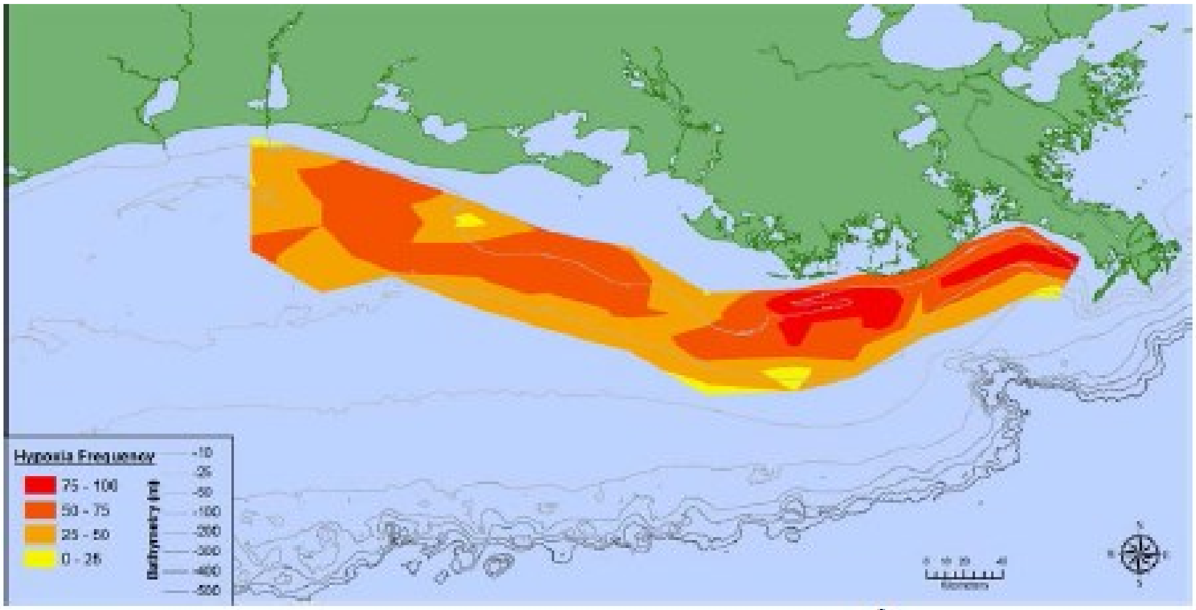
Average total phosphorus concentrations for the period of record for the Mississippi River upstream and downstream of the location proposed for the Project diversion structure and for the Barataria Basin are summarized in Table 3.5-6. Average total phosphorus concentrations in the Mississippi River exceed the ecoregional reference concentration of 0.125 mg/L (USEPA 2007) in all months. Average total phosphorus concentrations in the Barataria Basin exceed the ecoregional reference concentration in 3 of 12 months.

In the Mississippi River, average total phosphorus concentrations are fairly consistent with slight fluctuations throughout the year, and not strongly correlated with flow. In the Barataria Basin, the highest total phosphorus concentrations were observed in March. The average concentrations in the Barataria Basin do not exhibit seasonal trends. Turner et al. (2019) found that phosphorus concentrations in the basin decline from north to south.

Organic and inorganic phosphorus data were not consistently available within the datasets evaluated. Previous studies have indicated that particulate organic phosphorus is the dominant form of phosphorus within the Mississippi River (Robinson and DeRosa 2014). Inorganic phosphorus concentrations in the river remain at levels sufficient to support biological production (greater than 0.004 mg/L [Robinson and DeRosa 2014]) and as such, phosphorus would likely not be considered the limiting nutrient as it relates to productivity. In contrast to the Mississippi River, a review of Barataria Basin phosphorus data from stations shown in Figure 3.5-2 above show that concentrations drop below 0.004 mg/L, indicating they are not always sufficient to ensure continued productivity.

3.5.2.6 Dissolved Oxygen and Hypoxia

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/salinity directly impact the DO capacity within a system. In the absence of impacts 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. Other physical factors that could affect DO concentrations include wind wave mixing (increases DO), aeration (increases DO), and water column stratification (increases or decreases DO). The majority of the Barataria Basin is shallow and not typically prone to stratification (Orlando et al. 1993). In addition to these physical factors, biological processes (animal and plant respiration, photosynthesis, 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 eutrophication, or algal blooms, which can in turn deplete the bottom water DO levels due to photosynthetic processes and 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) (see Figure 3.5-6) (Rabalais et al. 2002, Rabalais et al. 1995, Turner and Rabalais 2017).



Source: Turner and Rabalais 2017

Figure 3.5-6. Frequency of Mid-summer Hypoxia (oxygen ≤ 2 mg/l) over the 70 to 90 Station Grid on the Louisiana and Texas Shelf during the Summer from 1985 to 2014.

In the Mississippi River, DO concentrations fluctuate with temperature with higher concentrations when water temperatures are cooler (see Figure 3.5-7). An analysis of the data showed that DO concentrations do not correlate with river flow levels. Average monthly DO concentrations ranged from 5.9 mg/L (July) to 12 mg/L (January) in the Mississippi River at Belle Chasse between 1977 and 2017. Individual sample concentrations fall below the water quality standard of 5.0 mg/L in the summer months of July, August, and September. At West Pointe A La Hache, average monthly DO concentrations ranged from 5.9 mg/L (August) to 11 mg/L (February) between 1977 and 2017, with individual concentrations falling below the 5.0 mg/L standard in July only.

Many of the subsegments in the Barataria Basin have site-specific seasonal DO water quality standard criteria variably ranging from 2.3 to 5.0 mg/L in selected months (LAC:IX.1123.Table 3). An analysis of the LDEQ data in the basin showed that DO average monthly concentrations ranged from 6.1 mg/L (August) to 10 mg/L (January) between 2000 and 2017. Individual concentrations fell below 5.0 mg/L in May, June, and August (see Figure 3.5-7).

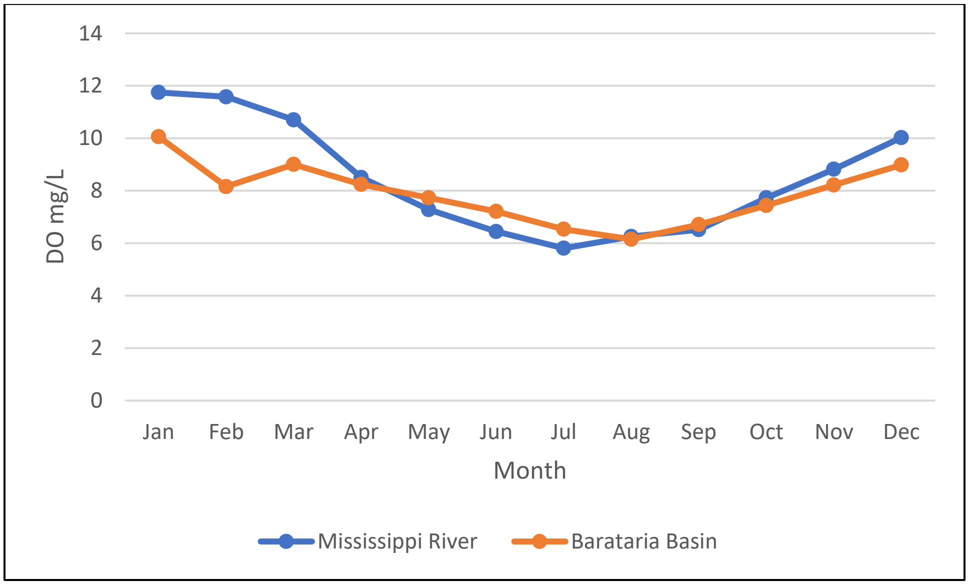


Figure 3.5-7. Monthly DO Average Concentrations in the Mississippi River at Belle Chasse (1977 to 2017) and at Select Barataria Basin Sites (2006 to 2018).

Starting in December 2014, LDEQ collected DO profiles within the Barataria Basin Coastal Bays and Gulf Waters subsegment (021102_00) in order to assess the impairment status of this subsegment, evaluate temporal data trends, and compare the Barataria Basin to neighboring systems—the coastal bays and Gulf waters of the Mississippi River (070601_00) and Terrebonne Basin (120806_00, LDEQ 2016). Both the Barataria and Mississippi River subsegments failed to meet the DO criterion of 5.0 mg/L for subsegment 021102_00, with 36.7 percent and 42.7 percent of the values below the state standard, respectively (LDEQ 2016). LDEQ's vertical profile data provided evidence that depressed DO values co-occurred with rapid increases in salinity indicative of a halocline (vertical gradient in salinity). It is likely that the influence of the Mississippi River resulted in abrupt salinity stratification and a subsequent DO decline within the deeper (more saline) waters. Excessive nutrient loading from the Mississippi River is also suspected as a cause of such DO declines observed in the Barataria Basin Coastal Bays and Gulf Waters subsegment (021102_00).

3.5.2.7 Total Suspended Solids

Total Suspended Solids (TSS) consists of those particles within the water column that are too large to pass through a filter. 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.

Monthly average TSS concentrations in the Mississippi River at the Belle Chasse station ranged from 41 mg/L in September to 199 mg/L in March over the period of 2006 to 2017. TSS concentrations at Belle Chasse exhibit a positive linear correlation with flow. At West Pointe A La Hache, average TSS concentrations ranged from 23 mg/L in September to 153 mg/L in December between 1971 and 1998.

In the Barataria Basin, the average monthly TSS concentrations over the period 2000 to 2017 ranged from 19 mg/L in August to 63 mg/L in January. Average TSS concentrations are lower in the summer (May to August) than at other times of the year. Comparatively, the Mississippi River typically has higher TSS concentrations than the Barataria Basin.

3.5.2.8 Turbidity

Turbidity is an optical measure of the amount of suspended particles within the water column, which can impact 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 and colored dissolved organic material. Louisiana's narrative turbidity criterion (LAC 33:IX.1113.B.9) states that turbidity other than that of natural origin shall not cause substantial visual contrast with the natural appearance of the waters of the state or impair any designated water use, and that turbidity shall not significantly exceed background values. The established turbidity standard for the Mississippi River is 150 nephelometric turbidity units (NTU). The established turbidity standard for estuarine waterbodies is 50 NTU. In other state waters, turbidity in NTU caused by any discharges shall be restricted to the appropriate background value plus 10 percent. LDEQ has identified a number of waters in the Barataria Basin as being impaired due to excessive turbidity.

The Mississippi River average monthly turbidity concentrations at the Belle Chasse station ranged from 22 NTU in September to 84 NTU in March between 1978 and 2017. Turbidity concentrations at Belle Chasse exhibit a positive linear correlation with flow. At West Pointe A La Hache, average turbidity concentrations ranged from 12 NTU in September to 70 NTU in February between 1971 and 1998.

In the Barataria Basin, the average monthly turbidity concentrations over the period of 2000 to 2017 ranged from 10 NTU in August to 40 NTU in January. Average turbidity concentrations are lower in the summer and fall (July to October) than at other times of the year. Comparatively, the Mississippi River typically has higher turbidity concentrations than the Barataria Basin.

3.5.2.9 Chloride

Chloride occurs naturally in fresh waters as a result of the dissolution of minerals. Sea water, which mixes with fresh water in the Barataria Basin and birdfoot delta, contains a high amount of chloride that contributes to its salinity. 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 West Pointe A La Hache, the standard is 75 mg/L; in the Barataria Basin the standard ranges from 65 to 600 mg/L and is not applicable in estuarine subsegments. Chloride criteria are based on the arithmetic mean of existing data plus three standard deviations and are not spatially distributed.

In the Mississippi River at Belle Chasse, average monthly chloride concentrations ranged from 23 mg/L (January) to 46 mg/L (July) between 1977 and 2017. The data indicate higher concentrations in the summer months with lower river flows, and lower concentrations in the winter months with higher river flows. At West Pointe A La Hache, average monthly chloride ranged from 22 mg/L (March to May) to 41 mg/L (November) between 1971 and 1998. The data from West Pointe A La Hache do not exhibit seasonal correlation.

In the Barataria Basin, chloride concentrations are significantly higher than in the Mississippi River. Average monthly chloride concentrations ranged from 2,600 mg/L (June) to 7,700 mg/L (November) between 2000 and 2017. The Barataria Basin data exhibit lower chloride concentrations in the spring and summer (March to July), and higher concentrations in the fall and winter (August to February). Similar to salinity, average chloride concentrations are higher in the southern portion of the Project area.

3.5.2.10 Sulfate

Sulfates commonly occur in fresh waters as a result of the dissolution of minerals. Sulfate in sea water contributes to salinity. 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 at Belle Chasse and West Pointe A La Hache, the standard is 120 mg/L; in the Barataria Basin the standards range from 50 to 150 mg/L and are not applicable in estuarine subsegments.

In the Mississippi River at Belle Chasse, average monthly sulfate concentrations ranged from 37 mg/L (April) to 136 mg/L (July) between 1977 and 2017. The data generally indicate decreasing concentrations with increasing flow. At West Pointe A La Hache, average monthly sulfate ranged from 37 mg/L (February) to 60 mg/L (October) between 1971 and 1998.

In the Barataria Basin, sulfate concentrations are significantly higher than in the Mississippi River. Average monthly sulfate concentrations ranged from 388 mg/L (July) to 1042 mg/L (November) between 2000 and 2017. The Barataria Basin sulfate data exhibit trends similar to chloride with lower concentrations in the spring/summer, and higher concentrations in the fall/winter.

3.5.2.11 Fecal Coliform

While fecal coliform bacteria are not typically pathogenic, they are analyzed as an indicator of the potential health risk of exposure to impacted waterbodies. Fecal coliform bacteria may occur as a result of sewage effluent discharges or nonpoint sources of human and animal waste. The Louisiana criteria for fecal coliform vary depending on 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 percent of the total samples collected on a monthly or near-monthly basis shall exceed a fecal coliform density of 400 colonies/100 milliliters (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 percent of the samples shall exceed an MPN of 43 per 100 ml for a five-tube decimal dilution test in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.

Louisiana also has criteria for Enterococci that are applicable between May and October for primary contact use as follows:

- The indicator, Enterococci, will be used for coastal marine waters, Gulf waters to the state three-mile limit, coastal bays, estuarine waters, and adjacent subsegments with recreational beach waters. The Enterococci geometric mean density shall not exceed 35 colonies/100 ml and no more than 10 percent of the individual samples in the data set shall exceed 130 Enterococci colonies/100 ml. The interval of time for calculating the geometric mean and the 10 percent exceedance rate may be one month or greater, but shall not exceed three months (LAC 33 Part IX Subpart 1113.C.5.a.i).

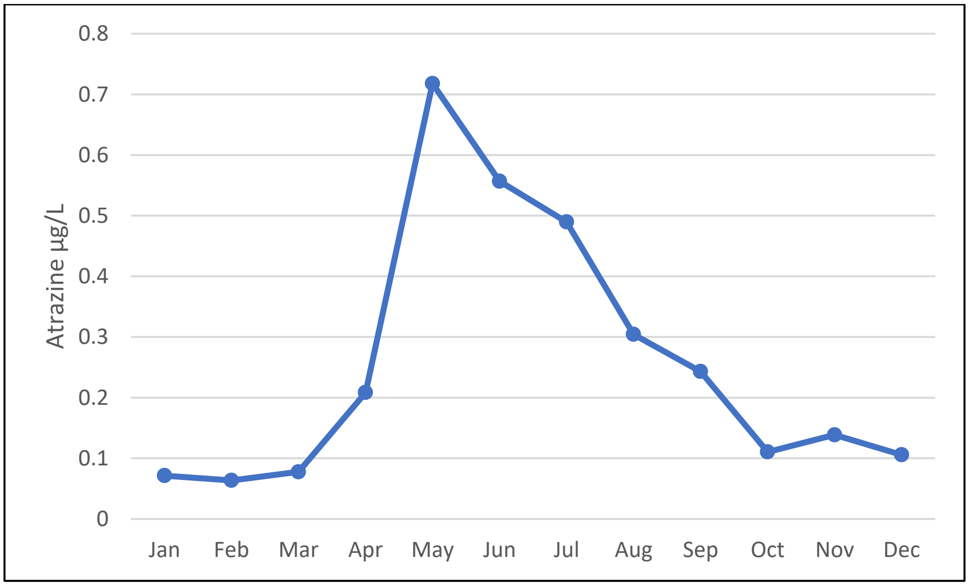
In the Mississippi River at Belle Chasse, average monthly fecal coliform concentrations ranged from 230 MPN/100 ml (April) to 2100 MPN/100 ml (October) between 1977 and 2017. The data generally indicate decreasing concentrations with increasing flow. At West Pointe A La Hache, average monthly fecal coliform concentrations ranged from 200 MPN/100 ml (February) to 630 MPN/100 ml (August) between 1971 and 1998.

In the Barataria Basin, fecal coliform concentrations are significantly lower than in the Mississippi River. Average monthly fecal coliform concentrations ranged from 3.5 MPN/100 ml (February) to 164 MPN/100 ml (December) between 2000 and 2017. The Barataria Basin fecal coliform data do not exhibit an obvious trend but do appear to be elevated in the winter (December to February).

3.5.2.12 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 USEPA established draft freshwater (1,500 micrograms/ liter [µg/L]) and saltwater aquatic life criteria (acute is 760 µg/L and chronic is 17 µg/L) for atrazine (USGS 2003); however, these criteria were later rescinded. The USEPA's primary drinking water standard for atrazine is 3 µg/L (USEPA 2020).

In the Mississippi River at Belle Chasse, average monthly atrazine concentrations ranged from 0.06 µg/L (February) to 0.7 µg/L (May) between 2007 and 2017 (see Figure 3.5-8). The data exhibit a rapid increase between March and May and a slow decline between June and February. The data do not correlate with flow conditions. No atrazine data were available for the Mississippi River at West Pointe A La Hache.



Source: USGS 2018a

Figure 3.5-8. Monthly Atrazine Concentrations in the Mississippi River at Belle Chasse (2007 to 2017).

LDEQ does not analyze atrazine at its ambient water quality stations. In March through August 1999, the USGS sampled atrazine at three locations within the Upper Barataria Basin: Bayou Chevreuil near Chackbay, Interior Canal at Salvador Wildlife Management Area, and Keyhole Six near Westwego. The concentrations ranged from 0.01 µg/L to 0.8 µg/L during the study (USGS 2003). Atrazine concentrations were consistently higher at Bayou Chevreuil than the other stations. The highest concentrations measured at Interior Canal or Keyhole Six were less than or equal to 0.1 µg/L during the course of the study. More recently, a Louisiana State University graduate student sampled three locations in Lake Cataouatche and Lake Salvador in June and August of 2014 (Starr 2016). Concentrations ranged from 0.1 µg/L to 0.2 µg/L.

3.5.3 Sediment Quality

3.5.3.1 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. Metals naturally occur in sediments; the highest concentrations of contaminant metals are mostly found in coastal areas in close proximity to human activities that release metals (Kennicutt 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 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 (1992) as well as current national guidance jointly developed by USEPA and USACE.

The RIA provides a list of potential contaminants of concern (COCs) to be included in the chemical analyses, which include USEPA Priority Pollutants. COCs typically analyzed include metals, Polycyclic Aromatic Hydrocarbons (PAHs), pesticides, organonitrogen compounds, chlorinated hydrocarbons including but not limited to PCBs, total organic carbon (TOC), and ammonia. 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 sediment quality evaluations performed in support of federal navigation channel maintenance projects provides information on the general conditions of sediment quality in the Mississippi River in proximity to the proposed Project intake structure:

- Mississippi River-Southwest Pass Louisiana Contaminant Assessment (CEMVN 2007);
- Contaminant Assessment Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana Southwest Pass (CEMVN 2009);
- Contaminant Assessment Mississippi River-Southwest Pass Louisiana (CEMVN 2011);
- Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana Navigation Project Southwest Pass Ocean Dumping Evaluation (CEMVN 2016); and
- Evaluation of Dredged Material Collected from the Deep-Draft Crossings of the Mississippi River (CEMVN 2017).

Individual COCs analyzed for each of the assessments are provided in Table 3.5-7. The assessments performed in 2007, 2011, and 2016 evaluated chemical, physical, and biological test data for the following media: water, sediment, elutriate, and tissue (bioaccumulation testing). The 2009 and 2017 assessments included chemical and physical analyses only.

In addition to the federal studies, CPRA conducted sediment sampling in the Mississippi River in 2009 in support of CPRA's Mississippi River Sediment Delivery System – Bayou Dupont Project (BA-39). River bottom sediments were sampled from the borrow area north of Myrtle Grove, from a reference area near New Orleans, as well as from the placement area in the Barataria Basin. The Sediment Testing of Dredging Material Proposed for the Mississippi River Sediment Delivery System-Bayou Dupont Project (BA-39) report (CPRA 2009) was reviewed. Sediment samples were analyzed for grain size, PAHs, PCBs, metals (lead, nickel, mercury and vanadium), total petroleum hydrocarbons (TPH), TOC, and oil and grease. Solid phase bioassay/benthic toxicity tests were also conducted on sediments from the borrow, reference, and placement areas. The study concluded that fluorene, dibenzo(a)anthracene (a PAH), and total PAHs exceeded Screening Quick Reference Tables (SQuiRTs) concentrations protective of marine life; however, the bioassay results determined that there was no significant difference between mortality to organisms exposed to the borrow and fill area sediments and those exposed to the reference sediment. Therefore, the dredged material is predicted not to be acutely toxic to benthic organisms.

Table 3.5-7 Parameters for Dredge Sediment Quality Evaluations[a]: USEPA Priority Pollutants, Contaminants of Concern (COC), and Conventional Parameters		
Metals and Cyanide	**LPAH and HPAH Compounds**	**Pesticides**
Antimony (Total)[c]	Acenaphthene[b]	Aldrin[c]
Arsenic (Total)[c]	Acenaphthylene[b]	Alpha-BHC[c]
Beryllium (Total)[c]	Anthracene[b]	Beta-BHC[c]
Cadmium (Total)[c]	Fluorene[b]	Gamma-BHC (Lindane)[c]
Chromium (Total)[c]	Naphthalene[b]	Delta-BHC[c]
Chromium (+3)[c]	Phenanthrene[b]	Chlordane[c]
Chromium (+6)[c]	Benzo(a)anthracene[b]	4,4'-DDD[c]
Copper (Total)[c]	Benzo(a)pyrene[b]	4,4'-DDE[c]
Cyanide (Total)[c]	Benzo(ghi)perylene[b]	4,4'-DDT[c]
Lead (Total)b	Benzo(b & k)fluoranthene[b]	Dieldrin[c]
Mercury (Total)[b]	Chrysene[b]	Alpha-endosulfan[c]
Nickel (Total)[b]	Dibenzo (a,h) anthracene[b]	Beta-endosulfan[c]
Selenium (Total)[c]	Fluoranthene[b]	Endosulfan sulfate[c]
Silver (Total)[c]	Indeno (1,2,3-cd) pyrene[b]	Endrin[c]
Thallium (Total)[c]	Pyrene[b]	Endrin aldehyde[c]
Zinc (Total)[c]	2-Methylnaphthalene[d]	Heptachlor[c]
Vanadium (Total)[d]		Heptachlor epoxide[c]
	Chlorinated Hydrocarbons	Toxaphene[c]
Conventional Parameters	1,2-Dichlorobenzene[c]	
Total Organiccarbon[c]	1,3-Dichlorobenzene[c]	**PCBs**
Total Petroleum Hydrocarbons[b]	1,4-Dichlorobenzene[c]	Total PCBs[b]
Ammonia	2-Chloronapthalene[c]	PCB-1242[b]
Percent Solids/Total Solids[c]	Hexachlorobenzene[c]	PCB-1254[b]
Oil & Grease[d]	Hexachlorobutadiene[c]	PCB-1221[b]
	Hexachlorocyclopentadiene[c]	PCB-1232[b]
Organic Compounds	Hexachloroethane[c]	PCB-1248[b]
Phenols/Substituted Phenols[c]	1,2,4-Trichlorobenzene[c]	PCB-1260[b]
2-Chlorophenol[c]		PCB-1016[b]
2,4-Dichlorophenol[c]	**Phthalate Esters**	
2,4-Dimethylphenol[c]	Bis(2-ethylhexyl) phthalate[c]	**Organonitrogen Compounds**
4,6-Dinitro-o-Cresol[c]	Butyl benzyl phthalate[c]	Benzidine[c]
2,4-Dinitrophenol[c]	Diethyl Phthalate[c]	3,3'-Dichlorobenzidine[c]
2-Nitrophenol[c]	Dimethyl Phthalate[c]	2,4-Dinitrotoluene[c]
4-Nitrophenol[c]	Di-n-Butyl Phthalate[c]	2,6-Dinitrotoluene[c]
p-Chloro-m-Cresol[c]	Di-n-octyl Phthalate[c]	1,2-Diphenylhydrazine[c]
Pentachlorophenol[c]		Nitrobenzene[c]
Phenol[c]	**Halogenated Ethers**	N-nitrosodimethylamine[c]

Table 3.5-7
Parameters for Dredge Sediment Quality Evaluations[a]:
USEPA Priority Pollutants, Contaminants of Concern (COC), and Conventional Parameters

2,4,6-Trichlorophenol[c]	Bis(2-chloroethoxy) methane[c]	N-nitrosodi-n-propylamine[c]
	Bis(2-chloroethyl) ether[c]	N-nitrosodiphenylamine[c]
Miscellaneous	Bis(2-chloroisopropyl) ether[c]	
Isophorone[c]	4-Bromophenyl phenyl ether[c]	
	4-Chlorophenyl phenyl ether[c]	

[a] Evaluations included: Mississippi River-Southwest Pass Louisiana Contaminant Assessment – 2007, Contaminant Assessment Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana Southwest Pass – 2009, Contaminant Assessment Mississippi River-Southwest Pass Louisiana – 2011, and Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana Navigation Project Southwest Pass Ocean Dumping Evaluation – 2016

[b] Parameters analyzed in all five assessments

[c] Parameters analyzed only in 2007, 2011, 2016, and 2017

[d] Parameters analyzed only in 2009 assessment

Although the above Mississippi River sediment assessments do not provide sediment quality data for sediments that would necessarily be transported to the Barataria Basin via the proposed Project diversion structure, the reports document general conditions of sediment quality in the Mississippi River in proximity to the location proposed for the Project intake structure, both north and south. The above 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, the Barataria Basin, 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. With the exception of CPRA’s Bayou Dupont sediment testing study (CPRA 2009), interpretation of the conclusions of the above reports is limited. This is because the reports draw conclusions from the specific disposal of sediments into either the Mississippi River or an ODMDS where currents, waves, and tides can rework or transport disposed sediments and potentially aid in contaminant dilution. Additionally, conclusions of the above reports consider dilution models that would likely require modification to be applicable to the Project outfall area. The proposed Project is designed to deliver sediments to an area for deposition that has lower water energy conditions than the Mississippi River or an ODMDS and likely a significantly lower dilution potential. The Bayou Dupont sediment study evaluated the placement of Mississippi River sediment dredged immediately upriver (within 0.5 mile) of the location proposed for the Project and placed into the eastern Barataria Basin in the Project area. Although some COCs were detected in the river sediments, the study concluded that the sediments would not be acutely toxic to benthic organisms. Mississippi River sediment quality is dependent upon the occurrence and condition of point source and nonpoint source pollution and is subject to significant change over time. Nonetheless, these assessments provide a snapshot of the types and concentrations of COCs known to be present in Mississippi River sediments.

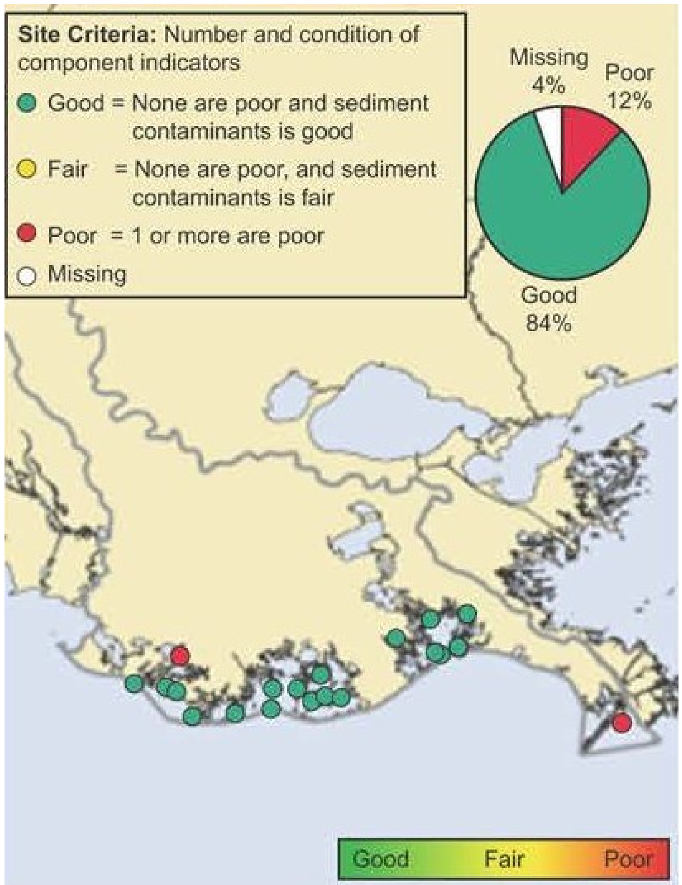
3.5.3.2 Barataria Basin

As part of a larger review of sediment quality data in the northern Gulf of Mexico and adjacent estuaries, Kennicutt (2017) reviewed sediment quality data collected from 2000 to 2001 in order to rate Gulf and estuarine sediments using a sediment quality index. The index was a composite indicator based on sediment toxicity, contaminants, and TOC content. Sediment quality index ratings were defined as good if no sampled contaminants at any sample sites exceeded effects range medium (ERM) values and fewer than five effects range low (ERL) values were exceeded; fair if five or more ERL values were exceeded; and poor (red) if one or more ERM values were exceeded. ERM value is the concentration of a chemical in sediments that resulted in biological impacts approximately 50 percent of the time based on the literature. The ERL value is the concentration of a chemical in sediments that resulted in biological impacts approximately 10 percent of the time based on the literature (Kennicutt 2017).

Using this index, sediment quality in 12 percent of the Barataria-Terrebonne Estuarine Complex (BTEC), of which the Project area is a part, was rated poor (see Figure 3.5-9). Two locations were rated poor mostly because of localized, elevated TOC concentrations (Kennicutt 2017).

Although less extensive than sediment quality data within the Mississippi River, federal navigation maintenance/dredging projects performed on the Barataria Bay Waterway provide additional sediment quality data within the Project area outside of the Mississippi River. The Barataria Bay Waterway runs from Bayou Villars, near Jean Lafitte, to Grand Isle, entering Barataria Bay approximately 7 miles south of the immediate outfall area of the proposed Project. Historically, sediments generated in the construction and maintenance of the waterway have been disposed of in open water areas adjacent to the channel, wetland development disposal areas, upland confined disposal areas or beneficial use sites along east and west banks of the waterway, and sites such as the Barataria Bay Waterway ODMDS (bar channel) (CEMVN 2017c). Additional sediment quality data within the Project area has been generated in support of the Fifi Island beneficial use/wetlands creation project near Grand Isle (Russo et al. 2014) and through evaluation of impacts from the DWH spill to the Barataria Bay Waterway (CEMVN 2010).

The Barataria Bay Waterway ODMDS Site Management Plan (CEMVN 1998) discusses historic sediment quality trends for the bar channel (mile 0 to mile -3.8). The plan states that sediments sampled in 1991 and 1994 were of sufficient quality for disposal at the ODMDS. In support of the Fifi wetlands creation/maintenance dredging project, sediment sampling performed in 2002 on the Bayou Rigaud (north of Grand Isle) portion of the Barataria Bay Waterway revealed that only ammonia was present at levels requiring action; the beneficial use/wetlands creation project was installed to use the dredge sediments in a beneficial way that would also result in mitigation of ammonia.



Source: Kennicutt 2017

Figure 3.5-9. Sediment Quality Index Ratings for Barataria-Terrebonne Estuarine Complex.

The bar channel reach of the Barataria Bay Waterway was evaluated for impacts from the DWH spill in 2010. Analytes indicative of oil contamination were present in shoal material only in trace amounts, and at concentrations that are not expected to adversely impact benthic organisms. The CEMVN concluded that additional biological impacts-based testing was not warranted and special management of dredged material was not required for channel maintenance. The majority of the length of the bar channel contains a high percentage of clay and silt; ODMDS surface sediments consist of sand (CEMVN 1980). Interpretation of this data for documentation of sediment quality within the Project outfall area is subject to limitations. The Barataria Bay Waterway bar channel and ODMDS are approximately 24 miles south/southeast from the Project's immediate outfall area, and Barataria Bay Waterway sediment quality is documented for in-channel sediments. Navigation channel sediment sources and depositional environment(s) vary from those existing in the immediate outfall area of the Project.

The Sediment Testing of Dredging Material Proposed for the Mississippi River Sediment Delivery System-Bayou Dupont Project (BA-39) evaluated sediment in the marsh creation placement area in the eastern Barataria Basin. Sediments sampled from the placement area contained naphthalene in excess of SQuiRTs concentrations protective of marine life, as well as detectable concentrations of PAHs, lead, nickel, vanadium, and TPH. As previously noted, there was no significant difference in mortality to benthic organisms exposed to the fill area sediments and those exposed to the reference and borrow sediments.

3.6 WETLAND RESOURCES AND WATERS OF THE U.S.

Under Section 404 of the CWA, the USACE regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. Waters of the U.S. 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 USEPA 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: it must exhibit appropriate hydrology, contain hydric soils, and support hydrophytic vegetation (USACE 1987).

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 2017a). 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 United States, by volume (NMFS 2017; see Section 3.14 Commercial Fisheries). 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). Climate change is projected to intensify the threat of flooding in the Project area due to more frequent, stronger hurricanes, sea-level rise, higher river discharges, and extreme weather events, further highlighting the importance of the ecological and economic function of wetlands (Day et al. 2021b). 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 where methane emissions and carbon sequestration are balanced (Mitsch et al. 2012). Wetlands also provide aesthetic and recreational value for human uses. Recreation and tourism in the Project area, including recreational fishing, is discussed in more detail in Section 3.16 Recreation and Tourism.

The Project area is within the Mississippi River Alluvial Plan and Gulf Coast Prairies and Marshes ecoregions in Louisiana, as described in Section 3.1.2 Introduction; these areas are naturally dominated by bottomland hardwood forests, freshwater swamps, and coastal marshes. However, as described in Section 3.6.2, coastal erosion, subsidence, sea-level rise, and other factors have resulted in the loss of natural wetlands in coastal Louisiana. To counteract these losses, wetland restoration efforts have been implemented to enhance, restore, and create some of the wetlands in the Project area. These include efforts under the federal CWPPRA program and CEMVN's program for the beneficial use of dredged material (BUDMAT), which transports material dredged for the maintenance of navigation channels via pipeline to marsh creation cells in the basin. Additionally, over the past 25 years, the State of Louisiana has implemented over 30 restoration projects in the Barataria Basin and birdfoot delta, using state-only funding or in partnership with federal agencies. Since 2007, investments in the restoration of coastal Louisiana, the Barataria Basin, and the birdfoot delta have been guided by the state's Coastal Master Plan (CPRA 2017a).

3.6.1 Wetland Types in the Project Area

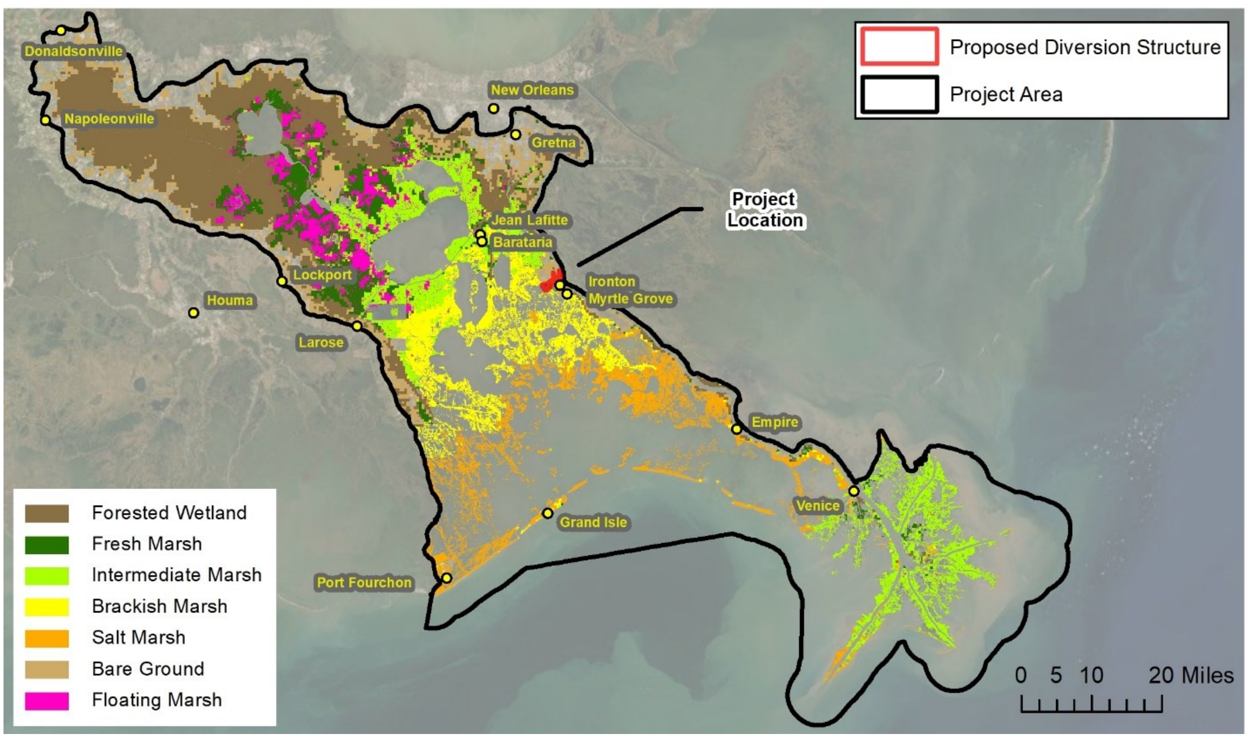
The Barataria Basin comprises a network of interconnecting waterbodies along with natural and artificial levees, coastal habitat, and wetlands (Conner and Day 1987). Salinity is the primary driver of wetland vegetation assemblages in the basin and accounts for the change from freshwater forested wetlands and marshes in the Upper Barataria Basin to saltwater marshes in the Lower Barataria Basin. The salinity gradient in the basin ranges from 0 ppt in the Upper Barataria Basin to 32 ppt in the Lower Barataria Basin (see Section 3.5.2.2 in Surface Water and Sediment Quality for more information about ambient water quality in the Project area). Salinities are typically low in the spring when rainfall is higher, and higher in the winter due to lower rainfall (Conner and Day 1987). Prior to Mississippi River Levee construction, freshwater marshes were more prevalent in the basin (Day et al. 2000, Bass and Turner 1997, Connor and Day 1987).

Wetland types within the Project area include forested (bottomland hardwood and swamp), scrub/shrub, and emergent wetlands, which are further classified by their salinity regimes and tidal influence. Emergent wetlands in the Barataria Basin and Mississippi River Delta are typically classified as freshwater, intermediate, brackish, or saline marsh based on salinities and the corresponding plant communities present (Chabreck 1972, CPRA 2017a). Wetland types on the west bank of the Mississippi River near the location proposed for the Project diversion complex (RM 60.7 AHP) include mostly freshwater forested bottomland hardwood and scrub/shrub wetlands, as well as some areas of freshwater emergent wetlands (CPRA 2017a). Batture vegetation communities occur where the Mississippi River meets the crest of the levee, and include seasonally flooded forested bottomland hardwood wetlands in the immediate vicinity (within 0.5-mile) of the location proposed for the Project diversion complex. However, revetments and other areas of impervious substrates limit vegetation growth where they are installed. Farther downstream (near RM 11.0 AHP and Venice, Louisiana), freshwater scrub/shrub and emergent wetlands predominate. Table 3.6-1 summarizes the acreage and percentage of the Project area covered by each wetland type, based on vegetation data from CPRA's 2017 Coastal Master Plan; these data are also depicted in Figure 3.6-1 (CPRA 2017a).

Table 3.6-1
Wetland Habitat Types Occurring within the Project Area

Wetland Type	Total Acres within the Project Area	Percent of the Project Area
Palustrine Wetlands		
Forested Wetlands (including swamp forest)	398,219.1	17.5
Freshwater Marsh (including floating marsh)	190,865.7	8.4
Estuarine Wetlands		
Intermediate Marsh	216,948.8	9.5
Brackish Marsh	144,015.3	6.3
Salt Marsh	141,235.0	6.2

Source: CPRA 2017a; These data reflect the entire Project area depicted in Figure 3.6-1, which is larger than the Delft3D Basinwide Model domain addressed in Chapter 4.



Source: CPRA 2017a

Figure 3.6-1. Wetland Types in the Project Area.

The following paragraphs describe these wetland systems on the basis of the Cowardin et al. (1979) classification system and vegetation cover classifications commonly used in the Project area (for example, Chabreck 1972, Visser et al. 2017a). Table 3.6-2 provides a detailed list of the vegetation species that occur in each wetland type, along with the state and global ranks for these habitat types; in addition, invasive wetland plant species occur in the Project area as discussed in Section 3.6.3. Submerged aquatic vegetation is also present within marshes in the Project area, and is described in detail in Section 3.10.2.1 in Aquatic Resources. CPRA conducted a desktop analysis to delineate jurisdictional waters and wetlands in the area that would be affected by the proposed Project; those data are addressed in detail in Chapter 4, Section 4.6 Wetlands.

Table 3.6-2
Common Plant Species Occurring within the Project Area by Wetland Type

	Scientific Name	Common Name	Scientific Name	Common Name
Forested Wetlands				
Bottomland Hardwood Forest (S4/G4G5)	*Quercus lyrata*	overcup oak	*Morus rubra*	red mulberry
	Fraxinus pennsylvanica	green ash	*Ulmus americana*	American elm
	Cornus foemina	swamp dogwood	*Quercus phellos*	willow oak
	Planera aquatica	water elm	*Acer negundo*	box elder
	Carya aquatica	water hickory	*Acer rubrum*	red maple
	Celtis laevigata	hackberry	*Crataegus spp.*	Hawthorn
	Forestiera acuminata	swamp privet	*Platanus occidentalis*	American sycamore
	Cephalanthus occidentalis	buttonbush	*Ilex decidua*	deciduous holly
	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
	Gleditsia aquatica	water locust		
Swamp Forest (S4/G3G5)	*Taxodium distichum*	bald cypress	*Acer rubrum var. drummondii*	swamp red maple
	Nyssa aquatica	tupelo gum	*Planera aquatica*	water elm
	Nyssa biflora	swamp blackgum	*Gleditsia aquatica*	water locust
	Fraxinus profunda	pumpkin ash	*Itea virginica*	Virginia willow
	Fraxinus pennsylvanica	green ash	*Cephalanthus occidentalis*	buttonbush
	Salix nigra	black willow		
Scrub/Shrub Wetlands				
Scrub/Shrub Wetlands (S4S5/G3G5)[a]	*Cephalanthus occidentalis*	buttonbush	*Forestiera acuminata*	swamp privet
	Acer rubrum var. drummondii	swamp red maple	*Planera aquatica*	water elm
	Baccharis halimifolia	saltbush	*Salix spp.*	willows
	Morella cerifera	wax myrtle	*Iva frutescens*	marsh elder
	Amorpha fruticosa	false indigo brush	*Sabal minor*	dwarf palmetto

Table 3.6-2
Common Plant Species Occurring within the Project Area by Wetland Type

	Scientific Name	Common Name	Scientific Name	Common Name
Emergent Wetlands (Marsh)				
Freshwater Marsh (S2/G3G4)[b]	*Panicum hemitomon*	maidencane	*Typha spp.*	cattail
	Sagittaria lancifolia	bulltongue arrowhead	*Vicia ludoviciana*	deer pea
	Alternanthera philoxeroides	alligator weed	*Ceratophyllum demursum*	coontail
	Eleocharis spp.	spikerush	*Eichhornia crassipes*	water hyacinth
	Spartina patens	saltmeadow cordgrass	*Peltandra virginica*	arrow arum
	Phragmites australis	Roseau cane	*Lemna minor*	common duckweed
	Bacopa monnieri	coastal water hyssop	*Nymphaea odorata*	white waterlilly
	Cyperus odoratus	fragrant flatsedge	*Utricularia spp.*	bladderworts
	Pontederia cordata	pickerelweed	*Zizaniopsis miliacea*	southern wildrice
	Hydrocotyle spp.	pennyworts		
	Myriophyllum spp.	watermilfoils		
Intermediate Marsh (S3/G4)	*Spartina patens*	saltmeadow cordgrass	*Bacopa monnieri*	coastal water hyssop
	Sagittaria lancifolia	bulltongue arrowhead	*Schoenoplectus americanus*	three-cornered grass
	Eleocharis spp.	spikerush	*Vicia ludoviciana*	deer pea
	Schoenoplectus californicus	giant bulrush	*Panicum virgatum*	switch grass
	Schoenoplectus americanus	common three-square	*Pluchea camphorata*	camphorweed
	Paspalum vaginatum	seashore paspalum	*Echinochloa walteri*	Walter's millet
	Leptochloa fascicularis	bearded sprangletop	*Najas guadalupensis*	southern naiad
	Cyperus odoratus	fragrant flatsedge	*Spartina cynosuroides*	big cordgrass
	Alternanthora philoxeroides	alligator weed		
	Spartina spartinae	gulf cordgrass		
	Phragmites australis	Roseau cane		

Table 3.6-2
Common Plant Species Occurring within the Project Area by Wetland Type

	Scientific Name	Common Name	Scientific Name	Common Name
Brackish Marsh (S3/G4)	*Spartina patens*	saltmeadow cordgrass	*Distichlis spicata*	saltgrass
	Schoenoplectus americanus	three-cornered grass	*Ruppia maritima*	widgeon grass
	Bolboschoenus robustus	salt marsh bulrush	*Eleocharis parvula*	dwarf spikesedge
	Paspalum vaginatum	seashore paspalum	*Juncus roemanianus*	black needlerush
	Bacopa monnieri	coastal water hyssop	*Spartina alterniflora*	smooth cordgrass
	Spartina cynosuroides	big cordgrass		
Salt Marsh (S3S4/G5)	*Spartina alterniflora*	smooth cordgrass	*Spartina patens*	saltmeadow cordgrass
	Distichlis spicata	saltgrass	*Juncus roemerianus*	black needlerush
	Batis maritima	salt wort	*Avicennia germinans*	black mangrove

Source: LDWF 2017a-g; Holcomb et al. 2015

Note: S1 = Critically imperiled in Louisiana because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extirpation.

S2 = Imperiled in Louisiana because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extirpation.

S3 = Rare and local throughout the state or found locally (even abundant at some of its locations) in a restricted region of the state, or because of other factors making it vulnerable to extirpation (21 to 100 known extant populations).

S4 = Apparently secure in Louisiana, with many occurrences (100 to 1,000 known extant populations).

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1,000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3,000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.

G3 = Either very rare and local throughout its range (21 to 100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.

G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery (100 to 1,000 known extant populations).

G5 = Demonstrably secure globally, although it may be quite rare in parts of its range, especially at the periphery (1,000+ known extant populations)

[a] Due to the similarity and common conservation needs, the conservation status of scrub/shrub wetlands is similar to the status of swamp forest.

[b] Includes Freshwater floating marsh (flotant; S2S3/G2G3)

3.6.1.1 Palustrine Wetlands

Palustrine, or non-tidal, freshwater wetlands occur where mean annual salinity is below 0.5 ppt and include forested, scrub/shrub, and emergent wetlands. In the Project area, palustrine wetlands occur inland from the Gulf of Mexico where tidal influence does not affect salinity, for example, in the vicinity of Lake Salvador and, in some locations, along the Mississippi River (USFWS 2017b, Chabreck 1972).

3.6.1.1.1 Palustrine Forested Wetlands

Forested wetlands are dominated by woody vegetation greater than 20 feet (6.1 meters) tall. In the Barataria Basin, palustrine forested wetlands may include bottomland hardwood forests and swamp forests. Bottomland hardwood forests within the Project area may vary in species composition from location to location but common genera include maples (*Acer)*, elms (*Fraxinus)*, with minor contributions of oaks (*Quercus)*, hickory (*Carya)*, sweetgum (*Liquidambar)*, and willows (*Salix)*. This habitat is generally located at the highest wetland elevations along natural and artificial ridges adjacent to the Mississippi River, canals, and bayous. Overbank flooding and deposition of nutrient-rich sediments make bottomland hardwood forests highly productive ecosystems (Mitsch and Gosselink 2000). Generally situated on broad floodplains of large to medium rivers, bottomland hardwood forests provide essential foraging habitat for numerous wildlife and avian species (LDWF 2017a). There are 47 wildlife species of greatest conservation concern that use bottomland hardwood habitat in Louisiana; threats to this habitat include drier site conditions due to hydrologic modifications, invasive species, and changes to precipitation associated with climate change (Holcomb et al. 2015).

Swamp forests are located at lower elevations and are saturated or inundated more frequently and for longer durations than the bottomland hardwood forests. Swamp forests in the Project area are typically dominated by bald cypress (*Taxodium distichum*) and tupelo gum (*Nyssa aquatica*) (LDWF 2017b). Typically inundated or saturated throughout the growing season, these wetlands are characterized by a sparse understory and low species diversity when compared with bottomland hardwood forests (LDWF 2017b). Swamp forests provide nesting and foraging habitat for a variety of waterfowl and other avian species. Many furbearing mammals also utilize this habitat as foraging and nesting habitat (LDWF 2017b). A detailed list of vegetation species that occur in bottomland hardwood and swamp forests is provided in Table 3.6-2. There are 25 wildlife species of greatest conservation concern that use cypress-tupelo-blackgum swamp habitat in Louisiana; threats to this habitat include subsidence and altered hydrology, including impoundments, which result in conversion to marsh in coastal areas (Holcomb et al. 2015).

3.6.1.1.2 Palustrine Scrub/Shrub Wetlands

Palustrine scrub/shrub wetlands are dominated by woody vegetation less than 20 feet (6.1 meters) 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 such as timber harvesting or storm damage (LDWF 2017c). However, some areas represent stable communities of shrubs and trees stunted by frequent or permanent inundation or other environmental conditions (LDWF 2017c). Common species occurring within the scrub/shrub wetlands of the Barataria Basin include genera such as maples and willow, and species including sabal palm (*Sabal* *minor*), wax myrtle (*Morella cerifera*), swamp privet (*Forestiera acuminate*), and buttonbush (*Cephalanthus occidentalis*; see Table 3.6-2).

3.6.1.1.3 Palustrine Emergent Wetlands

Palustrine emergent wetland vegetation is characterized by erect, rooted, herbaceous hydrophytic vegetation (Cowardin et al. 1979). Palustrine emergent wetlands encompass more than 190,000 acres within the Project area and represent approximately 8.4 percent of the cover types (CPRA 2012) (see Table 3.6-1). This marsh type is usually adjacent to intermediate marsh and the farthest inland of all the coastal marsh types. Salinity within this marsh type is usually below 2.0 ppt, averaging between 0.5 and 1.0 ppt. Palustrine emergent wetlands have the highest plant diversity of all emergent marsh types, with more than 90 different species identified in some areas (LDWF 2017d). Dominant species include maidencane (*Panicum hemitomon*), bulltongue arrowhead (*Sagittaria lancifolia*), spikerush (*Eleocharis* spp.), alligator weed (*Alternanthera philoxeroides*), and Roseau cane (*Phragmites australis*). Table 3.6-2 provides a more detailed list of species that are common within the freshwater marsh of the Barataria Basin (LDWF 2017d). Of the 218 species of birds that are known permanent residents that breed in Louisiana or that winter in the state, most use habitat in the Barataria Basin (Connor and Day 1987). Specifically, freshwater emergent wetland habitat supports large numbers of wintering waterfowl (Odum et al. 1984; LDWF 2017d). Freshwater marsh also provides important nursery habitat for juvenile marine species (LDWF 2017d). There are 40 wildlife species of greatest conservation concern that use freshwater marsh habitat in Louisiana; threats to this habitat include subsidence, relative sea-level rise, saltwater intrusion, invasive species, and increased storm frequency and intensity associated with climate change (Holcomb et al. 2015).

While typical freshwater emergent vegetation grows with roots in the soil because this marsh type has the lowest frequency of inundation, much of the detritus material produced by the marsh vegetation accumulates on the water surface. Emergent vegetation with a live root mat and associated detritus can form thick mats called flotant or floating marsh. This flotant is held together by living roots and extends out from the original shoreline (Conner and Day 1987; Visser et al. 2017a). Flotant supports 16 wildlife species of greatest conservation concern and is threatened by the input of nutrients and salinity, as well as inadequate fire regimes that allow for shrub dominance (Holcomb et al. 2015).

3.6.1.2 Estuarine Wetlands

Estuarine wetlands are tidally influenced habitats that have salinities ranging from 0.5 to 30.0 ppt. Within the Project area, these wetland habitats include three distinct emergent marsh habitats separated by salinity and species composition: intermediate (0.5 to 5.0 ppt), brackish (5.0 to 18.0 ppt), and saline (18.0 to 30.0 ppt) wetlands (Cowardin et al. 1979). Plant diversity within these marsh types decreases as the salt content increases. Increased inundation (depth and duration) and salinity limit plant species diversity and productivity (Mendelssohn and McKee 1988, McKee and Mendelssohn 1989, Howard and Mendelssohn 1999, Visser and Sandy 2009, Sneddon et al. 2015, Leuschner and Ellenberg 2017, and see Teal et al. 2012 for reviews). Fewer plant species are tolerant of higher salinities, resulting in competition between fewer species and conspicuous plant zonation in salt marshes, compared with heterogeneous species mixes in freshwater marshes (Latham 1994). Collectively, estuarine wetlands comprise more than 500,000 acres (22.0 percent) of the Project area.

3.6.1.2.1 Estuarine Emergent Wetlands

Estuarine emergent wetlands include intermediate, brackish, and saline marshes. Intermediate marsh has the lowest salinity of the estuarine marshes and is situated between the freshwater marsh and the brackish marsh. Estuarine emergent wetlands provide important wintering habitat for a variety of waterfowl as well as foraging and nesting habitat for many other avian species. Many larval and juvenile marine species utilize intermediate marsh as their nursery habitat (LDWF 2017e). Plant diversity within the intermediate marsh is the highest of the three estuarine marshes and is dominated by herbaceous species such as marsh hay (saltmeadow) cordgrass (also known as wiregrass; *Spartina patens*), bulltongue arrowhead, and Roseau cane. Table 3.6-2 provides additional species found within this habitat type (LDWF 2017e). There are 47 wildlife species of greatest conservation concern that use intermediate marsh habitat in Louisiana; threats to this habitat include habitat disturbance, subsidence, and saltwater intrusion that convert intermediate marsh to open water, brackish marsh, or salt marsh (Holcomb et al. 2015).

Seaward of the intermediate marsh, brackish marsh exhibits salinity ranges from 5.0 to 18.0 ppt but can fluctuate from fresh to saline conditions depending on tidal movements and freshwater runoff from the Upper Barataria Basin (Conner and Day 1987). Salt is a stressor affecting osmosis and cell structure. Plants occurring in saline and brackish marshes have developed adaptations to either exclude uptake or excrete salt; however, when competition with other species is removed, even salt marsh species grow better at lower salinities (Mitsch and Gosselink 2000, Teal et al. 2012). Similar to intermediate marsh, brackish marsh provides valuable nursery habitat for larval and juvenile forms of many estuarine and marine species as well as wintering habitat for large numbers of waterfowl. Plant diversity within this marsh type is not as high as the intermediate marsh but is higher than that found in saline marsh. Dominant species in brackish marsh include marsh hay (saltmeadow) cordgrass, saltgrass (*Distichlis spicata*), three-cornered grass (*Schoenoplectus americanus*), and salt marsh bulrush (*Bolboschoenus robustus*). Additional species common in the brackish marsh can be found in Table 3.6-2 (LDWF 2017f). There are 52 wildlife species of greatest conservation concern that use brackish marsh habitat in Louisiana (Holcomb et al. 2015); threats to this habitat include subsidence and increased storm frequency and intensity associated with climate change (Holcomb et al. 2015).

Situated adjacent to Barataria Bay, the saline marsh exhibits the highest salinity levels of the three estuarine marshes, ranging from 18.0 to 30.0 ppt (Cowardin et al. 1979). This marsh type can experience salinity shifts on a seasonal basis and sometimes daily, depending on weather conditions, tides, and rainfall (Conner and Day

1987). As with the intermediate and brackish marsh, saline marsh also provides important nursery habitat for an abundance of estuarine species and wintering habitat for numerous waterfowl species. Saline marsh has the lowest plant diversity of any of the marsh types and is dominated by two species, smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemerianus*) (Lin et al. 2016). Black mangroves (*Avicennia germinans*) are expanding into the saline marshes of Louisiana (Alleman and Hester 2011). Other species common in this marsh type are listed in Table 3.6-2 (LDWF 2017g). There are 48 wildlife species of greatest conservation concern that use salt marsh habitat in Louisiana; threats to this habitat include disturbance, subsidence, and increased storm frequency and intensity associated with climate change (Holcomb et al. 2015).

3.6.1.2.2 Vegetated Shallows

Vegetated shallows are permanently inundated areas that contain rooted submerged aquatic vegetation (SAV); SAV communities are described in greater detail in Section 3.10.2 in Aquatic Resources.

3.6.1.3 Open Water

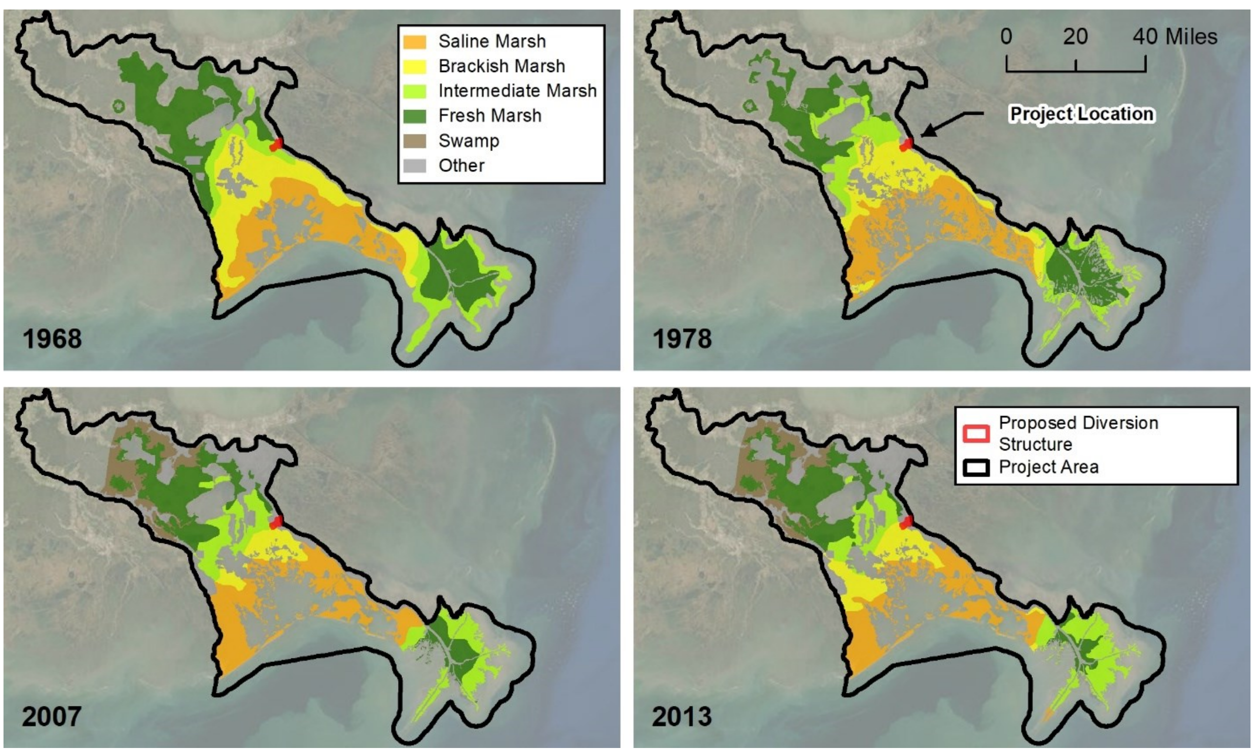
Open water in the Project area includes natural and dredged/excavated channels and open water ponds, lakes, or bays that are designated as deepwater habitats by Cowardin et al. (1979). These open water habitats are further classified as either lacustrine or riverine for freshwater systems and estuarine 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).

3.6.2 Wetland Loss

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous U.S.; however, coastal erosion, subsidence, sea-level rise, and other factors have resulted in the loss of greater than 1 million acres in coastal Louisiana since the late 19th century (LCWCRTF and the Wetlands Conservation and Restoration Authority 1998). Based on an analysis of aerial and satellite imagery between 1932 and 2016 in coastal Louisiana, approximately 1,866 square miles (4,833 square kilometers) of land have been lost. This amounts to a decrease of approximately 25 percent of the 1932 land area within the coastal Louisiana assessment 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 impacts could be related to lower rates of oil and gas extraction (which peaked in 1969) and restoration activities (Couvillion et al. 2017).

The Barataria Basin has one of the highest rates of land loss in Louisiana; approximately 29 percent of the total land area in the Barataria Basin was lost between 1932 and 2016 (Couvillion et al. 2017). As shown in Figure 3.6-2, the most significant wetland losses in the Project area have occurred in saline marshes nearest to the Gulf of Mexico and brackish marshes farther inland. Between 1968 and 1978, saline marshes surrounding Barataria Bay were lost and brackish marshes shifted to saline marshes; that trend continued between 1978 and 2007, with a further reduction in brackish marshes. Barrier islands along the southern extent of the Barataria Basin were generally subject to persistent land loss between the 1930s and 1970s; some localized areas have been subject to land gain since that time, including the Gulf-facing shore of Grand Isle, which has been protected by erosion controls via the construction of breakwaters and placement of sand for beach nourishment (Couvillion et al. 2017; Kindinger et al. 2013). The Mississippi River Delta has experienced a net loss of wetlands since the 1930s; however, since the 1960s, wetland loss rates in that 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).

In more recent analyses, Potter reviewed aerial satellite imagery between October 2005 and 2020 in western Barataria Basin, and documented about 16.3 square miles (42.3 square kilometers) of wetland losses and 13.0 square miles (34.0 square kilometers) of wetland gains (much of which was associated with shoreline protection and dredging restoration projects; Potter 2021). Wetland gains have also been documented in the Breton Sound Basin since 1985 (Potter and Amer 2020). While the land loss rates estimated by Couvillion et al. (2017) may not capture wetland gains from recent and/or ongoing restoration projects in Barataria Bay, coastal erosion, subsidence, sea-level rise, and other factors continue to cause wetland losses in the Project area (Potter 2021, Potter and Amer 2020).



Source: Chabreck et al. 1968, Chabreck and Linscombe 1978, Carpenter et al. 2008, Sasser et al. 2014

Figure 3.6-2. Marsh Type Change in the Project Area, 1968 through 2013.

3.6.2.1 Patterns of Wetland Loss

There are two general patterns of wetland loss: (1) lateral loss caused by shoreline erosion and the physical removal of marsh soils rich in organic matter, which are transported as suspended sediments into nearby waterbodies, and (2) interior marsh loss caused by numerous factors including land-surface subsidence; soil waterlogging, erosion, and loss; saltwater intrusion; and eventually death of the vegetation holding the marsh soils in place (Gosselink et al. 1977 and Mendelssohn and McKee 1988, from Morton et al. 2003). Interior marsh loss accounts for approximately 43 percent of the loss in coastal Louisiana (Leibowitz and Hill 1987 from Morton et al. 2003). Lateral retreat 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 wave erosion accounted for 63 percent of the marsh deflation and differential subsidence accounted for 37 percent of marsh loss. Marsh shorelines in coastal Louisiana are erosion-dominated and unstable and yield significant material into the adjacent bays with their rapid retreat (approximately 3.3 feet [1 meter] per year) (Wilson and Allison 2008).

3.6.2.2 Causes of Wetland Loss

Louisiana's wetland losses have been attributed to a variety of natural and human causes, including subsidence and compaction, sea-level rise, saltwater intrusion, fluid withdrawal (for example groundwater, oil), levee construction, canal dredging, storms, boat wakes, invasive species (including nutria), 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, Day et al. 2021a). These causes are complex, interacting, and may have differing impacts 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.

3.6.2.2.1 Subsidence and Relative Sea-level Rise

Subsidence is the sinking of land and can result from natural and anthropogenic processes. See Section 3.4.1.1 in Surface Water and Coastal Processes for information regarding causes and estimated subsidence rates for the Project area and a discussion of relative sea-level rise.

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 (Barataria-Terrebonne National Estuary Program [BTNEP] 2010; USGS 2016a). For wetlands to remain healthy, the accumulation of sediment and aboveground and belowground organic matter must occur at a rate sufficient to keep pace with rapid subsidence and relative sea-level rise (Boesch et al. 1994).

The accumulation of organic matter in wetland soils contributes to the sequestration of carbon as well as wetland soil accretion rates; organic matter accumulates when root growth is greater than decomposition (Baustian et al. 2017; Snedden et al. 2015). In addition, marsh vegetation traps sediment and results in soil accumulation. Changes in salinity or inundation levels, such as those resulting from saltwater intrusion and sea-level rise, can reduce the productivity of wetland vegetation, thereby reducing organic matter 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).

3.6.2.2.2 Risk Reduction Levees

Risk reduction levees along the Mississippi River have reduced freshwater inputs into the Barataria Basin, contributing to impacts on salinity. 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). Historically, the Barataria Basin received regular river water inputs via crevasses, minor distributaries, and Mississippi River and Bayou Lafourche overbank flooding (Day et al. 2021a, 2021b). However, by preventing overbank flooding and flows from the Mississippi River and its distributaries into the Barataria Basin, levees have reduced the sediment load that enters the basin (Boesch et al. 1994). Further, Bayou Lafourche was cut off from the Mississippi River in 1900 (Day et al. 2021a). As described in Section 3.1.4 Overview and History of the Project Area, the volume of introduced sediment no longer offsets the loss of soil volume due to compaction of previously deposited sediments. The deficit, combined with the increased rate of sea-level rise since delta formation, means that a significant area of wetlands is being submerged (Blum and Roberts 2009). In addition, construction of dams and reservoirs and farming practices that control soil erosion upriver have resulted in declines in the suspended sediments in the Mississippi River (Meade and Moody 2010).

3.6.2.2.3 Storms

Hurricanes are a significant source of large-scale disturbances in coastal marshes. Unlike hurricane impacts in forested systems, where the primary disturbance is the creation of canopy gaps, hurricanes in coastal 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 (69 kilometers) from the storm track, near the Mississippi River and adjacent distributaries.

Storms deposit suspended sediments on wetland surfaces and bring freshwater inflows; however, they can also convert wetlands to open water from erosion when large storm surges bring salt water inland (Day et al. 2007). Large 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 impacts on vegetation communities (LCWCRT and the Wetlands Conservation and Restoration Authority 1998).

3.6.2.2.4 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 from Turner and Cahoon 1989). In 2017, an estimated 10,472 miles (16,853 kilometers) of canals and an associated 20,943 miles (33,705 kilometers) of spoil banks were present in the Louisiana coastal zone (Turner and McClenachan 2018, Day et al. 2021a). 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 (an estimated 4.6 times more land area than is directly affected by dredging the canal; Bass and Turner 1997, Turner and McClenachan 2018). North-south canals provide a conduit for salt water to enter into 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 from Turner and Cahoon 1989).

Canal construction has also impacted the natural hydrology of marshes within the Barataria Basin. Spoil banks are the piles of dredged material placed adjacent to canals during canal construction, which may be 3 to 10 times the height of the natural tidal range (Turner and McClenachan 2018), can obstruct the sheet flow of water across the marsh and subsurface flow of water through the marsh, if not returned to preconstruction contours. 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 (Swenson and Turner 1987). Prolonged flooding of a marsh can lead to waterlogged soils and stressed vegetation, as well as sulfide accumulation (Mendelssohn and Seneca 1980 from Bass and Turner 1997). As a result, canals facilitate wetland to open water conversion, including the formation of ponds (Turner and McClenachan 2018).

3.6.2.2.5 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 is responsible for wetland loss across coastal Louisiana, including in the Barataria Basin (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 damaged 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 (CNCP) in 2002, nutria damage along survey transects in coastal Louisiana has been reduced from 82,080 acres in 2002 to 5,866 acres in 2016 (LDWF 2017h). Herbivory by native muskrats may also result in wetland loss (Boesch et al. 1994). 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). This species is further discussed in Section 3.9.4 in Terrestrial Wildlife and Habitat.

The Roseau cane scale (*Nipponaclerda biwakoensis*), native to China and Japan, has also contributed to widespread die-off of Roseau cane in the birdfoot 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 3.9.4 in Terrestrial Wildlife and Habitat.

Salt marshes may be converted to mudflats due to herbivory, for example, via marsh periwinkle grazing (Silliman and Zieman 2001). While herbivory is a greater influence in freshwater 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 (Hale et al. 2011, Minter et al. 2014, Weishar et al. 2008). Soil oxidation via fiddler crab burrowing facilitates smooth cordgrass growth, “balancing” the detrimental impacts of the periwinkles (Gittman and Keller 2013).

3.6.2.2.6 Deepwater Horizon Oil Spill

The 2010 DWH oil spill was the direct cause of a minimum of 850 miles (1,368 kilometers) of shoreline oiling in coastal Louisiana, with the most widespread oiling occurring in Barataria Bay salt marshes (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). Marshes in the upper portion of Barataria Bay that were heavily oiled had reduced biomass and higher erosion rates more than 3 years after oil exposure (Lin et al. 2016). 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. 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 3 to 6 years after the spill.

3.6.3 Wetland Invasive Plants

Wetland and aquatic habitats in coastal Louisiana, including the Barataria Basin, 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). For example, the Davis Pond Freshwater Diversion Project, which diverts Mississippi River water into the Barataria Basin, provides an opportunity for invasive species to become established in areas outside their normal range (Kravitz et al. 2005). Invasive aquatic species (including water hyacinth [*Eichhornia crassipes*] and Eurasian watermilfoil [*Myriophyllum spicatum*]) have been documented in the vicinity of the Caernarvon Diversion, which discharges water and sediment into Breton Sound (Kravitz et al. 2005; aquatic invasive species are addressed further in Section 3.10.6 Aquatic Invasive Species). In addition, vegetation data near the Davis Pond Freshwater Diversion has shown an increase in the vegetation cover of alligatorweed at monitoring sites in the vicinity of the diversion since the early 2000s (CPRA 2019a). 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 2000). Louisiana is the largest port in terms of imported goods (in tons) in the world, providing ample opportunity for invasive species introduction for both aquatic and terrestrial species (Molnar et al. 2008). At the local level, wildlife can further disperse plant species (Lockwood et al. 2013).

In Louisiana, organizations such as USGS, the BTNEP, 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 3.6-3. The most prominent species are described below (aquatic invasive species are presented in Section 3.10.6 Aquatic Invasive Species and terrestrial species are presented in Section 3.9.4.1, Terrestrial Invasive Plants).

- Wild taro (*Colocasia esculenta*) forms dense growth stands in riparian zones and displaces native vegetation; many types of taro are sold at garden stores as ornamental plants.

- Water hyacinth 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 impacts 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.

- Chinese tallow tree (*Triadica sebifera*, formerly *Sapiem sebifera*) is a nuisance species in many Louisiana prairies, parks, and wetlands (see also Section 3.9 Terrestrial Wildlife and Habitat).

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

- Cogon grass (*Imperata cylindrica*) is a perennial grass that infests stream banks, pastures, roadsides, golf courses, and forests (see also Section 3.9 Terrestrial Wildlife and Habitat).

Table 3.6-3 Potential Invasive Wetland Plant Species and Habitat Type in the Barataria Basin		
Scientific Name	**Common Name**	**Habitat Type (Fresh/ Marine/Brackish)**
Alternanthera philoxeroides	Alligatorweed	Freshwater
Amaranthus cannabinus	Tidal marsh amaranth	Brackish
Ceratopteris richardii	Triangle water fern	Freshwater
Colocasia esculenta	Wild taro[a]	Freshwater
Cyperus blepharoleptos	Cuban bulrush	Freshwater
Cyperus difformis	Smallflower umbrella sedge	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
Ludwigia grandiflora	Large-flower primrose-willow	Freshwater
Murdannia keisak	Marsh dewflower	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
Typha angustifolia	Narrow-leaved cattail	Freshwater
[a] Species also included in the State Management Plan for Aquatic Invasive Species (Kravitz et al. 2005).		

3.7 AIR QUALITY

3.7.1 Regulatory Setting

Air quality in Louisiana is regulated by USEPA Region 6 and the LDEQ Air Quality Assessment Division. The Clean Air Act (42 USC 7401-7671q), as amended, gives USEPA 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: fine particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), carbon monoxide (CO), nitrous oxides (NO_x), ozone (O_3), and lead (Pb). Primary standards are designated for the protection of public health, while secondary standards are designated to protect the public welfare (including protection against decreased visibility and damage to vegetation, crops, animals, and buildings). The NAAQS are summarized in Table 3.7-1. Each state has the authority to adopt standards that are more stringent than those established by USEPA; however, Louisiana accepts the federal standards.

Table 3.7-1
National Ambient Air Quality Standards[a]

Pollutant	Time-Frame	Primary	Secondary	Form
CO	8-hour	9 ppm ($10,000\ \mu g/m^3$)	NA	Not to be exceeded more than once per year
	1-hour	35 ppm ($40,000\ \mu g/m^3$)	NA	
Pb[b]	Quarterly	$0.15\ \mu g/m^3$	$0.15\ \mu g/m^3$	Not to be exceeded
NO_2	Annual	0.053 ppm ($100\ \mu g/m^3$)	0.053 ppm ($100\ \mu g/m^3$)	Annual mean
	1-hour	0.100 ppm	NA	98th percentile, averaged over 3 years
O_3[c]	8-hour	0.070 ppm ($150\ \mu g/m^3$)	0.070 ppm ($150\ \mu g/m^3$)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
$PM_{2.5}$	Annual	$12\ \mu g/m^3$	$15\ \mu g/m^3$	Annual mean, averaged over 3 years
	24-hour	$35\ \mu g/m^3$	$150\ \mu g/m^3$	98th percentile, averaged over 3 years
PM_{10}	24-hour	$150\ \mu g/m^3$	$150\ \mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
SO_2[d]	3-hour	NA	0.5 ppm ($1,300\ \mu g/m^3$)	Not to be exceeded more than once per year
	1-hour	75 ppb ($195\ \mu g/m^3$)	NA	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

a $\mu g/m^3$ = micrograms per m^3; NA = Not applicable; Pb = lead; O_3 = ozone; ppb = part(s) per billion; ppm = part(s) per million.

b 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 ($1.5\ \mu g/m^3$ as a calendar quarter average) also remain in effect.

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: (b) 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 implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a State Implementation Plan (SIP) call under the previous SO_2 standards (40 CFR 50.4(3)). A SIP call is an USEPA action requiring a state to resubmit all or part of its SIP to demonstrate attainment of the require NAAQS.

The Project area is located in the Southern Louisiana-Southeast Texas Interstate Air Quality Control Region (AQCR); AQCRs are designated by USEPA per Section 107 of the Clean Air Act for air quality planning purposes. Within each AQCR, the USEPA assigns an attainment status for specific geographic areas (such as parishes) 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. An area is designated as *nonattainment* if the concentration of one or more criteria pollutants exceeds the NAAQS. Areas for which sufficient data are not available to determine attainment status are designated as *unclassifiable* and are managed as attainment areas.

3.7.1.1 Conformity

In 1993, the USEPA established General Conformity Regulations 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. However, because the Project area is in attainment of the NAAQS, a conformity determination is not required.

3.7.2 Existing Conditions

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 USEPA; however, the most recent available monitoring data are from 2005 (USEPA 2017b). Existing sources of emissions in the Project vicinity include operation of the Alliance Refinery[15] and other industrial facilities, as well as the Cenex Harvest States (CHS) terminal (a grain export facility). Plaquemines Parish, where the location proposed for the Project diversion complex would be located, is designated as "unclassifiable/in attainment" for all criteria pollutants.

3.7.2.1 Climate Change and Greenhouse Gases

Greenhouse gases (GHG) trap heat in the atmosphere. Key GHGs are carbon dioxide (CO_2), NOx, methane (CH_4), and fluorinated gases (such as hydrofluorocarbons). While some GHGs occur naturally in the atmosphere, a primary source of GHG emissions is from the burning of fossil fuels (such as natural gas and coal) for electricity, heat, and transportation. Globally, GHGs from human activities have been accumulating in the atmosphere since the beginning of the industrial era, primarily due to fossil fuel combustion, agriculture, and clearing forests. Since 1895, the average temperature in the U.S. has increased by about 1.3 to 1.9°F (-17.1°C to -16.7°C); the majority of that change has occurred since 1970 (Melillo et al. 2014). GHG emissions from human activity are the primary cause of the warming of the climate since the 1950s, and current and future emissions of GHGs will result in further warming and impacts on the climate (IPCC 2014). The primary source of GHG emissions in Louisiana is the release of CO_2 from fossil fuel combustion, representing about 87.0 percent of GHG emissions in 2018; the second highest source, representing about 6.0 percent of GHG emissions, is methane from natural gas and oil systems (Louisiana

[15] In November 2021, Phillips 66 announced its plan to convert its Alliance Refinery into a terminal facility.

State University 2021). Other emissions sources include industrial processes, agriculture, forestry, transportation, and wastes (municipal solid waste and wastewater). The impacts of climate change, including sea-level rise, are generally addressed in Section 3.1.3 in the Introduction. See Section 3.4.1.1 for a more detailed discussion about sea-level rise.

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.

3.8 NOISE

3.8.1 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 (Federal Highway Administration [FHWA] 1995). Sound is a physical disturbance in a medium, such as air or water, which can be detected by the ear. Sound is appropriately described as having two components: (1) a pressure component, and (2) a particle motion component. Particle motion—the oscillatory displacement, velocity, or acceleration of the actual “particles” of the medium at a particular location—is directional and best described by a 3-dimensional vector (Southall et al. 2007).

Sound pressure levels (intensity) are measured in units of decibels (dB) with respect to a reference pressure value on a logarithmic scale; the pitch of sound is its frequency (high or low), which is measured in hertz (Hz). To account for the human ear’s reduced sensitivity to low and high-frequency sounds relative to mid-frequency sounds, airborne noise is measured in decibels on the A-weighted scale (dBA). In water, noise measurements are either not weighted or weighted for the species of interest (for example, marine mammals).

Airborne sound is measured in dB relative to a reference pressure of 20 micro Pascals (μPa), which is derived from the average human hearing threshold; however, the reference pressure in water is 1 μPa. Therefore, a given sound will produce a higher sound pressure level in water than in air. Sound travels much faster through water than through air (about 0.9 mile per second [1.4 kilometers per second] in water and about 0.2 mile per second [0.3 kilometers per second] in air) (OSPAR Commission 2009).

Types of noise relevant to the MBSD can be characterized as pulsed (impulsive) or non-pulse (non-impulsive) noises. Pulsed noises, such as those generated from explosives and impact pile driving, have rapid rise times from ambient to maximal pressure followed by a decay period (Southall et al. 2007). Pulsed noise is typically broadband (covering a range of frequencies) and intermittent. Non-pulse noise (such as vibratory pile driving and drilling) lack the rapid rise time pressure of pulsed noise and can be tonal (single frequency), broadband, or both. Although non-pulse noises can be intermittent or continuous, sounds relevant here are continuous (for example, vessel transit, vibratory pile driving). It is important to distinguish noise types because pulsed noise generally has an increased capacity to induce physical injury than non-pulsed noises (Southall et al. 2007).

In addition to identifying metrics and noise types, when discussing noise it is also important to identify whether the measurement refers to the source level or received level (RL). Typically, source levels reference the pressure level 3.3 feet (1 meter) from the source; however, many pile-driving source levels are measured 32.8 feet (10 meters) from the source. RLs indicate the dB at which the receiver (for example, a human, dolphin) is exposed.

3.8.1.1 Airborne Sound

Sound levels and human sensitivity to sound vary over time; for example, a nuisance sound (noise) generated during the night may be perceived as a greater disturbance than the same sound generated during the day. Evaluation of the noise environment is therefore based on measurements of noise exposure over time to characterize cumulative noise. Two measures used to measure time-varying noise exposure are the 24-hour equivalent sound level (L_{eq}) and day-night sound level (L_{dn}). The L_{eq} is the level of steady sound with the same total (equivalent) energy as the time-varying sound, averaged over a 24-hour period. The L_{dn} is the L_{eq}, weighted to account for people's greater sensitivity to night-time sound by adding 10 dBA between the hours of 10:00 pm and 7:00 am.

Table 3.8-1 demonstrates relative noise levels, measured in dBA, of common sounds in the environment. The human ear's threshold of perceptible sound level change is considered to be 3 dBA; 5 dBA is clearly noticeable to the human ear, and 10 dBA is perceived as a doubling of sound (FHWA 1995).

Table 3.8-1
Sound Levels and Relative Loudness

Noise Source or Activity	Sound Level (dBA)	Subjective Impression
Jet aircraft takeoff from carrier (50 feet away)	140	Deafening (130 dBA is the threshold of pain)
Loud rock concert near stage	120	
Loud car horn (10 feet away)	100	Very loud
Train	80 to 85	Loud
School cafeteria with untreated surfaces	80	
Barge traffic	67 to 76	
Near freeway auto traffic	60	Moderate
Average office	50	
Average residence without stereo playing	30	Quiet
Quiet library, soft whisper	20	Very quiet
Threshold of hearing	0	Silence
Source: HUD 1985, USEPA 1971, Thornton 1975		

3.8.1.2 Underwater Sound

Sound levels in water may be unweighted or referenced to a species-specific hearing threshold at a given frequency (similar to A-weighting for human hearing). For example, generalized frequency weighting for various hearing groups of marine mammals are referred to as M-weighting (Southall et al. 2007; see Section 3.11 Marine Mammals for species-specific hearing frequency ranges). The sound pressure level (SPL) is a measure of the pressure component of sound. It can be presented in multiple ways. Common metrics include root mean square (RMS) and peak. The RMS is defined as the square root of the average of the square of the pressure of the sound signal over a given duration (ANSI 2005). An RMS value can apply to both pulsed and non-pulsed noise. SPL peak is defined as the greatest absolute instantaneous sound pressure within a specified time interval and frequency band (ANSI 1986; ANSI 2013). Because non-pulsed noise (for example, vibratory pile driving) does not contain rapid rise times, peak pressure is typically reserved for pulsed noise (for example, impact pile driving, explosives). Finally, the sound exposure level (SEL) differs from the SPL in that it takes into account the duration of the signal.

3.8.2 Regulatory Overview

There are no federal regulations that limit overall environmental noise levels; however, several federal agencies have published guidelines and policies for noise levels. USEPA guidance indicates that a L_{dn} of 55 dBA (which is equivalent to a continuous sound level of 48.6 dBA) protects the public from indoor and outdoor activity noise interference (USEPA 1974). Additionally, the U.S. Department of Housing and Urban Development (HUD) has developed a noise abatement and control policy applicable to HUD programs codified in 24 CFR Part 51. Consistent with USEPA's guidance, it is a HUD goal that exterior noise levels not exceed 55 dBA L_{dn}. However, according to HUD policy, airborne noise at or below 65 dBA is acceptable, noise between 65 and 75 dBA is generally acceptable, and noise exceeding 75 dBA is unacceptable. The FHWA has developed noise abatement criteria as hourly L_{eq} 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 772 and presented in Table 3.8-2. The FHWA's noise abatement criteria can be used for assessment of the impacts associated with construction noise.

Where proposed Project construction would occur in Plaquemines and Jefferson Parishes, 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: Noise). 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 am and 10:00 pm) and 55 dBA at night. Jefferson Parish has established a similar ordinance (Jefferson Parish Code of Ordinances, Chapter 20, Article V: Offenses Against Public Peace). Construction activities are generally exempt from the Jefferson Parish noise ordinance unless operating within 300 feet (92 meters) of noise sensitive areas (NSAs).

Table 3.8-2 FHWA Noise Abatement Criteria Hourly A-weighted Sound Level Decibels			
Activity Category	**Hourly L_{eq} (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 through 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.			

3.8.3 Existing Conditions

3.8.3.1 Airborne Sound

The ambient sound level comprises the total sound generated within a specific environment, including natural and anthropogenic sounds. The magnitude and frequency of ambient sound at any specific location is variable in time, and that variation may be due to changing weather conditions, seasonal changes in vegetative cover, and, in developed areas, daily traffic patterns. Land uses and their associated human activities have different ambient sound levels. Existing sources of noise in the Project area typically include local road and railroad traffic, high altitude aircraft overflights, vessels (including airboats and ships on the Mississippi River) in open water areas, and natural noises such as wildlife vocalizations. Estimated sound levels associated with existing sources of man-made noise in the Project area are presented in Table 3.8-1, above. In industrial areas, noise may also result from the operation of equipment at industrial facilities. Ambient sound levels in outdoor noise environments across the U.S.

range from about 40 L_{dn} in rural residential areas to as much as 90 L_{dn} in congested urban settings (USEPA 1974).

NSAs are those locations which, because of their use by people, may be more susceptible to noise impacts. NSAs include residences, churches, and schools. Table 3.8-3 identifies the NSAs nearest to the Project construction footprint based on a review of aerial imagery.

Table 3.8-3
Nearest Noise Sensitive Areas to the Mid-Barataria Sediment Diversion Project Facilities

Proposed Project Feature	Parish	Distance and Direction to nearest NSA[a]	Nearest NSA Description	Surrounding Land Use
Diversion Complex	Plaquemines and Jefferson	0.5 mile south-southeast	Residencies in Ironton, Louisiana	Developed land and forest land
Outfall South Beneficial Use Areas	Plaquemines	0.4 mile east	Residences along Wilkinson Canal	Developed land, wetlands, and open water
Outfall North Beneficial Use Area	Jefferson	1.3 mile northwest	Possible residence along an unnamed canal	Open water, wetlands

[a] Distances are based on the nearest distance to the diversion complex, where potential airborne noise from Project construction would be greatest.

Where construction activities are planned in Jefferson and Plaquemines Parishes, the location proposed for the Project would be in areas that are mostly rural in nature with residential, commercial, and industrial development concentrated along LA 23 and the Mississippi River (see Section 3.18 Land Use and Land Cover). The proposed Project features in Plaquemines Parish include the diversion complex, LA 23 and NOGC Railroad modifications, Outfall South beneficial use areas, and a portion of the Outfall North beneficial use area. The proposed Project features planned for Jefferson Parish include a portion of the Outfall North beneficial use area and a portion of the barge access channels.

3.8.3.2 Underwater Sound

Ambient underwater sound levels represent noise from natural sources such as wind-driven waves, storms, fish, tidal currents, and vocalizing marine mammals. When anthropogenic sources are added to ambient noise 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. Measurements of baseline ambient underwater sound in the Project area are not available. However, in the Barataria Basin, sources of anthropogenic underwater sound include commercial fishing and recreational vessels (see Sections 3.14 Commercial Fisheries and 3.16 Recreation and Tourism), 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 (for example, oil tankers and container ships), pile driving, and dredging.

As with airborne noise, ambient underwater noise is variable over time due to changes in the intensity and abundance of noise sources. Biological sounds associated with a host of mammals, fishes, and invertebrates can generate broadband noise in the frequency range of about 10 to 10,000 kHz (Discovery of Sound in the Sea [DOSITS] 2017). Ambient sound in the mid-frequency range of 500 to 10,000 Hz is primarily due to sound from breaking waves; the intensity of sound in this frequency range increases with wind speed (DOSITS 2017). Higher frequency sounds are primarily generated by thermal noise, which is the sound of the random movement of water molecules as a result of water temperature increases (DOSITS 2017). Most underwater sound in the 20 to 500 Hz range is due to distant shipping, rather than natural sources; vessel traffic generates low-frequency sounds that can travel considerable distances (DOSITS 2017).

3.9 TERRESTRIAL WILDLIFE AND HABITAT

While the majority of habitat in the Barataria Basin includes wetland and open water (see Section 3.6 Wetland Resources and Waters of the U.S.), a small amount of terrestrial habitat (less than 13 percent, including agriculture and developed lands) exists and provides habitat for numerous species of wildlife. Although certain wildlife species may use wetlands extensively, they are considered terrestrial species and are discussed below.

3.9.1 Historical Context

The Barataria Basin is characterized by predominantly open water and wetlands, although there are also natural and artificial levees, lakes, bayous, coastal beaches, and barrier islands. Natural levee ridges associated with the Mississippi River and Bayou Lafourche that were historically characterized by upland hardwood forests have been nearly eliminated and converted to agricultural, residential, and industrial land uses. However, some stands of American elm (*Ulmus americana*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), and swamp red maple (*Acer rubrum* var. *drummondii*) are still present (Braud et al. 2006).

In the late 1800s, explorers also identified the area as having interminable swamps of giant cypresses unlike any other in North America, with red and orange birds (parakeets) and herds of bison in the coastal lands between Barataria and Calcasieu bays (Condrey et al. 2008). While parakeets and bison no longer occur in the Project area, other species have not experienced the same population declines when compared with historic levels. For example, in more recent years (mid- to late- 1900s), wading birds and raptors were generally identified as not experiencing population declines, despite the loss of marsh and barrier island habitat (Condrey et al. 1996).

3.9.2 Vegetation

The Barataria Basin includes two ecoregions, the Mississippi River Alluvial Plain and the Gulf Coast Prairies and Marshes ecoregions (LDWF 2005a, Holcomb et al. 2015). Upland habitat types in these ecoregions are listed in Table 3.9-1 and discussed further below. Information on community associations below is based on descriptions provided by LDWF (2005 and 2009).

Table 3.9-1
Terrestrial Habitat Types and Ranks in the Barataria Basin Ecoregions

Upland	State Rank	Global Rank	Mississippi River Alluvial Plain	Gulf Coastal Plain, Marshes
Agriculture/crop/grassland	NA	NA	X	X
Coastal Dune Grassland/Shrub Thicket	S1/S2	G1	NA	X
Barrier Island Live Oak Forest	S1	G1	NA	X
Live Oak Natural Levee Forest	S1	G2	X	X

Sources: Holcomb et al. 2015, Louisiana Natural Heritage Program (LNHP) 2009

Note: NA = Not applicable; X = habitat present

S1 = Critically imperiled in Louisiana because of extreme rarity (5 or fewer known extant populations) or because of some factor(s) making it especially vulnerable to extirpation.

S2 = Imperiled in Louisiana because of rarity (6 to 20 known extant populations) or because of some factor(s) making it very vulnerable to extirpation

S3 = Rare and local throughout the state or found locally (even abundant at some of its locations) in a restricted region of the state, or because of other factors making it vulnerable to extirpation (21 to 100 known extant populations).

S4 = Apparently secure in Louisiana, with many occurrences (100 to 1,000 known extant populations).

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1,000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3,000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.

G3 = Either very rare and local throughout its range (21 to 100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.

G4 = Apparently secure globally (may be rare in parts of range).

Terrestrial vegetation is limited to areas with nonhydric soils (that is, without wetland soils) and therefore is limited to areas without extensive inundation. The distribution of terrestrial vegetation ends where wetlands, such as bottomland hardwoods and marshes, begin. As such, upland habitats and vegetation in the Project area are generally limited to the northern portion of the basin and to ridges and coastal barrier islands (LNHP 2009). Much of the upland habitat in the basin has been converted to agriculture.

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.

3.9.2.1 Agriculture/Crop/Grassland

The agriculture/crop/grassland vegetation category comprises 6.5 percent of the Project area (see Section 3.18 Land Use and Land Cover). This category includes orchards (such as pecan and citrus orchards), vineyards, experimental plots, plant nurseries, roadway rights-of-way, field crops (for example, grain, cotton, soybeans, rice and sugarcane), cover crops, fields prepared or partially exposed, fallow (idle) fields, and grasslands (pastures and/or rangeland). Historically throughout Louisiana, agricultural lands and practices had higher plant species diversity that provided habitat and forage for many species; however, monocultures have resulted in a decline in potential habitat quality (Holcomb et al. 2015). 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 (Holcomb et al. 2015). Holcomb et al. (2015) indicates that no species of conservation concern are fully dependent upon these habitats for survival, although many (71) resident and migratory species may rely on them.

3.9.2.2 Coastal Dune Grassland/Shrub Thicket

Coastal dune grasslands and shrub thickets occur on beach dunes and elevated backshore areas (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 from other places. The sites are normally well drained due to elevation above mean high water, but are exposed to the impacts 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 agriculture/aquaculture, 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 (Holcomb et al. 2015).

The density of coastal dune grasslands ranges from sparse to fairly dense and is dominated by salt spray tolerant grasses, which may include wiregrass (*Spartina patens)* usually present and often dominant, sea oats *(Uniola paniculata),* beach panic *(Panicum amarum*), purple sandgrass (*Triplasis purpurea)*, jointgrass (*Paspalum vaginatum)*, seacoast bluestem (*Schizachyrium maritimum)*, saltgrass, sandspurs (*Cenchrus 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*), camphorweed (*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, 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 (Holcomb et al. 2015). Holcomb et al. (2015) indicates that 24 species of greatest conservation use coastal dune grassland/coastal dune shrub thicket as habitat.

3.9.2.3 Barrier Island Live Oak Forest

The barrier island live oak (*Quercus virginiana*) forest occurs on eroding deltas of the Mississippi River and is reportedly limited to about 40 acres (historically between 500 and 1,000 acres) on Grand Isle in the Barataria Basin (Holcomb et al. 2015). This habit was historically created by delta processes, which are no longer active due to the construction of levees and other anthropogenic factors (see Section 3.1.4 in Introduction for more details on the history of the Project area). The quality of the existing barrier island live oak forest is adversely affected by development, invasive species, shoreline erosion, understory removal, and fragmentation. The community is considered distinct from live oak communities to the east and west, but is not well studied. The dominant canopy species is live oak, with smaller representation by hackberry (*Celtis laevigata*). This habitat is considered critically imperiled in Louisiana (Holcomb et al. 2015, LNHP 2009). Holcomb et al. (2015) indicates that 61 species of greatest conservation use this habitat type.

3.9.2.4 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 and was historically one of the most extensive natural uplands in the Barataria Basin. This forest type occurs in the deltaic plain of southeastern parishes from Orleans and St. Bernard Parishes westward to St. Mary Parish. 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, invasive species, 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 (1 to 5 percent) remain in Louisiana. The forest is considered critically imperiled in Louisiana.

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, hackberry, Drummond red maple (*Acer rubrum var. drummondii*), and green ash (*Fraxinus pennsylvanica*). In the understory, dwarf palmetto (*Sabal minor*) is often conspicuous, reaching up to 13 feet (4 meters) 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, elderberry (*Sambucus canadensis*), and red bay (*Persea borbonia*). The herbaceous layer is often poorly developed, but may contain such species as seaside goldenrod and vines such as climbing hempvine (*Mikania scandens*) and greenbriar (*Smilax rotundifolia*) (Holcomb et al. 2015, LNHP 2009). Epiphytes such as Spanish moss (*Tillandsia usneoides*) may also be conspicuous (LNHP 2009). Holcomb et al. (2015) indicates that 28 species of greatest conservation use this habitat type.

3.9.3 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 Barataria Basin are listed in Table 3.9-2, by habitat. Species designated as federally threatened or endangered are addressed in Section 3.12 Threatened and Endangered Species.

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 2020e). See Section 3.16 Recreation and Tourism for information related to state hunting regulations and licensing.

Table 3.9-2
Select Terrestrial Wildlife Species in the Project Area

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

Table 3.9-2
Select Terrestrial Wildlife Species in the Project Area

Common Name	Scientific Name	Representative Habitats			
		Upland Forest	Urban/ Agricultural	Wetlands/ Marsh/ Bottomland Hardwoods	Shoreline /Barrier Islands
Nutria[d]	*Myocastor coypus*			X	
Whitetail deer[d]	*Odocoileus virginianus*	X		X	

Sources: DeMay et al. 2007, American Bird Conservancy (ABC) 2012, Conner and Day 1987, Anderson and Seigel 2003, The Cornell Lab of Ornithology 2018.

a Species of greatest conservation need (including species considered critically imperiled [S1], imperiled [S2], and rare [S3] in the state).

b Protected by the Migratory Bird Treaty Act.

c Protected by the Bald and Golden Eagle Protection Act.

d Game species.

e Birds of Conservation Concern recognized by the USFWS.

3.9.3.1 Birds

Louisiana's coast is located within the Mississippi Flyway for migratory birds, is recognized by the American Bird Conservancy (ABC) as a Globally Important Bird Area, and is part of the Gulf Coast Joint Venture (GCJV; specifically, Mississippi River Coastal Wetlands Initiative Area), which aims to advance conservation of important bird habitats. The Louisiana coast provides important wintering and stopover sites for migrant waterfowl, shorebirds, and passerines, with much of the Project area, from Lake Salvador and south, within the Northern Gulf Coast Migration Staging Area (ABC 2017). The 1986 *North American Waterfowl Management Plan* (later updated to include Mexico) identified the preservation and maintenance of critical over-wintering habitats as a key factor in preventing the further decline in the continental waterfowl population (USFWS and Environment Canada 1986).

Migrant birds expend huge amounts of energy during migration, and foraging opportunities in habitat along the immediate coast and inlands are critical to their ability to successfully arrive on their breeding and wintering grounds (ABC 2017). 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 U.S. 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), which prohibits the take or killing of individual migratory birds, their eggs and chicks, and active nests.

The BTNEP has identified approximately 400 different species of birds in Barataria and Terrebonne Basins, including nearly 200 species considered common to abundant at least during part of the year and 64 year-round inhabitants (DeMay et al. 2007). Remaining upland forests along natural ridges and beach ridges in the Barataria and Terrebonne Basins provide habitat and a source of seeds, fruit, and insects to numerous migratory songbirds. Even urban areas in the basin with a variety of trees and shrubs can offer suitable habitat for species. In addition, crawfish ponds are commonly used by waterfowl, wading birds, and shorebirds (DeMay et al. 2007). Restoration projects in the Project area, including, but not limited to beneficial use projects and the Davis Pond Freshwater Diversion, also can benefit birds and other flora and fauna over the long-term. For example, dredged material has been used to restore dunes, shoreline, and interior marsh habitat along Caminada and Shell Islands, both of which are barrier islands adjacent to Barataria Bay (CPRA 2016a). The Davis Pond Freshwater Diversion has benefited birds by maintaining wetlands that provide SAV; food sources; and wintering, resting, and roosting habitat.

Louisiana's coastal wetlands and marshes provide winter habitat for more than 50 percent of the duck population of the Mississippi Flyway. Thirty-five species of waterfowl have been recorded in the Project area (Mitchell 1991). Louisiana's estimated contribution to some of these species populations is significant, such as the mottled duck (*Anas fulvigula*), which is a priority species of the GCJV-Mississippi River Coastal Wetlands Initiative Area and for which Louisiana is estimated to contribute 48 percent of the northern Gulf of Mexico breeding population's abundance (Remsen et al. 2019, GCJV 2016). Located in the southern extent of the Project area, the Delta National Wildlife Refuge (NWR) has counted more than 1.2 million waterfowl in a peak year, with gadwall (*Anas strepera*) and northern pintails (*Anas acuta*) accounting for about half (ABC 2017). Most of the waterfowl consume either aquatic vegetation or aquatic invertebrates, although some prey on fish.

Louisiana is also a center for colonial wading bird and seabird nesting in the U.S., 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 two common characteristics: (1) they tend to gather in large assemblies, called colonies or rookeries, during the nesting season, and (2) they obtain all or most of their food from the water (USFWS 2002). Colonial wading birds that occur in the Project area include herons, egrets, bitterns, spoonbills, ibis, gulls, and pelicans. These birds are largely carnivorous and insectivorous, feeding in shallow-water areas, especially marshes, flooded fields, and along bayou banks. Rookeries tend to be located in shrub swamps, which typically flood during the nesting season (Mitchell 1991). Surveys conducted by LDWF as recently as 2017 indicate that colonial waterbird rookeries are located in the Barataria Basin. The closest rookery to the location proposed for the Project, which was active in 2014, is in the proposed Project outfall area, approximately 0.25-mile (0.4 kilometer) from the mouth of the proposed diversion channel.

Raptor species (for example, osprey [*Pandion haliaetus*], peregrine falcons [*Falco peregrinus anatum*], bald eagle [*Haliaeetus leucocephalus*], red-tailed hawk [*Buteo jamaicensis*]) 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. Bald eagles are known to nest in the Project area as discussed in Section 3.12.2.2 in Threatened and Endangered Species.

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 (Holcomb et al. 2015) reports that the bird habitats in most peril include barrier islands and coastal forests. Holcomb et al. (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.

3.9.3.2 Reptiles and Amphibians

According to Conner and Day (1987), more than 60 species of reptiles and amphibians occur in the Barataria Basin, with the highest concentrations and species diversity on natural ridges and levees leading away from the Mississippi River and into the cypress swamps in the northern part of the Barataria Basin. The second highest concentration of reptiles and amphibians in the basin is found in the fresh and intermediate marshes. Here, too, the animals are more common along spoil banks and levees than in the marsh. Those with distributions that include salt marshes are 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 impacts (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.

3.9.3.3 Mammals

The large area and variety of habitats within the Project area support numerous species of mammals. According to Conner and Day (1987), there are eight species of bats, 11 species of small mammals, seven furbearers, five game animals, and armadillo (*Dasypus novemcinctus*) found in the Barataria Basin; however, surveys conducted more recently in the Barataria-Jean Lafitte National Historical Park and Preserve reported 41 mammal species (Hood 2005). Representative species identified in both studies are included in Table 3.9-2.

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. They also are found throughout the marshes where spoil banks and small ridges of scrub habitat provide cover (Conner and Day 1987). 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.

3.9.4 Terrestrial Invasive Species

An invasive species is defined as one that is nonnative to the ecosystem being considered, and causes, or is likely to cause, economic or environmental harm or harm to human health, pursuant to EO No. 13112 (1999) (U.S. Forest Service [USFS] 2004). Terrestrial invasive animals and plants are listed by state and parish/county by the Electronic Early Detection and Distribution Mapping System (EDDMapS 2018). The potential adverse impacts of invasive species on the quality of native habitats described in Section 3.10.6 in Aquatic Resources for aquatic plant species apply to terrestrial habitats as well. While species and habitats vary, pathways of introduction and establishment can be similar.

3.9.4.1 Terrestrial Invasive Plants

Terrestrial invasive plant species can adversely affect the quality of native forests, agriculture operations, and wildlife habitat, and are a challenge for restoration and management of native habitats (Walker and Smith 1997). Native habitats are particularly susceptible to invasive species establishment following disturbances that create a gap in the tree canopy or soil surface, providing light and space for invasive species that are then often able to outcompete native species for available resources. While most invasive species are dispersed via anthropogenic means (for example, through the transport of timber, crops, and nursery materials), wildlife can disperse plant species locally (for example, in bird droppings and mammal scat) (Lockwood et al. 2013).

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. Based on a review of invasive species occurrences by parish (EDDMapS 2017), the numbers of terrestrial invasive plant species in the Barataria Basin exceed 40; however, only a few are considered invasive or noxious enough to require management considerations. These species are further described in Table 3.9-3.

3.9.4.2 Terrestrial Invasive Animals

In addition, the USGS Invasive Species Program lists species by HUC. Based on reviews of these databases, three frogs (coastal plain toad [*Incilius nebulifer*], cane toad [*Rhinella marina*], and greenhouse frog [*Eleutherodactylus planirostris*]), four birds (common pheasant [*Phasianus colchicus*], European starling [*Sturnus vulgaris*], rock dove [*Columba livia*], and Eurasian collared dove [*Streptopelia roseogrisea*]), and two mammals (nutria [*Myocastor* coypus] and feral hogs [*Sus scrofa*]) occur in the Project area. Many species are nonnative, 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 in Project area parishes, 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 3.10.6 in Aquatic Resources.

3.9.4.2.1 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 CNCP. Approved under CWPPRA, the CNCP encourages nutria harvest via monetary incentives; thousands of nutria were harvested in the Project area between 2016 and 2017 (Normand and Manuel 2017). 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 Barataria-Terrebonne Basins had been severely damaged or lost due to nutria in 1996, with coast-wide damage increasing from approximately 90,000 acres in 1998 to 105,000 acres in 1999 (LDWF 2007).

Table 3.9-3
Primary Terrestrial Invasive Plant Species Reported for Parishes in the Barataria Basin[a]

Common name	Scientific name	Description	USDA Federal Noxious Weeds List	USDA-NRCS Louisiana state-listed noxious weeds	Louisiana Parishes
Cat's claw vine	*Macfadyena unguis-cati*	An invasive vine that grows in full sun or partial shade under a variety of soil conditions. It can cover the forest floor, shading other native groundcover. Disturbed areas are particularly susceptible to invasion but it also invades river/stream banks and undisturbed hammocks. It is not known to be tolerant of saltwater intrusion. Introduced from China and Japan as a forage crop and ornamental plant.			7
Chinese privet	*Ligustrum spp.*	Chinese (and European) privets were the most comment shrub species identified in Louisiana forests in 2005 and 2016 (Oswalt 2013). The Chinese privet is not especially salt tolerant and occurs along freshwater streams and in bottomland hardwoods, although it is not tolerant of prolonged flooding. It invades disturbed areas and the margins of natural habitats. Where it displaces native vegetation, Chinese privet may be foraged upon by wildlife populations. Introduced from China in the 1850s.	X		All (64)
Chinese tallow	*Triadica sebifera*	Tree species that occurs in wetlands and uplands and is tolerant of saline conditions. Common along canals, spoil banks, and road and trail margins. Identified in 17 percent of surveyed forested areas in Louisiana during 2016 (Oswalt 2013). Designated as Extensively or Locally Established in the Louisiana Aquatic Invasive Species Management Plan (LAISMP), tallow can be controlled by fire and chemical spraying, but there are no effective methods for control in bottomland forests. Introduced from China in the 1700s.	X	X	All (64)
Kudzu	*Pueraria lobata*	An invasive vine that displace native vegetation by growing up and over structures, shading the vegetation, and by girdling stems and trees.			56

Sources: EDDMapS 2017, Urbatsch et al. 2009, Miller 2006, USDA 2010

[a] Each species is also identified by BTNEP 2017, Southeast Exotic Pest Plant Council 2017, and the USFS.

3.9.4.2.2 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 (including fields and crops), habitat, levees, and soils while foraging and traveling, providing areas for invasive plant species to become established (Perot 2011). 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 (USFWS 2009, Ashe 2009).

3.9.4.2.3 Roseau Cane Scale

The Roseau cane scale 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, 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.

3.10 AQUATIC RESOURCES

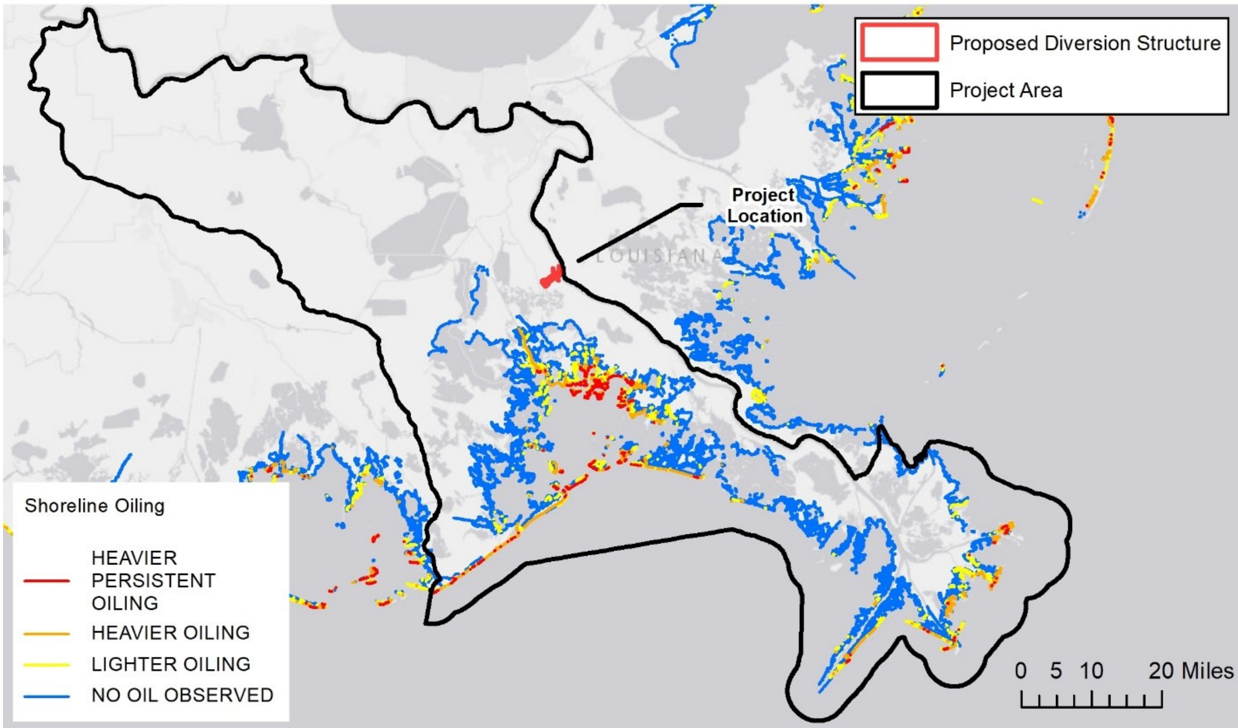
Aquatic resources in the Barataria Basin presented in this EIS include: aquatic vegetation; benthic resources; essential fish habitat (EFH); fish, shellfish, and fisheries; and invasive species. The aquatic resources in the basin are influenced by salinity, inundation, inputs of sediments and nutrients, wind and wave action, hurricanes, and other climate events (Fitzgerald et al. 2008, Twilley and Rivera-Monroy 2009). Salinity (see Section 3.5 Surface Water and Sediment Quality), hydrology (see Section 3.4 Surface Water and Coastal Processes), and wetland vegetation (see Section 3.6 Wetland Resources and Waters of the U.S.) are presented in earlier sections, but are referenced here as appropriate. Marine mammals and threatened and endangered species in the Barataria Basin, regardless of habitat, are addressed in Section 3.11 Marine Mammals and Section 3.12 Threatened and Endangered Species, respectively. Fishes of the Mississippi River are also included in aquatic resources because the proposed Project diversion complex could impinge, entrain, and potentially relocate some fish into the Barataria Basin when operating.

3.10.1 Historical Context

As discussed in Section 3.2.1.1 in Geology and Soils, the Mississippi River Delta, including the Barataria Basin, was formed from river sediments deposited during seasonal pulses of fresh water from the Mississippi River during natural deltaic processes that existed prior to leveeing of the Mississippi River; coarse sediment depositions formed natural levees along the river course, and finer sediments accumulated landward 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. The normal delta cycle involves the sequential construction and abandonment of individual delta lobes, as summarized in Section 3.1.2 in Introduction. As such, a normally functioning delta typically includes both one or more active delta lobes, as well as older, abandoned delta lobes with lower sediment loads.

Construction of flood control projects (for example, levees and channels) in the early and mid-1900s disrupted the hydrologic connection between the Mississippi River and its adjacent wetlands, reducing or eliminating freshwater and sediment inputs to the delta (Conner and Day 1987, Day et al. 2000, Bass and Turner 1997). See Section 3.6.2.2 for a discussion about the causes of wetland loss in the Barataria Basin. 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 Barataria Basin.

One of the first accounts of Louisiana's fisheries abundance was by Pierre le Moyne d'Iberville in 1699, prior to European settlement, who described vast offshore oyster reefs and schools of white shrimp in what is now the Barataria-Terrebonne estuarine system (Condrey et al. 2008). Early accounts also identified a coastline advancing into the sea, with four distributaries of the Mississippi River resulting in plumes of fresh water that extended more than 6 miles into the Gulf of Mexico during spring floods (Condrey et al. 2008, Day et al. 2021). The input of river waters into the estuarine system was recognized in the early 1900s as being beneficial to fisheries, with the Mississippi River Basin later described as the center of production for white shrimp, as well as for blue crab and oysters (Gunter 1952, Caffey and Schexnayder 2002, Viosca 1927). Levees subsequently limited the input of Mississippi River waters to the estuarine basins, which negatively impacted system productivity (Viosca 1927). The reduction in freshwater input also facilitated saltwater intrusion into the estuarine basins, which damaged oyster reefs in the lower basins but also allowed for the expansion of oyster populations into more interior areas (Van Sickle 1976). The early 1900s also saw a rise in reports in the loss of individual oyster reefs due to both general increases in salinities attributed to the river levees and from sporadic but significant input of freshwater from crevasses and spillways (Gunter 1952). 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 (Browder et al. 1989, Chesney et al. 2000, Beck et al. 2001). The impacts of the DWH oil spill and subsequent remediation efforts in the Barataria Basin are important in the context of describing historical conditions of the system. Oiling exposure in Louisiana from the DWH oil spill was extensive, with over 684 miles (1,100 kilometers) of marsh oiling statewide. Marsh oiling in Louisiana represented approximately 95 percent of the total marsh oiling Gulf-wide (DWH NRDA Trustees 2016a, Nixon et al. 2015). Within Louisiana, the majority of the heaviest oiling occurred in Barataria Bay (see Figure 3.10-1). Impacts of oiling on sediment, soil, benthic infauna, oysters, shrimps, crabs, and benthic feeding fishes in Barataria Bay were also documented (see Section 3.10.3 and Section 3.10.5).



Source: Nixon et al. 2015

Figure 3.10-1. Observed Shoreline Oiling in and around the Project Area.

3.10.2 Aquatic Vegetation

Aquatic vegetation in the Barataria Basin, like wetlands vegetation, reflects salinity and inundation gradients, but is also influenced by sediment deposition, nutrient and light availability, erosion, subsidence, sea-level rise, and storm surge (Paola et al. 2011, Alexander et al. 2012). SAV is described in this section, while emergent wetland vegetation is described in more detail in Section 3.6 Wetland Resources and Waters of the U.S. Terrestrial vegetation is presented in detail in Section 3.9 Terrestrial Wildlife and Habitat.

3.10.2.1 Submerged Aquatic Vegetation

The Barataria Basin exhibits an increasing salinity gradient, ranging from freshwater swamps in the uppermost basin, followed by intermediate habitats, brackish habitats, and then extensive salt marshes at the coast, with estuarine and marine SAV becoming more prevalent in the open water. 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 impact species composition, biomass, and distribution of the SAV as well as the fauna that rely on SAV for habitat (Koch 2001). SAV in lakes, ponds, and open water also responds to sedimentation and agricultural water and nutrient runoff from the Upper Barataria Basin.

SAV species distributions and biomass are influenced by salinity, water depth, 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), common duckweed (*Lemna minor*), Eurasian watermilfoil, stonewort (*Chara vulgaris*; an algae), coontail (*Ceratophyllum demersum*), and dwarf spikerush (*Eleocharis parvula)* (Chabreck 1972, Merino et al. 2009). More recently, Hillmann et al. (2016a) documented 14 SAV species in the coastal areas, four of which (coontail, Eurasian watermilfoil, widgeon grass, and hydrilla [*Hydrilla verticillata*]) accounted for 73 percent of the aboveground biomass collected. Coontail, widgeon grass, and lesser pondweed (*Potamageton pusillus*) were collected across freshwater, intermediate, brackish, and saline zones. Hydrilla was collected only in freshwater habitat; common water nymph (*Najas guadalupensis*), and wild celery (*Vallisneria americana*) in all but saline habitat; and Eurasian watermilfoil in all but freshwater habitat. Although seagrasses (for example, turtle grass [*Thalassia testudium*]) are present in some areas of coastal Louisiana, no seagrasses are present in the Project area. Other relationships among SAV and environmental variables found by Hillmann et al. (2016b) included:

- SAV species corresponded significantly to environmental variables (salinity, water depth, and turbidity); and
- combining all samples (including those without SAV), biomass was significantly lower in the saline zone when compared with other zones when all samples were combined.

Limiting analysis to only sites with 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 impact on SAV. The factors controlling SAV distribution across salinity regimes in the northern Gulf Coast are not well documented, making predictions of resource availability difficult (Hillmann et al. 2017). Consequently, SAV coverage is predicted as a group rather than by species (Visser et al. 2013, 2017a). Changes in salinity, water depth, and light transmission can result in changes in biomass, productivity, species composition, and distribution of SAV (Hillmann et al. 2017). SAV declines in the Middle and Upper Barataria Basin have been attributed to saltwater intrusion associated with hurricanes and flood control activities. SAV increased in the Upper and Middle Barataria Basin coincident with the Davis Pond Freshwater Diversion Project (operational in 2002), but declined following abrupt salinity increases and scouring associated with Hurricanes Gustav and Ike in 2008. Freshwater SAV along the Lake Cataouatche shoreline was also impacted when the Davis Pond

Freshwater Diversion was operated to release an above-normal volume of summer river water to keep DWH oil from migrating farther into Barataria Bay. The increased turbidity and immediate and extreme decrease in salinity caused the loss of 83 percent (50 acres) of SAV and a decrease in SAV diversity along the eastern shoreline of Lake Cataouatche (DWH NRDA Trustees 2016a). SAV is now essentially absent in and around Lake Cataouatche, in the Upper Barataria Basin (LDWF 2015c).

SAV has been described as “the most significant form of complex cover for aquatic animals in the Barataria Basin” (LDWF 2015c). 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 over-wintering shrimp and crabs, and coastal fishes such as drum, croaker, seatrout, and flounder; and habitat and foraging areas for invertebrates and fish (Hillmann et al. 2017, 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 1987, LDWF 2005a). Rozas et al. (2012) found that the density and biomass of the most abundant faunal taxa were higher within seagrass areas when compared to the most abundant faunal taxa within *Spartina* marsh; however, no seagrass areas are present in the Project area.

3.10.3 Benthic Resources

Coastal regions are among the most productive ecosystems in the world, and links between benthic and open water environments are important 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 macroinvertebrates such as grass shrimp (*Palaemonetes pugio*), penaeid shrimp (*Penaeidae*), and crabs are often referred to as benthic resources. The penaeid shrimps (brown shrimp [*Farfantepenaeus aztecus*], white shrimp [*Litopenaeus setiferus*]) and blue crab (*Callinectes sapidus*) are presented in detail in Section 3.10.5 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 environmental impact statements (for example, DWH NRDA Trustees 2016a). Eastern oysters (*Crassostrea virginica*) are presented in Section 3.10.5 because they also support a valuable commercial fishery and important ecological functions in Louisiana estuaries.

Benthic resources of the Barataria 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 the oyster reefs. Within the Barataria Basin, these lower trophic level benthic groups include benthic algae (for example, chlorophytes, cyanophytes, and diatoms), infauna (for example, amphipods, polychaetes, nematodes, and oligochaetes), and epifauna (for example, 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, Dynamic Solutions 2012, Tango and Batiuk 2016 Kimmerer and Thompson 2014, Adamack et al. 2017). However, no benthic monitoring program exists for the Barataria Basin, and there are not many available ecological field studies evaluating how habitat and environmental conditions impact benthic resources in coastal Louisiana.

The major benthic groups and the predominant taxa for the Barataria Basin are listed in Table 3.10-1, including any known differences in benthic abundance, density, or biomass (per area or volume) by salinity zones, water quality conditions, or habitat type. One benthic community study within the Barataria Basin identified greater numerical abundance of benthos in freshwater habitats, which decreased as habitats became more saline. This study also indicated that crustaceans and mollusks occurred basin-wide, whereas insects, nematodes larger than 500 millimeters, and oligochaetes were predominantly found in fresh or intermediate habitats and polychaetes and nemerteans were prevalent in brackish and marine habitats (Philomena 1983).

Table 3.10-1
Benthic Lower Trophic Level Taxa and Habitat Associations in the Barataria 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 impact 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).
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). • 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 to 7 ppt compared to fresh (1 to 2 ppt) and two higher-salinity zones (greater than or equal to 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 et al. 1998) 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 and SAV stems within the estuary. • Marsh periwinkles highest in salt marsh (*Spartina alterniflora*) and sea grasses 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 approximately 8 ppt) on Juncus spp. And higher at marsh edge than interior sites (Honig et al. 2015).

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. For example, increased nutrient availability generally increases growth, but excessive nutrient concentrations can cause algal blooms, which can reduce light and DO levels for the benthic lower trophic level groups. Community assemblage may also be influenced by sediment size, as studies have linked higher benthic microalgal biomass to larger grain size, and higher benthic species richness to sandy soils (Cahoon et al. 1999, Gaston et al. 1998).

The DWH oil spill severely impacted benthic species, including amphipods, fiddler crabs, and marsh periwinkles along oiled marsh shorelines, including the Barataria Basin (DWH NRDA Trustees 2016a). The “heavier” and “heavier persistently” oiled marsh sites in Louisiana (see Figure 3.10-1) were expected to reduce survival of amphipods by 36 to 95 percent in 2010 (Powers and Scyphers 2016). Densities of periwinkles were reduced by 80 to 90 percent at the oiled marsh shoreline edge and by 50 percent in the oiled marsh interior due to oiling and clean-up actions (Zengel et al. 2015). An estimated 204 metric tons of periwinkles were lost in the 38.5 miles of heavy persistently oiled marsh-edge shorelines in Louisiana (Powers and Scyphers 2016). Recovery of the periwinkles was expected to take 3 to 5 years if wetland vegetation recovered enough to support the animals, but normal sized ranges in shell lengths of the snails are not expected to recover until at least 2021 (Powers and Scyphers 2016). Reductions in the benthic resources along the oiled marsh shoreline and interior habitats resulting from the oil spill, impacted and may be continuing to impact, the prey availability and distribution of shrimp, crab, and fish that depend on the benthic resources for growth and recruitment in the Barataria Basin.

3.10.4 Essential Fish Habitat (EFH)

As further discussed in Appendix N (Essential Fish Habitat), the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), which governs marine fisheries management in U.S. federal waters, was passed in 1976 to accomplish several objectives (NMFS 2007a), including to:

- prevent overfishing;
- rebuild overfished stocks;
- increase long-term economic and social benefits; and
- ensure a safe and sustainable supply of seafood.

EFH is defined by NMFS as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 CFR 600.10). Regional fishery management councils are required to provide both text descriptions and maps of EFH, and to review EFH information every five years. The 1996 amendment to the MSFCMA mandates that regional fishery management councils delineate EFH for managed species (16 USC 1801 et seq.). The Gulf of Mexico Fishery Management Council (GMFMC) defines six Fishery Management Plans (FMP) for the Gulf of Mexico: shrimp, red drum (*Sciaenops ocellatus*), reef fish, coastal migratory pelagics, corals, and spiny lobster. In addition, NMFS' Highly Migratory Species Division manages an FMP for highly migratory species (HMS; sharks, tuna, billfish, and swordfish) as they cross domestic and international boundaries. Managed species in and around the Project area are included under the following FMPs, each of which includes one or more species:

- 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 HMS.

EFH was first designated for GMFMC species in 1998 and subsequently refined by a 2005 amendment and corresponding EIS (GMFMC 2004 and 2005). Reviews were undertaken in 2010 and 2016, both of which further refined the EFH and corresponding mapping data. However, the regulatory definitions have not been altered since the Generic Amendment in 2005.

EFH for HMS is defined by the 2006 Consolidated Atlantic HMS FMP and its amendments. The most recent amendment was finalized in September 2017 (82 FR 42329). Although HMS may be found globally, the MSFCMA only authorizes EFH in federal, state, or territorial waters to the seaward limit of the U.S. Exclusive Economic Zone (EEZ).

EFH includes habitats necessary for various life stages of fish species and provides a regulatory mechanism linking estuarine and marine habitats. Coastal wetlands provide important habitat for numerous fish species along the northern Gulf of Mexico, and access to these areas is a function of hydrology (Minello 1999, Beck et al. 2001, Baker et al. 2013a). Six of the 12 habitats identified as important to life stages of fish, and therefore classified as EFH in the Gulf of Mexico, occur within the Project area:

- Emergent marshes (includes tidal wetlands, salt marshes, tidal creeks, rivers/streams);

- Oyster reefs;
- SAV (including benthic algae);
- Soft bottom (mud, clay, silt);
- Sand/shell bottom (sand, shell); and
- Water column (pelagic, open water).

Habitat areas of particular concern (HAPC) 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 undergo more scrutiny and potentially be subject to additional conservation measures (NMFS 2020a). No HAPCs are located in the Project area.

Actions that may adversely impact the quality of EFH, and potentially result in habitat degradation and/or loss, include, but are not limited to: physical impacts such as dredging, filling, excavations, water diversions, impoundments, and other hydrologic modifications; pollution due to point source discharges, nonpoint sources, and increased sedimentation; introduction of potentially hazardous materials; or activities that diminish or disrupt the functions of EFH, such as fishing activities and overfishing.

Life history and habitat use varies widely among fish species (Able 2005, see Section 3.10.5). Many fish species rely on coastal estuaries, which include numerous shallow-water habitat types such as marsh, oyster reefs, SAV, sand/shell bottoms, soft bottoms, and water column. These estuarine habitats act as nursery grounds for juvenile and subadult finfish and shellfish; adults move offshore to spawn, linking the coastal, nearshore, and offshore systems (La Peyre and Gordon 2012, DWH NRDA Trustees 2016a). Marshes are particularly important to some commercial fisheries, providing refuge from predators, and contributing secondary production in food webs of adjacent aquatic habitats via direct foraging, trophic relay, and export of detritus, all of which depend on flooding (Baker et al. 2013). The structural heterogeneity of SAV habitats provides equal and greater densities of juveniles as compared to the marsh-edge habitats (La Peyre and Gordon 2012, Castellanos and Rozas 2001). Oyster beds, including cultched reefs, provide shelter, food, or spawning substrate for many species (Plunket and La Peyre 2005).

3.10.4.1 Coastal Fish

NMFS and the GMFMC (GMFMC 2016, GMFMC 2018, NMFS 2018) identify EFH along the estuarine and nearshore coastal zones in the Project area for 5 of the 14 species managed under the GMFMC FMPs (see Table 3.10-2), including white shrimp, brown shrimp, red drum, lane snapper (*Lutjanus synagris*), and gray snapper (*Lutjanus griseus*). Although EFH for the dog snapper (*Lutjanus jocu*) was also 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 remaining species expected to use habitats in the nearshore shelf waters within the Project area (see Table 3.10-2) are king mackerel (*Scomberomorus cavalla*), and cobia (*Rachycentron canadum*).

These seven species are managed through the shrimp, red drum, coastal migratory pelagic fish, and reef fish FMPs; their corresponding life stage, coastal zone (estuarine and/or nearshore areas), and habitat in estuarine and nearshore shelf waters off Louisiana in the northern Gulf of Mexico are summarized in Table 3.10-2.

Sediment, nutrients, and food resources move between and among the estuarine habitats and out to the continental shelf, connecting the productivity of marsh to the production of fish and shellfish in the Gulf (Beck et al. 2003, Boesch and Turner 1984, Thomas et al. 1990, Zimmerman et al. 2000). For example, white shrimp begin their life cycle off the continental shelf in the Gulf and may move through all of the salinity zones in the estuary as they mature from "post-larvae" to large juveniles (Deegan 1993, Zimmerman et al. 2000). Brown shrimp and red drum similarly use all of the salinity zones in the estuary as juveniles, subadults, and/or adults. Modeled optimum salinity ranges for the penaeid shrimps and red drum, which are the only federally managed species that use Barataria Bay extensively, are identified in Section 3.10.5.2; as further discussed in Section 3.10.5.2, these optimum ranges are based on species salinity ranges identified in relevant literature. The snapper species use habitats around the barrier islands and otherwise are found in the nearshore shelf waters of the Gulf. Particularly, gray snapper juveniles and adults can be found along shallow shorelines of the barrier islands, as well as beach habitats outlining the Lower Barataria Basin and Gulf waters. Lane snapper larvae, post-larvae, and juveniles are similarly found around the barrier islands and shallow SAV habitats at the outer edges of the Lower Barataria Basin. The coastal migratory pelagic fish are found in the nearshore shelf waters of the Gulf.

3.10.4.2 Highly Migratory Species

HMS are mobile, pelagic species such as tuna, sailfish (*Istiophorus platypterus*), and sharks that have wide distributions in open ocean, coastal and estuarine waters, and vertically within the water column. Adult, juvenile, and especially early life stages (larvae for tuna and sailfish and neonates [newborn] for sharks) may be limited by temperature, salinity, or oxygen levels (NMFS 2017b). Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) are widely distributed as adults but often use specific estuaries as nursery areas for neonate and young of year (YOY) life stages. For example, estuarine environments, such as Barataria Bay, provide young bull sharks (*Carcharhinus leucas*) protection from predation and abundant food sources that allow it to achieve high growth and survival rates (Hunt and Doering 2013). Tuna and billfish distributions are typically associated with hydrographic features such as density fronts between different water masses, for example, such as 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.

Table 3.10-2
Essential Fish Habitat in the Barataria Basin and Nearshore Shelf Waters Off Louisiana

Species and Life Stage	Estuarine						Nearshore						
	WCA	EM	SAV	SB	S/S	OR	WCA	SAV	HB	SB	S/S	OR	DA
COASTAL MIGRATORY PELAGIC FISH													
King mackerel													
Adult							X						
Juvenile							X						
Cobia													
Adult							X						
Spawning							X						
Juvenile							X						
Larvae	X						X						
Eggs/parturition	X												
RED DRUM													
Red drum													
Adult		X	X	X	X		X		X				
Juvenile		X	X	X					X		X		
Larvae		X	X	X									
Eggs/parturition							X						
REEF FISH													
Gray snapper													
Adult		X		X	X				X	X	X		
Juvenile		X	X	X	X			X		X	X		
Spawning									X				
Lane snapper													
Adult									X		X		
Juvenile			X	X	X			X	X	X	X		
Larvae	X		X				X	X					

Table 3.10-2
Essential Fish Habitat in the Barataria Basin and Nearshore Shelf Waters Off Louisiana

Species and Life Stage	Estuarine						Nearshore						
	WCA	EM	SAV	SB	S/S	OR	WCA	SAV	HB	SB	S/S	OR	DA
SHRIMP													
Brown Shrimp													
Adult				X						X	X		
Subadult				X	X					X	X		
Juvenile		X	X	X	X	X							
Larvae							X						
White Shrimp													
Adult										X			
Subadult				X	X					X	X		
Spawning				X						X			
Juvenile		X	X	X		X		X		X		X	
Larvae	X						X						
Eggs/parturition				X	X					X	X		
HIGHLY MIGRATORY SPECIES													
Blacktip shark (Gulf of Mexico stock)													
Adult							X						
Juvenile							X						
Neonate/YOY	X						X[a]						
Bull shark													
Adult	X						X						
Juvenile	X						X						
Neonate/YOY	X						X[a]						
Spinner shark													
Adult							X[a]						
Juvenile							X[a]						
Neonate/YOY							X						
Scalloped hammerhead shark													
Adult							X[a]						
Juvenile							X[a]						

Table 3.10-2
Essential Fish Habitat in the Barataria Basin and Nearshore Shelf Waters Off Louisiana

Species and Life Stage	Estuarine						Nearshore						
	WCA	EM	SAV	SB	S/S	OR	WCA	SAV	HB	SB	S/S	OR	DA
Finetooth shark													
Adult							X[a]						
Spawning							X[a]						
Juvenile							X[a]						
Neonate/YOY							X[a]						
Sharpnose shark													
Adult							X[a]						
Juvenile							X[a]						
Neonate/YOY							X[a]						
Yellowfin tuna													
Juvenile							X[a]						
Sailfish													
Adult							X[a]						

Source: GMFMC 2016, NMFS 2017b, pre-consultation technical assistance.

[a] Found in the Coastal Gulf only (not Barataria Bay)

DA = Drift Algae

EM = Emergent Marshes

HB = Hard Bottom

OR = Oyster Reefs

S/S = Sand/Shell

SAV = Submerged Aquatic Vegetation

SB = Soft Bottom

WCA = Water Column Associated

YOY = young-of-the-year

HMS EFH is established for six shark species, yellowfin tuna (*Thunnus albacares*), and the sailfish in the estuarine and nearshore waters of the Project area (see Table 3.10-2).

3.10.5 Aquatic Fauna

Aquatic fauna of the Project area 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.

Aquatic fauna described in this section include key shellfish populations (shrimp, crabs, and oysters) and fish in the Barataria Basin, although some of these species also can inhabit the inland freshwater lakes and bayous or the nearby coastal and shelf waters of the northern Gulf of Mexico at different times during the year. Freshwater, estuarine, and marine waters and vegetation are used during different life stages by these species, making impacts on any of these habitats relevant to the species. The most common freshwater fish species found in the lower reaches of the Mississippi River below New Orleans are also briefly described because the location proposed for the Project could potentially impact these species.

3.10.5.1 Habitat Preferences and Environmental Requirements

All fauna within the Barataria Basin spend at least some part to all of their life cycle within the estuary. 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 impact 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 impacts up to observable population results (Rose 2000, Rose and Sable 2013). The species catch-per-unit-effort (CPUE) data from the LDWF Fisheries-Independent Monitoring (FIM) program, as well as data available from several independent field studies (for example, Baltz et al. 1998, Minello and Rozas 2002, Soniat et al. 2013), and expert opinions were used to define the impacts of temperature, salinity, and the proportion of vegetation to open water on species habitat suitability and/or biomass distribution. Other factors that can impact habitat preferences and conditions are briefly summarized below for estuarine fish and shellfish populations. Certain habitat preferences (such as salinity, temperature, and vegetation coverage) are often used in habitat suitability index (HSI) models, which are simple, widely accepted methods for defining the habitat suitability or capacity for supporting a particular species. HSI models for selected key species, including a discussion of the habitat preferences included in each model, are discussed in Appendix N.

3.10.5.1.1 Water Flow and Tidal Transport

As described in Chapter 3, Section 3.4.2.4 Tides, Currents, and Flow in Surface Water and Coastal Processes, tides and wind-driven currents are the principal driver of circulation within the Barataria Basin. Tides have been shown to be the most important driver of larval transport into Barataria Bay (Schaefer 2001). The migration of larvae and movement of early juveniles into suitable nursery habitat can be impacted by water flow in and out of the estuary, and hydrologic connectivity among the estuarine channels (Rozas et al. 2012). Northerly cold fronts can push water out of the estuaries to impact juvenile shrimp and blue crab recruitment in the estuary (Rogers et al. 1993, Guillory et al. 2001), while southerly winds preceding cold fronts push water into and up the estuary and facilitate recruitment (Kupchik 2013). Water elevations and fine-scale differences in marsh morphology can impact species access and movement patterns among the estuarine habitats (Rozas et al. 2012, Roth et al. 2008, Minello and Rozas 2002, Rozas and Reed 1994).

3.10.5.1.2 Substrates

The presence of hard substrate such as oyster shell, or the presence of SAV in open waters, can impact the perceived habitat suitability and relative abundance of juvenile fish and shellfish in comparison to soft bottom or unvegetated bottom habitats. SAV (see Section 3.10.2) 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 estuarine fish and invertebrates can use for feeding and as predation refuge (La Peyre et al. 2014, Stunz et al. 2010, Humphries et al. 2011, Grabowski et al. 2005).

3.10.5.1.3 Turbidity and Sedimentation

Visual predators such as largemouth bass (*Micropterus salmoides*), spotted seatrout (*Cynoscion nebulosus*), southern flounder (*Paralichthys lethostigma*), alligator gar (*Atractosteus spatula*), and red drum prefer low turbidity and slower moving waters to better detect and catch their prey (Pattillo et al. 1997). However, the abundance of other key estuarine species, such as Atlantic croaker (*Micropogonias undulatus*), shrimp, and crabs, tend to be higher in higher turbidity waters likely due to increased benthic prey availability and less detection by visual predators (for example, Minello et al. 1989, Lassuy et al. 1983). Forage fish such as bay anchovy (*Anchoa mitchilli*) and Gulf menhaden (*Brevoortia patronus*) also tend to be attracted to higher turbidity waters where plankton concentrations can be higher. 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).

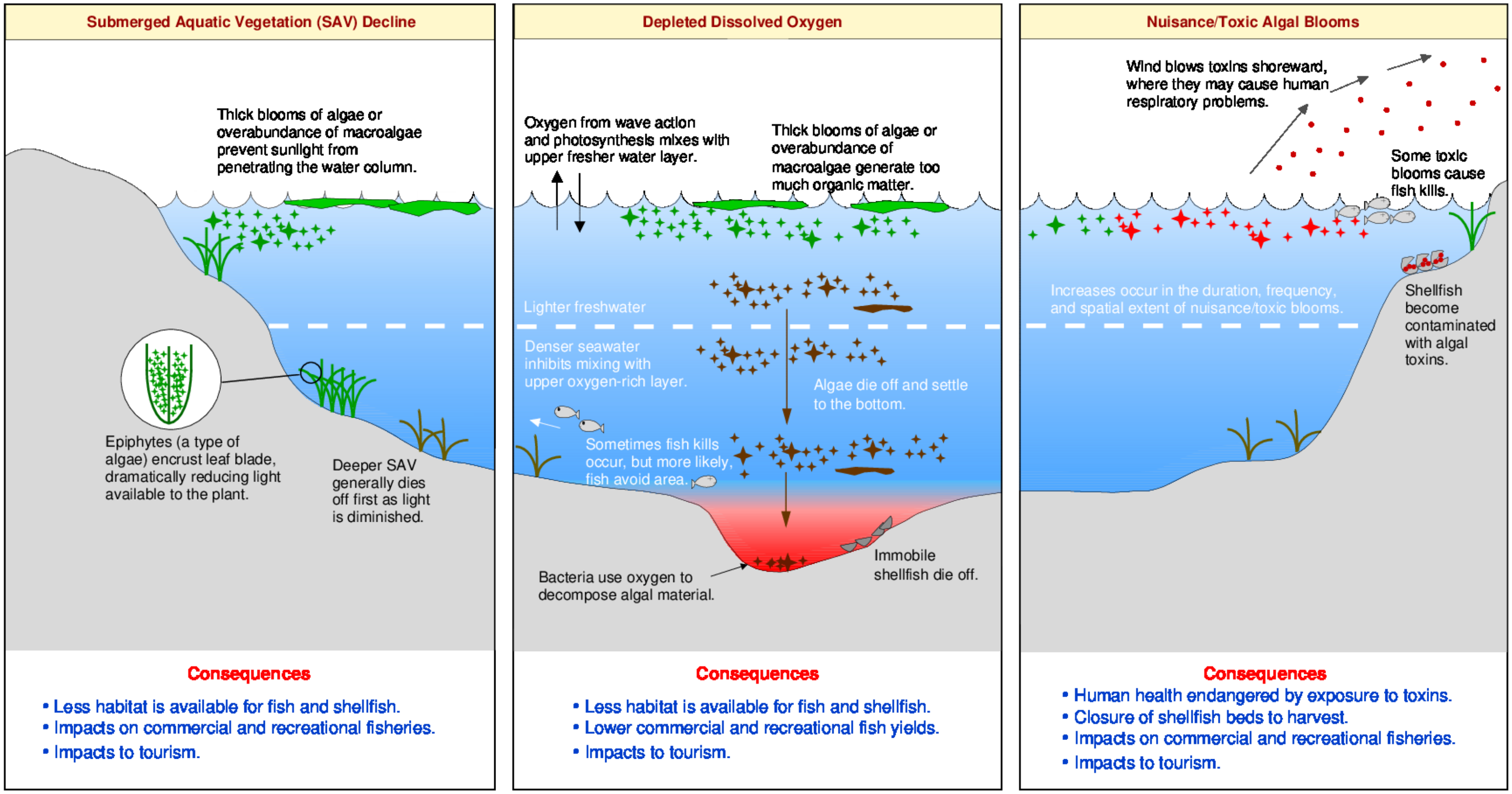
3.10.5.1.4 Nutrient Loading

Shifts in species composition of phytoplankton communities are commonly attributed to changes in nutrient supply ratios. Multiple studies have identified the impact of bottom-up increases in consumer biomass from increased nutrients (de Mutsert 2010, Nixon and Buckley 2002, Rose et al. 2019).

Although estuaries have always received nutrients from natural sources, which is required for the growth and production of the phytoplankton community (and therefore the food web for the estuarine community), anthropogenic sources have increased estuarine nutrient input to levels far exceeding natural inputs (Bricker et al. 1999). This nutrient loading is recognized as an indirect causal agent of hypoxia, harmful algal blooms (HAB), fish kills, shellfish bed closures, and reduced seagrass and coral reef habitats, as depicted in Figure 3.10-2 (Nixon 2009, Turner et al. 2019, Bricker et al. 1999). Nitrogen and phosphorus are generally considered to be the largest contributors to nutrient loading. Sources of nitrogen include agricultural operations, atmospheric deposition, urban runoff, and point sources (for example, wastewater treatment plants). Sources of phosphorus also include agricultural operations, urban runoff, and point sources, as well as stream channel erosion and natural soil deposits (Mississippi River/Gulf of Mexico Hypoxia Task Force 2018). In 1997, the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force was established to understand the causes and effects of eutrophication (excessive primary production due to nutrient supply) in the Gulf. The Task Force's 2008 Action Plan (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2008) and its New Goal Framework (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force 2014) outline a strategy to improve water quality in the Mississippi River Basin and reduce the size and impact of the Gulf of Mexico hypoxic zone. A goal of the plan is to reduce the hypoxic zone to less than 5,000 square kilometers by 2035 with an interim target to reduce nitrogen and phosphorus loading by 20 percent by 2025 (relative to the 1980 to 1996 baseline average loading to the Gulf). Achieving this goal will require a reduction in nutrient loading from all major sources of nitrogen and phosphorous in the Mississippi/Atchafalaya River Basin. The same upstream reductions that are expected to reduce hypoxic conditions in the Gulf of Mexico would also be expected to reduce nitrogen and phosphorus concentrations in the Mississippi River and to reduce the likelihood of HAB formation in the Project area.

3.10.5.1.5 Dissolved Oxygen

Faunal species will move away from low or hypoxic/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 (Pattillo et al. 1997). The Barataria 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 events can occur in shallow eutrophic waters such as marsh ponds when connectivity is reduced and temperatures rise in the summer.



Source: Bricker et al. 1999

Figure 3.10-2. Possible Adverse Impacts of Nutrient Loading.

3.10.5.1.6 Salinity and Temperature

Many aquatic species can be defined by their salinity preferences, with euryhaline species able to tolerate an often wide range of salinity and stenohaline species tolerating a smaller range of salinity. Estuaries, which often have wide and fluctuating salinity regimes due to the mixing of fresh and salt water, are home to many euryhaline species and/or species life stages. Although individual species can tolerate (survive in) a wide salinity range, salinities outside of a species' smaller optimal range may affect growth, movement, behavior, reproduction, and larval dispersal and recruitment, which may change the structure of a community (Smyth and Elliott 2016, Gilles and Payan 2001). Similar to that discussed for salinity, aquatic fauna generally have specific temperature ranges that they survive and thrive in as fish, crustaceans, and mollusks rely on environmental temperatures to control their metabolism and growth. The optimum salinity and temperature ranges for specific species are summarized in Table 3.10-3 (Dynamic Solutions 2016).

Table 3.10-3
Modeled Habitat and Environmental Requirements for Fauna in the Barataria Basin

Species	Life Stage	Optimum Salinity (ppt)[a]	Optimum Temperature (°F [°C])[a]
Caridean shrimp	Single population	0 to 15	54 to 86°F (12 to 30°C)
Small crabs	Single population	0 to 40	54 to 77°F (12 to 25°C)
Eastern oysters	Spat	10 to 30	68 to 86°F (20 to 30°C)
	Seed, Sack	10 to 15	68 to 86°F (20 to 30°C)
Blue crab	Early juvenile	1 to 20	54 to 77°F (12 to 25°C)
	Large juvenile, adult	7 to 20	64 to 91°F (18 to 33°C)
Brown shrimp	Early juvenile	10 to 25	63 to 84°F (17 to 29°C)
	Large juvenile, subadult	10 to 25	64 to 84°F (18 to 29°C)
White shrimp	Early juvenile	5 to 25	63 to 81°F (17 to 27°C)
	Large juvenile, adult	5 to 25	54 to 90°F (12 to 32°C)
Killifish	Single population	5 to 20	61 to 77°F (16 to 25°C)
Silversides	Single population	5 to 20	64 to 81°F (18 to 27°C)
Bay anchovy	Juvenile	1 to 17	68 to 81°F (20 to 27°C)
	Adults	1 to 25	64 to 82°F (18 to 28°C)
Threadfin shad	Single population	0 to 15	64 to 90°F (18 to 32°C)
Gizzard shad	Single population	0 to 10	68 to 90°F (20 to 32°C)
Gulf menhaden	Juvenile	1 to 10	68 to 81°F (20 to 27°C)
	Adults	5 to 40	68 to 90°F (20 to 32°C)
Sunfish	Single population	0 to 2	64 to 82°F (18 to 28°C)
Striped mullet	Juvenile	0 to 20	64 to 82°F (18 to 28°C)
	Adult	0 to 15	68 to 82°F (20 to 28°C)
Pinfish	Juvenile	5 to 20	68 to 86°F (20 to 30°C)
	Adult	5 to 20	72 to 86°F (22 to 30°C)
Silver perch	Juvenile	5 to 20	68 to 84°F (20 to 29°C)
	Adult	5 to 25	68 to 84°F (20 to 29°C)

Table 3.10-3
Modeled Habitat and Environmental Requirements for Fauna in the Barataria Basin

Species	Life Stage	Optimum Salinity (ppt)[a]	Optimum Temperature (°F [°C])[a]
Spot	Early juvenile	NA	64 to 82°F (18 to 28°C)
	Late juvenile	0 to 20	64 to 86°F (18 to 30°C)
	Subadult, adult	15 to 35	64 to 82°F (18 to 28°C)
Atlantic croaker	Early juvenile	0 to 10	59 to 77°F (15 to 25°C)
	Late juvenile	0 to 20	63 to 77°F (17 to 25°C)
	Subadult, adult	0 to 25	63 to 77°F (17 to 28°C)
Spotted seatrout	Early juvenile	5 to 20	63 to 83°F (17 to 25°C)
	Late juvenile	5 to 20	64 to 81°F (18 to 27°C)
	Subadult, adult	8 to 20	64 to 81°F (18 to 27°C)
Red drum	Early juvenile	5 to 20	61 to 82°F (16 to 28°C)
	Late juvenile	5 to 20	64 to 82°F (18 to 28°C)
	Subadult, adult	1 to 25	64 to 82°F (18 to 28°C)
Black drum	Juvenile	5 to 25	68 to 86°F (20 to 30°C)
	Subadult, adult	3 to 25	75 to 90°F (24 to 32°C)
Largemouth bass	Juvenile	0 to 9	68 to 81°F (20 to 27°C)
	Subadult, adult	0 to 9	68 to 81°F (20 to 27°C)
Sheepshead	Juvenile	0 to 10	64 to 82°F (18 to 28°C)
	Subadult, adult	0 to 15	64 to 82°F (18 to 28°C)
Blue catfish	Single population	0 to 2	54 to 72°F (12 to 22°C)
Southern flounder	Single population	0 to 20	68 to 86°F (20 to 30°C)
Sand seatrout	Single population	0 to 15	68 to 82°F (20 to 28°C)
Atlantic brief squid	Single population	22 to 30	68 to 86°F (20 to 30°C)
Sea catfish	Juvenile	7 to 25	68 to 86°F (20 to 30°C)
	Adult	5 to 20	68 to 86°F (20 to 30°C)
Alligator gar	Single population	0 to 5	64 to 82°F (18 to 28°C)

NA = Not applicable

[a] Optimum salinity and temperature ranges are based on literature review conducted for the Comprehensive Aquatic Systems Model (CASM) Report (Dynamic Solutions 2016); however, optimum ranges may vary in other published literature.

3.10.5.1.7 Emergent Vegetation

As discussed in Section 3.6, Wetland Resources and Waters of the U.S., emergent vegetation provides habitat for aquatic fauna. Species richness of benthic epifauna is correlated to proximity to marsh edge (see Table 3.10-1), and studies have shown that there is a strong trophic link between infauna and nekton near the marsh edge that contributes to high fishery productivity in Gulf Coast marshes (Whaley and Minello 2002). As detailed in Section 3.10.5.2, various life stages of fish and shellfish species found in the Barataria Basin utilize emergent vegetation as nursery and foraging areas. Wetlands are extremely important to many estuarine and marine species, providing important edge habitat for fish and invertebrates with respect to feeding, reproduction, and refuge (Peterson and Turner 1994, Castellanos and Rozas 2001).

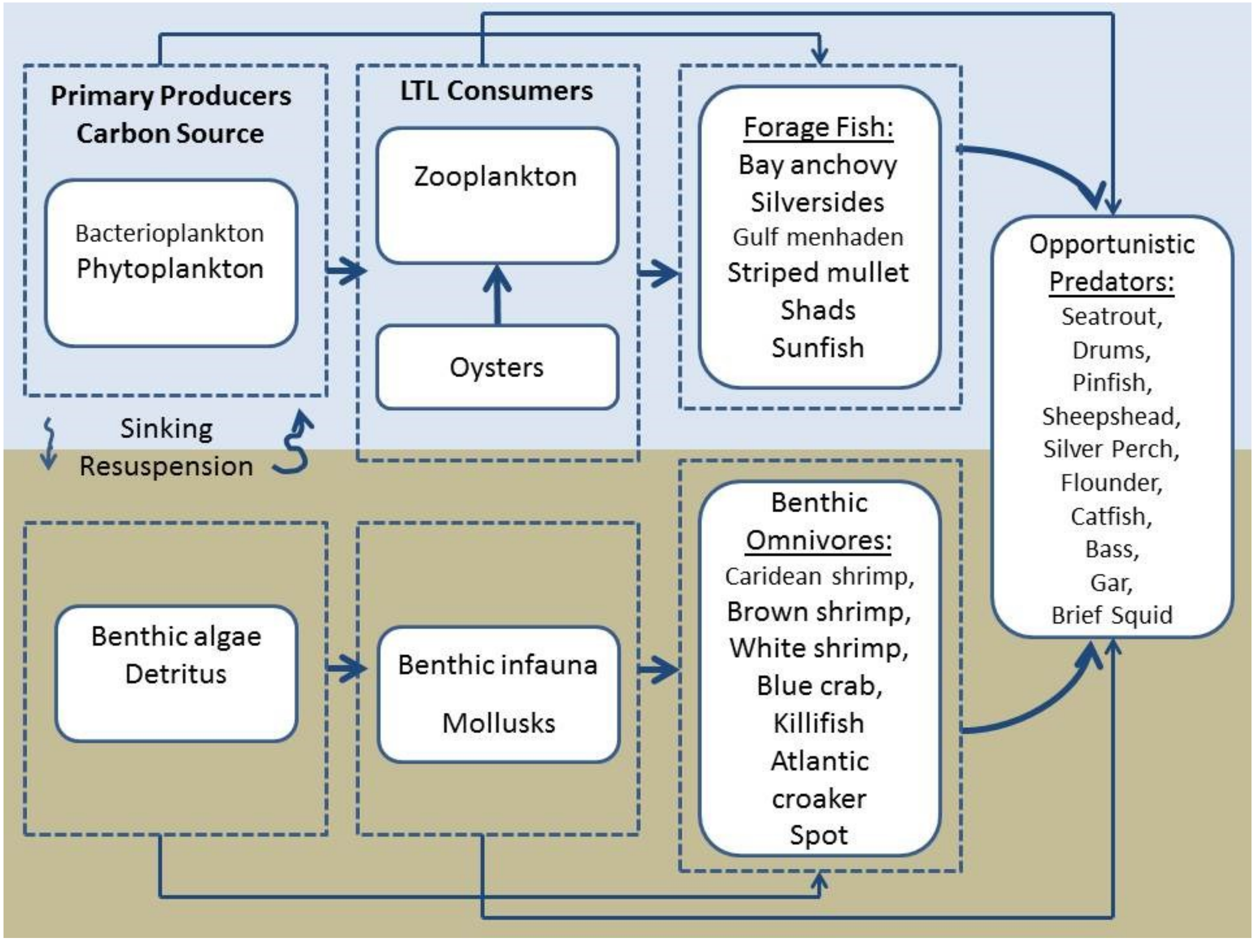
Because of the importance of wetland habitat for aquatic species, HSIs, and the Comprehensive Aquatic Systems Model (CASM) and the Ecopath with Ecosim (EwE) food web models use optimum ranges of wetland habitat availability within defined areas or sub-regions of the Barataria Basin and the surrounding delta to define optimum wetland cover for some of the estuarine species. For example, the juvenile life stages of shrimp, crab, bay anchovy, menhaden, Atlantic croaker, southern flounder, spotted seatrout, and red drum had defined habitat optimums of 25 to 80 percent wetland cover in the estuaries. Largemouth bass and sunfish that typically prefer vegetated shoreline or SAV beds had optimum wetland cover defined as 30 to 50 percent.

3.10.5.1.8 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 benthic algal and epiphyte distribution and production (see Figure 3.10-3). 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 (Shaffer et al. 1988).

The composition and characteristics of these benthic 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 in the estuaries 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 (*Pogonias cromis*), 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 episodic catastrophes like hurricanes or hard freezes, which are the primary factors that limit or reduce recruitment in the estuaries (Pattillo 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. 2010, Baker et al. 2014).



Source: Dynamic Solutions 2016

Figure 3.10-3. Simplified Conceptual Diagram of the Food Web for the Barataria Basin. The arrows indicate the general bottom-up flows from 1) primary producers, to 2) lower trophic level (LTL) consumers of phytoplankton and benthic algae, to 3) forage fishes and benthic omnivores, to 4) opportunistic predators that differentially feed on benthic and pelagic prey groups.

Food web interactions were defined among all modeled populations (species and life stages identified in Table 3.10-3) in the CASM and EwE models developed for the Barataria Basin under the Mississippi River Hydrodynamic and Delta Management Study (de Mutsert et al. 2016, Dynamic Solutions 2016). For demonstration in this 2016 Mississippi River Study report, the life stages have been combined for species, and the key species were grouped by similar diets and used as examples to create a simplified predator-prey interaction and energy flow diagram among the major trophic groups and key fauna for the Barataria Basin (see Figure 3.10-3).

Rose et al. (2019) analyzed previously derived outputs from two food web modeling platforms for the Mississippi River Delta region, the CASM and the EwE model, as well as a suite of model-derived ecosystem indicators to illustrate the structure and energy flows of the Barataria Basin aquatic food web. This study indicated that (a) detritus plays a very important role in fueling the food web; (b) increased productivity in the spring is channeled up the food web through relatively few pathways and species compared to the rest of the year; (c) energy flows up the food web but quickly dissipates within the first few trophic levels with a lot of consumers eating several of the lower trophic levels (plankton, algae, infauna) as well as small shrimps and crabs; (d) the Barataria Basin food web is relatively complicated and provides many potential pathways for energy to flow to consumers; and include because of the redundancy of pathways, the food web shows a high degree of resilience (see Figure 3.10-3).

3.10.5.2 Key Fish and Shellfish Species in the Barataria Basin

The life history and population dynamics of key fish and shellfish species in the Barataria Basin and birdfoot delta are presented first since their abundance and use of the Barataria Basin differs among species. The mean and median CPUE (total individuals caught per unit sample) for the key harvested and/or ecologically important species are reported from the LDWF FIM data and briefly discussed as an indication of population trends in the Barataria Basin and birdfoot delta over time. Recent major events (hurricanes, DWH oil spill, and the initial opening of the Davis Pond Freshwater Diversion Project) are labeled in these catch figures to provide general reference within the timeline. The DWH impacts that have been reported for specific species are also summarized in the species subsections. Reported impacts of the DWH oil spill have concentrated on marsh shoreline oiling for key species based on the period of time the species would have used these habitats (2010 through 2013). Although not directly assessed, the impacts of DWH oiling exposure and remediation efforts in the Project area could be expected to produce similar impacts on the other key fauna that use the marsh shoreline habitats (that is, blue crab and spotted seatrout).

The species selected for discussion in this section and Chapter 4, Section 4.10 Aquatic Resources represent the range of trophic levels, different feeding guilds, habitat usage, and life histories of fish and shellfish species in the Project area.

3.10.5.2.1 Brown Shrimp

Brown shrimp are benthic omnivores distributed from Massachusetts to southern Florida, and throughout the Gulf Coast to the northwestern Yucatan Peninsula (Pattillo 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, 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. (2016a) present details of 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 summarized here is for the Barataria Basin. At 10 to 15 millimeters total length (TL), brown shrimp post-larvae are carried into the Barataria Basin by shelf currents and tides with peak migration in the Barataria Basin occurring from January through June (Zein-Eldin and Renaud 1986). Metamorphosis to juveniles and settlement occurs around 25 millimeters TL in the estuaries, with peak months of early juveniles in the Barataria

Basin 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 the Barataria Basin for about three months until they grow to approximately 60 millimeters 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 millimeters 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 Louisiana estuaries, and the migrating subadults support valuable commercial inshore and offshore fisheries in the early spring through late summer (see Section 3.14.2 in Commercial Fisheries). 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).

Using total number of individual shrimp caught by the LDWF (in 50-foot seines and 16-foot trawls) for the coastal study areas in Watkins et al. (2014), the Barataria Basin has historically accounted for approximately 15 percent of the total coast-wide shrimp catch in both gears. The relative abundance (CPUE) of brown shrimp in the basin has been generally stable through 2013, following the opening of the Davis Pond Freshwater Diversion Project in 2002 and Hurricane Katrina in 2005 (see Figure 3.10-4). Higher than usual CPUE estimates for 2011 through 2013 in the Barataria Basin are evident but not outside of historical annual values in the basin (see Figure 3.10-4).

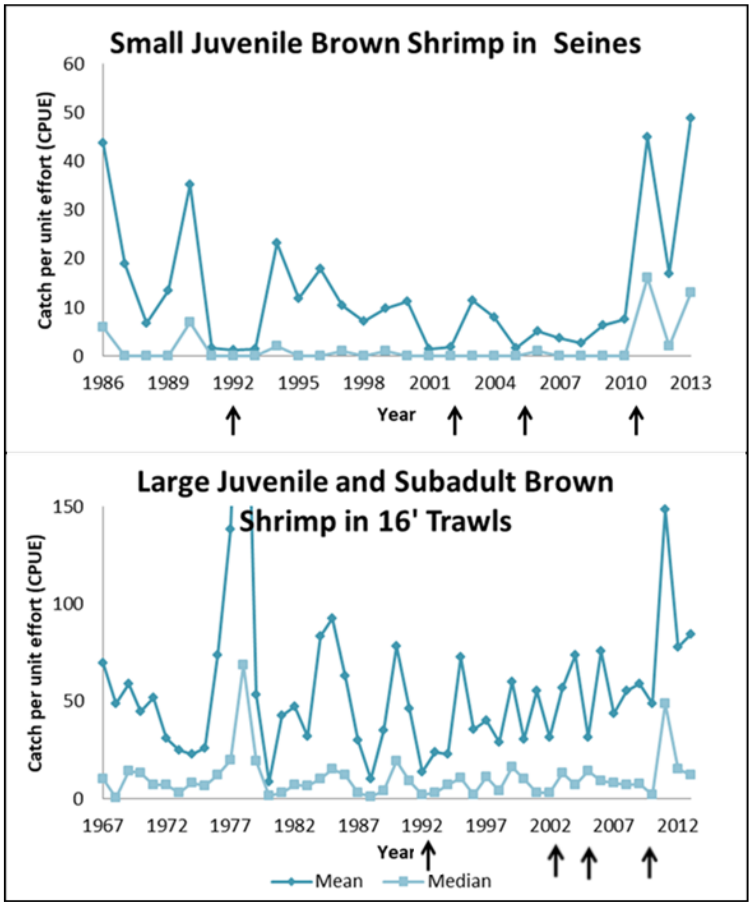


Figure 3.10-4. Mean and Median CPUE of Small Juvenile Brown Shrimp (top), and Large Juveniles and Subadults (bottom) in the LDWF Samples for the Barataria Basin. The mean CPUE is equal to 311 shrimp per trawl sample for 1978 (see bottom panel). Arrows indicate recent major events for reference. (Hurricane Andrew in 1992, Davis Pond Freshwater Diversion began operations in 2002, Hurricane Katrina in 2005, and the DWH oil spill in 2010).

A study to examine the impacts of the DWH oil spill oiling exposure and remediation efforts on brown shrimp juvenile growth for the Barataria Basin (Rozas et al. 2014) showed growth of juvenile brown shrimp was reduced by 27 to 56 percent in heavier persistently oiled and heavier oiled shorelines compared to sites not oiled. Freshwater releases in response to the spill reduced basin-wide salinity and likely reduced juvenile brown shrimp production by impacting benthic prey abundance or by the stress of adapting to lower salinities (Adamack et al. 2012). The impact of oiling on shrimp growth caused an estimated total loss of 1,176 metric tons of brown shrimp in the marsh over 2010 and 2011. Oiling impacts lasted at least into fall of 2011 along the 179 miles of heavier oiled and heavier persistently oiled shoreline in Louisiana and Mississippi (Powers and Scyphers 2016).

3.10.5.2.2 White Shrimp

White shrimp 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 (Pattillo et al. 1997). The highest abundance of white shrimp occurs along the Louisiana coast (Kilma 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 the brown shrimp by a few months. O'Connell et al. (2016b) 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. (2016b) is summarized here for the Barataria 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 millimeters TL (Cook and Lindner 1970, Muncy 1984). Juveniles and subadults, from 25 to 120 millimeters TL, move to waters well below 10 ppt, and farther up into the estuary compared to brown shrimp. Juveniles leave the shallow habitats of the estuary after about 3 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 Barataria Basin and support a valuable commercial inshore and offshore fishery in Louisiana (see Section 3.14.2 in Commercial Fisheries).

By comparing total number of individual shrimp caught by the LDWF fisheries-independent surveys (50-foot seine and 16-foot trawls) for the coastal study areas in Watkins et al. (2014), the Barataria Basin accounted for only 2 percent of the total coast-wide white shrimp catch in seines and 6.5 percent of the catch in the trawls. The CPUE of white shrimp in the trawl samples has been generally increasing since the late 1990s in the Barataria Basin (see Figure 3.10-5). Higher CPUE estimates for 2010, 2011, and 2012 are evident and similar to what is shown for brown shrimp. The LDWF data were only available through August of 2013 at the time of analysis (Watkins et al. 2014), so the 2013 seine and trawl CPUE estimates are likely low since fall and winter samples are missing from the dataset.

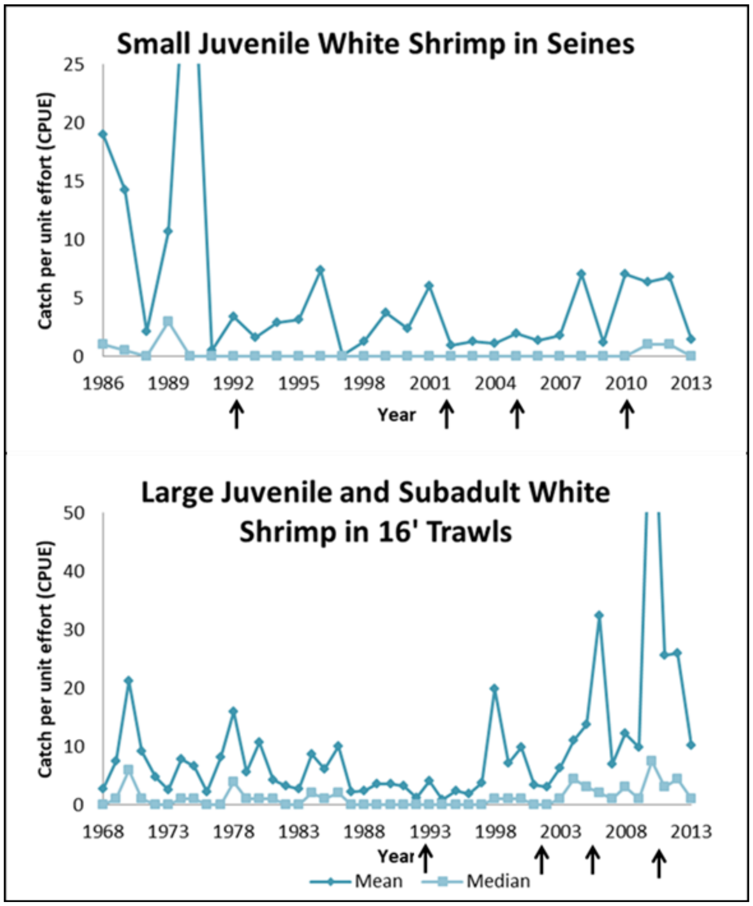


Figure 3.10-5. Mean and Median CPUE of Small Juvenile White Shrimp (top), and Large Juveniles and Subadults (bottom) in LDWF Samples from the Barataria Basin. Mean CPUE = 45 shrimp per seine sample for 1990 (top) and 78 shrimp per trawl sample for 2010 (bottom). Arrows indicate recent relevant events (Hurricane Andrew in 1992, Davis Pond Freshwater Diversion began operations in 2002, Hurricane Katrina in 2005, the DWH oil spill in 2010).

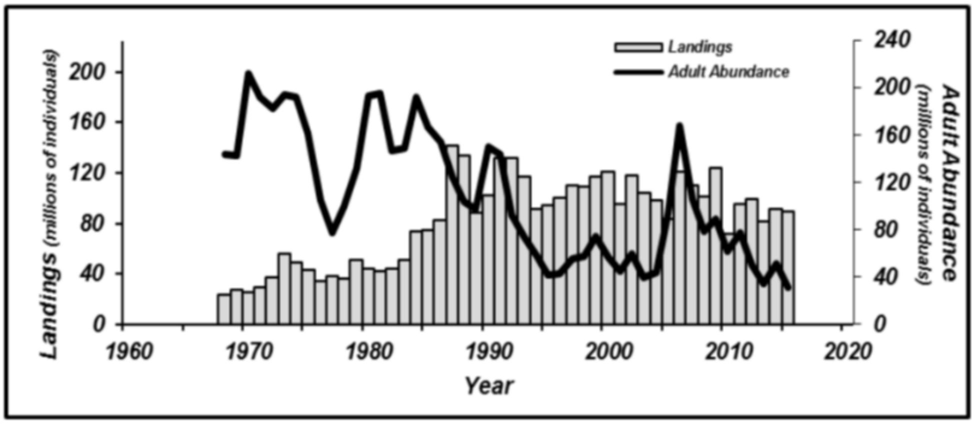
DWH impacts on white shrimp juvenile growth were estimated in the Barataria Basin by Rozas et al. (2014), with Powers and Scypher (2016) using the reduced growth data and modeled assumptions to estimate production foregone in the northern Gulf of Mexico coastal marshes that were oiled (DWH NRDA Trustees 2016a). The authors demonstrated that growth of juvenile white shrimp was reduced by 31 to 46 percent in heavier persistently oiled and heavier oiled shorelines compared to shrimp growth in sites that were not oiled. Unlike brown shrimp, the white shrimp juveniles would not have been impacted by the release of fresh water into the estuaries by the diversions because juvenile white shrimp occur in the marshes later in the summer and fall. The reductions in white shrimp growth were assumed to occur only when they were in the marsh edge and not after they move to deeper waters as late juveniles and subadults (Powers and Scyphers 2016). Powers and Scyphers (2016) estimated that the impact of marsh shoreline oiling caused approximately 913 metric tons of white shrimp production to be lost in the marsh system over 2010 and 2011. As long as any marshes remained heavily oiled, the same injury to white shrimp juvenile production could be assumed to have occurred (DWH NRDA Trustees 2016a). The reported DWH impacts are not necessarily coincident with the somewhat stable and higher annual basin-wide CPUE estimates demonstrated from the LDWF fishery-independent data for 2010 to 2012 (see Figure 3.10-5), although the results are not directly comparable.

3.10.5.2.3 Blue Crab

Blue crabs 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 (Pattillo 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. (2016c) 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. The description from O'Connell et al. (2016c) is condensed here. 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 greater than 186 miles (300 kilometers) 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 (Perry et al. 1995, Thomas et al. 1990). Juveniles (2 to around 125 millimeters [males] to 145 millimeters [females] carapace width [CW]) and adults tend to remain in the estuary (Pattillo et al. 1997). Small juveniles prefer shallow (less than or equal to 1.6 to 3.3 feet [0.5 to 1 meter] deep) vegetated habitats while larger juveniles and adults prefer muddy or sandy substrates in deeper (greater than or equal to 3.3 feet [1 meter] deep) channels and bays. Adult males spend most of their time in low-salinity waters (less than or equal to 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 (Pattillo et al. 1997, Williams 1984).

Adult blue crabs (greater than or equal to 125 millimeters carapace width) support important commercial and recreational fisheries in the Gulf and Atlantic Coasts (see Section 3.14.4 in Commercial Fisheries). A general decline in adult blue crab abundance has been observed in trawl data (West et al. 2016); however, observed landings for Louisiana have remained high since the late 1980s (see Figure 3.10-6). West et al. (2016) determined that the Louisiana blue crab stock is currently overfished and that the annual fishing mortality rates are extremely close to overfishing limits.



Source: West et al. 2016.

Figure 3.10-6. Estimated Adult Abundance from the LDWF Stock Assessment Model and Observed Landings of Louisiana Blue Crab. Commercial crab landings are expanded by 5 percent to approximate for the recreational harvest. Units are in millions of individuals.

The Barataria Basin accounted for 7 percent of the total coast-wide blue crab catch in the seines and 14 percent of the coast-wide catch in the 16-foot trawls (unpubl. data in Watkins et al. 2014). The relative abundance in seine and trawl data over time for the Barataria Basin (see Figure 3.10-7) indicate peak numbers in 1990 that are also evident in the data for the coast-wide stock. Similarly, an annual decreasing trend observed over the past 10 years for Louisiana blue crab also exists for blue crab CPUE in the trawl samples for the Barataria Basin.

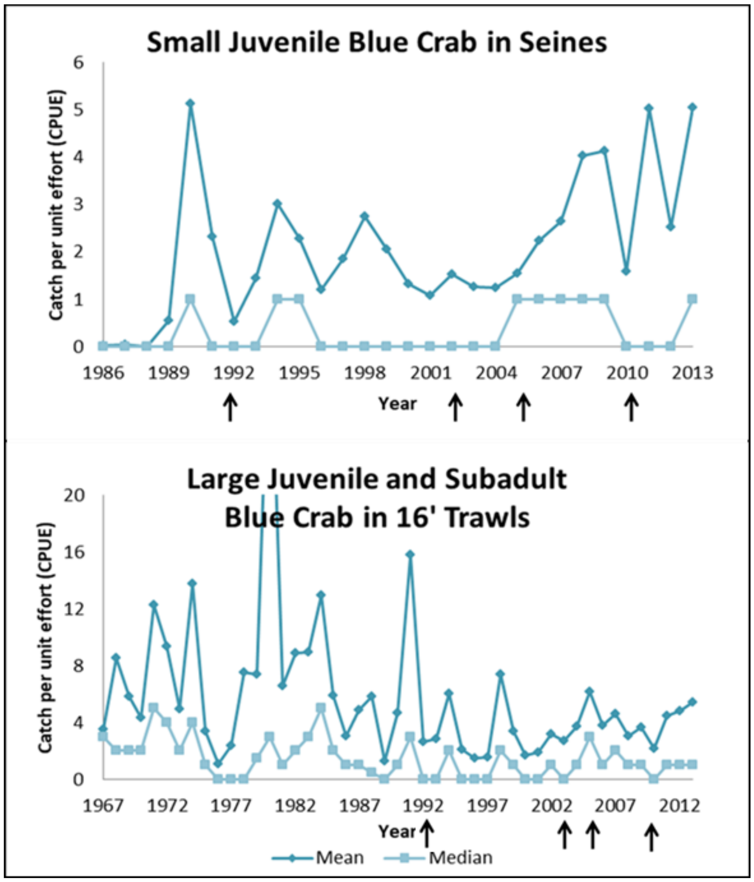


Figure 3.10-7. Mean and Median CPUE of Small Juvenile Blue Crab in the LDWF 50-foot Seine Samples (top), and CPUE of Large Juveniles and Subadults in the LDWF 16-foot Trawl Samples (bottom) for the Barataria Basin. The mean CPUE is equal to 33 crab per trawl for 1980 (bottom). The arrows indicate some recent natural and anthropogenic events just for reference in the time series (Hurricane Andrew in 1992, Davis Pond Freshwater Diversion began operations in 2002, Hurricane Katrina in 2005, the DWH oil spill in 2010).

3.10.5.2.4 Bay Anchovy

Bay anchovy 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. Large schools form during the day in protected areas close to shore to minimize predation risk, and smaller schools form to feed at night (Daly 1970, Hoese and Moore 1998).

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. Bay anchovies prey exclusively upon zooplankton and are a dominant prey item for many predatory coastal bird and fish species such as red drum, spotted and sand seatrout (*Cynoscion arenarius*), Atlantic croaker, gar, southern flounder, and blue catfish (*Ictalurus furcatus*) (Shipp 1986, Hildebrand 1943). Their abundance and distribution in estuaries appear to be influenced primarily by zooplankton distribution (Houde and Zastrow 1991).

The Barataria Basin accounted for 7 percent of the total coast-wide anchovy catch in the LDWF 50-foot seines and 14 percent of the coast-wide catch in the 16-foot trawls (Watkins et al. 2014). The relative abundance in the trawls appeared higher and more variable through the early 1980s compared to the last 30 years in the Barataria Basin (see Figure 3.10-8).

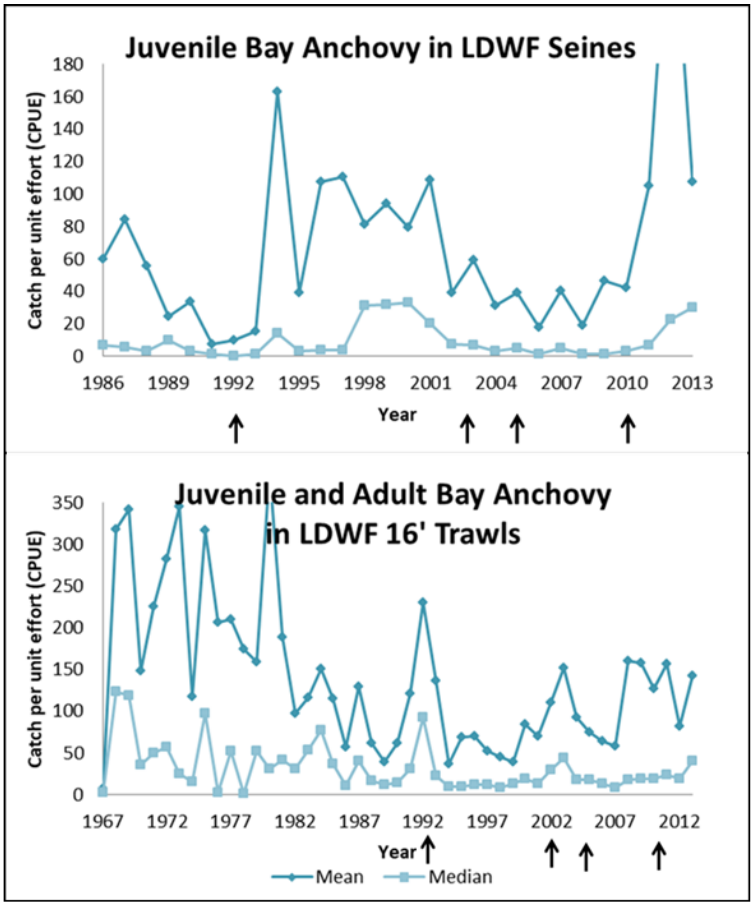


Figure 3.10-8. Mean and Median CPUE of Juvenile Bay Anchovy in the LDWF 50-foot Seine Samples (top), and of Juvenile and Adult Bay Anchovy in the 16-foot Trawls (bottom) for the Barataria Basin. The mean CPUE is equal to 298 anchovies per seine for 2012 (top), and equal to 387 anchovies per trawl for 1980 (bottom). The arrows indicate some recent natural and anthropogenic events just for reference in the time series (Hurricane Andrew in 1992, Davis Pond Freshwater Diversion began operations in 2002, Hurricane Katrina in 2005, the DWH oil spill in 2010).

3.10.5.2.5 Gulf Menhaden

Gulf menhaden 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 (Pattillo et al. 1997).

Sable et al. (2016b) 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. The description from the report is summarized here for the Barataria Basin. 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 millimeters standard length (SL) 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 millimeters SL in the low-salinity upper estuary and around river mouths (Christmas et al. 1982). Juveniles remain in the low-salinity regions (typically less than or equal to 10 ppt) until they reach a size around 40 millimeters SL over 2 to 3 months. They move farther down the estuary (greater than or equal to 10 ppt) and into deeper waters as they grow from 40 millimeters to about 85 millimeters SL. 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).

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). As discussed in Section 3.14.5 in Commercial Fisheries, 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 U.S. and has been managed under a regional FMP since 1978 (NOAA 2013b).

By comparing the total number of menhaden caught by the LDWF seines and gillnets for the coastal study areas in Watkins et al. (2014), the Barataria Basin accounted for only 4 percent of the total coast-wide catch of juvenile menhaden in seines, but accounted for 30 percent of the total coast-wide adult menhaden catch in gillnets. Figure 3.10-9 uses the unpublished LDWF data from Watkins et al. (2014) to show the CPUE of juvenile menhaden in the 50-foot seines from January through June, and CPUE of adult menhaden collected by gillnets from March through October.

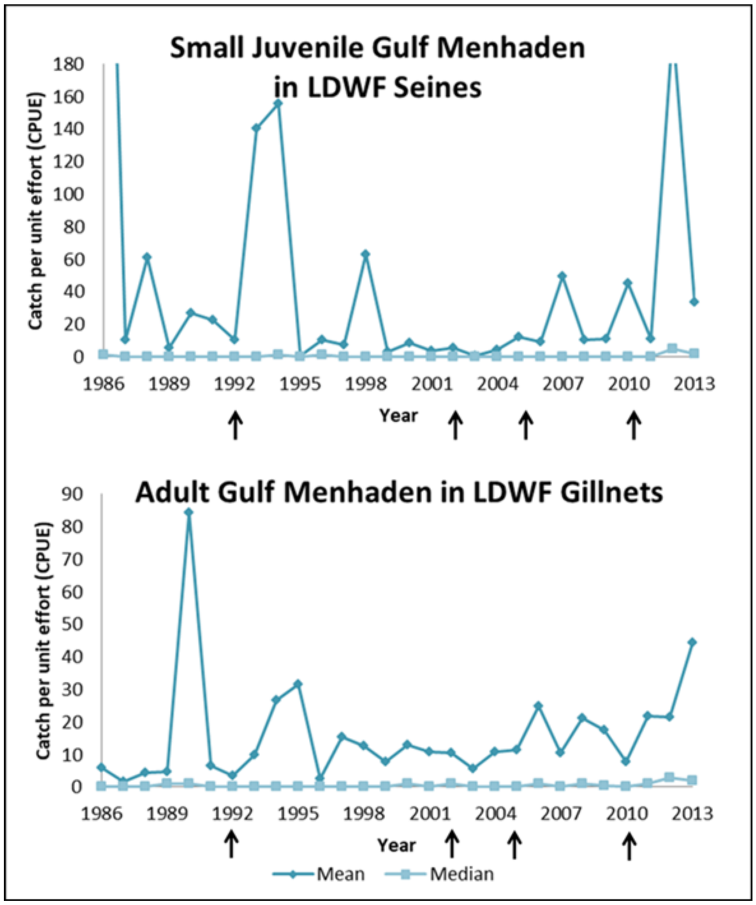


Figure 3.10-9. Mean and Median CPUE of Juvenile Gulf Menhaden (top), and Adult Menhaden (bottom) for the Barataria Basin. The mean CPUE of juvenile menhaden is equal to 454 in 1986 and 202 in 2012 (top). The arrows indicate some recent events just for reference in the time series (Hurricane Andrew in 1992, Davis Pond Freshwater Diversion began operations in 2002, Hurricane Katrina in 2005, the DWH oil spill in 2010).

3.10.5.2.6 Red Drum

Red drum occur throughout the Gulf Coast and along the Atlantic Coast to Massachusetts (Pattillo et al 1997). 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 millimeters TL at age four, with a maximum age of 37 years reported for the northern Gulf of Mexico (Powers and Burns 2010, Wilson and Neiland 1994, Pattillo 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 millimeters TL with metamorphosis to the juvenile stage occurring at 15 millimeters TL (Pattillo 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 McMichael 1987). Early juvenile drum leave the shallow nursery habitats when they reach about 40 to 120 millimeters TL to move into bays and deeper channel waters. As juveniles approach 200 millimeters TL in their first spring, they may remain in deep water bays or congregate in tidal passes (Simmons and Hoese 1959, Peters and McMichael 1987). Large juvenile and adult red drum make long-range movements throughout the estuaries and into backwaters with increasing temperature and foraging opportunities. Subadults appear to remain in the bays throughout the year while older fish (greater than 3 years) move to the shelf in early fall and winter to spawn (Perret et al. 1980, Hein and Shepard 1986, Wilson and Neiland 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, with the annual proportion of recreational landings from Louisiana constituting more than 70 percent of the total (NMFS 2018a). Recreational fisheries for juvenile and subadult red drum 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. 2012).

Although early juvenile red drum less than 100 millimeters TL use the marsh edge and shallow vegetated habitats of the estuaries extensively, the LDWF seines do not collect high numbers of juveniles as they likely outswim the gear (LDWF pers. comm.). Using total catch of red drum in the LDWF fisheries-independent gillnet samples from the CSAs in Watkins et al. (2014), the Barataria Basin accounted for approximately 12 percent of the coast-wide catch. The Barataria Basin trammel net samples accounted for only 5 percent of total catch from LDWF's coast-wide FIM. The CPUE of subadult red drum in the LDWF gillnets, and subadult and adult red drum in the trammel nets (unpubl. data from Watkins et al. 2014) show a generally small increasing trend since 2000 (see Figure 3.10-10). Higher mean seasonal CPUEs equal to three red drum per sample are evident in two to three years between the late 1980s and mid-1990s for both LDWF gears.

The injury to red drum production was estimated for marshes in Louisiana due to DWH oiling (DWH NRDA Trustees 2016a). Red drum juveniles settled in the fall of 2010 adjacent to the oiled marsh shorelines. Juvenile drum growth was reduced by 47 percent in 2010 along oiled shorelines when compared to shorelines without oiling (Powers and Scyphers 2016). By 2013, heavier persistently oiled marshes were still sufficiently contaminated to reduce drum growth by an estimated 21 percent. Juvenile drum exposed to oil gained less weight and were smaller than fish exposed to clean sediment (Powers and Scyphers 2016). The reduction in growth of red drum exposed to heavier persistently oiled marsh sites was assumed to result in fewer adults due to smaller fish suffering higher levels of predation. An estimated 563 metric ton (MT) wet weight of red drum was lost due to oiling of salt marsh in Louisiana. This impact was estimated to occur over 38.5 miles of oiled shoreline in Louisiana between 2010 and 2012 (DWH NRDA Trustees 2016a).

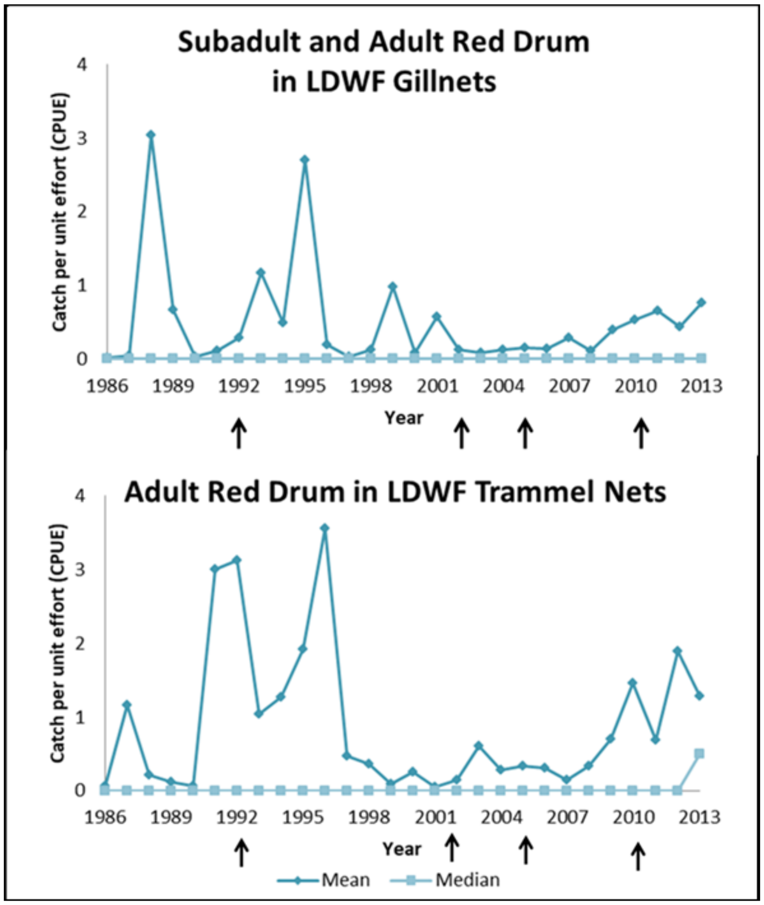


Figure 3.10-10. Mean and Median CPUE of Adult Red Drum in the LDWF Gillnet Samples (top) and in the Trammel Nets (bottom) for the Barataria Basin. The arrows indicate some recent natural and anthropogenic events just for reference in the time series (Hurricane Andrew in 1992, Davis Pond Freshwater Diversion began operations in 2002, Hurricane Katrina in 2005, the DWH oil spill in 2010).

3.10.5.2.7 Spotted Seatrout

Spotted seatrout 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. 2014, Murphy et al. 2011). Spotted seatrout reach maturity by age 2 and have an average life span of 5 to 9 years (Nieland et al. 2002, West et al. 2019). The average size of age-2 and age-3 seatrout in the Louisiana recreational harvest data are typically 300 to 380 millimeters in TL (West et al. 2019). A maximum reported length of a single age-6+ fish exceeded 580 millimeters TL (West et al. 2019).

Spotted seatrout generally spend their entire life cycle in and near their natal estuary, showing very little to less than 30 percent 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.

(2017) 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 less than or equal to 15 ppt). Metamorphosis of larvae to juveniles occurs after about 23 days and around 12 millimeters TL. Early YOY 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 millimeters 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/upper estuary in the winter, and to deeper cooler waters of the bays and barrier island passes in the summer. Male seatrout mature around 220 millimeters TL while female seatrout typically mature around 300 millimeters TL (Nieland et al. 2002). Adult seatrout move to the deep channels and the waters around the barrier island beaches and 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. Louisiana constitutes an average annual 62 percent of the total U.S. landings for the Atlantic and Gulf Coasts (NMFS 2018a). The states manage their own fishery stocks that are evaluated under a regional fisheries management plan (GSMFC 2001).

The LDWF seines do not collect high numbers of juvenile seatrout because they can outswim the gear (LDWF pers. comm.). By comparing the total number of seatrout caught by the LDWF gillnets for the coastal study areas in Watkins et al. (2014), the Barataria Basin accounted for 17 percent of the total coast-wide catch. Figure 3.10-11 shows the mean and median annual CPUE of adult spotted seatrout in the LDWF gillnets from April through August (unpubl. data in Watkins et al. 2014). Although adult seatrout catch has declined to about half to a third of the seasonal CPUE recorded in the Barataria Basin from about 1988 to 1995, the CPUE has been relatively steady since 2000 at around four trout per gillnet sample (see Figure 3.10-11).

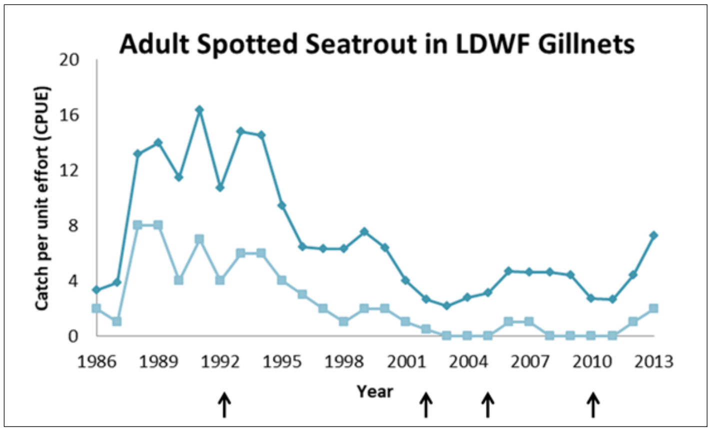
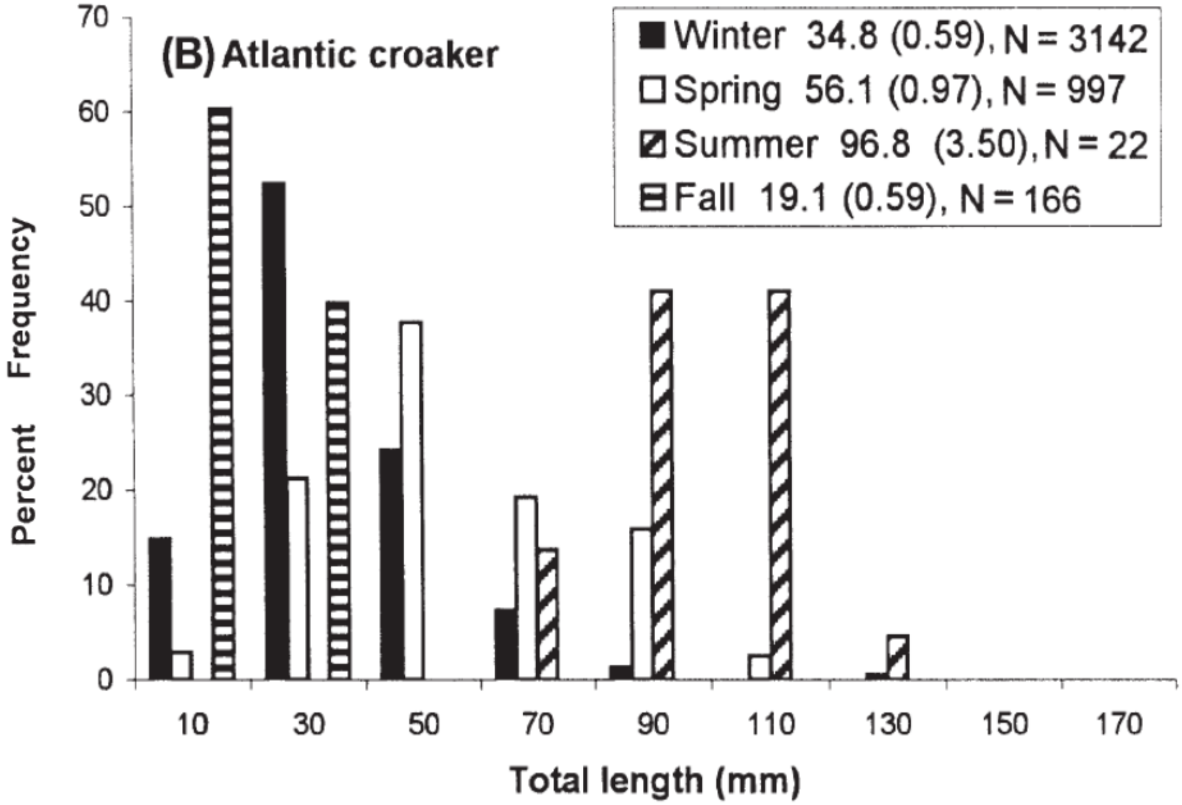


Figure 3.10-11. Mean and Median CPUE of Adult Spotted Seatrout in the LDWF Gillnet Samples for the Barataria Basin. The arrows mark Hurricane Andrew, the opening of the Davis Pond Freshwater Diversion, Hurricane Katrina, and the DWH oil spill.

3.10.5.2.8 Atlantic Croaker

Atlantic croaker are found throughout the Gulf of Mexico, with the highest abundance off the coasts of Louisiana and Mississippi (Lassuy 1983, GSFMC 2017). Adults occur offshore, spawning from fall to spring, with peaks in October/November and January/February (GSMFC 2017, Cowan 1988, Barbieri et al. 1994, Kupchik and Shaw 2016). The pelagic eggs hatch offshore, larvae migrate shoreward between 30 and 90 days post-hatch, and juveniles recruit to upper estuarine habitats (Cowan and Shaw 1988, Kupchik and Shaw 2016, GSMFC 2017). Larvae and juveniles in estuaries are demersal habitat generalists, occurring in seagrass meadows, salt marshes, tidal creeks, and in areas with mud or sand substrates (Weinstein 1979, Rooker et al. 1998, Petrik et al. 1999, GSMFC 2017). Subadults emigrate out of the upper estuaries to higher-salinity areas in the lower estuaries and bays, where they are found in widely ranging habitats, from pier pilings, coastal shorelines, and oyster reefs (GSFMC 2017).

Fish older than one year are less abundant inside estuaries (GMFMC 1980) with only larvae and juveniles being identified as abundant or highly abundant in the Barataria Basin (Pattillo et al. 1997). Of 373 beam trawl samples collected within the Barataria Basin between October 1992 and September 1993, Atlantic croaker represented 13.7 percent of the catch, second only to bay anchovy (28.0 percent of the catch; Jones et al. 2002). The same collections indicated that the abundance of Atlantic croaker decreased significantly by the time they reached 130 millimeters TL and were absent at 150 millimeters TL and above (Jones et al. 2002), likely because the beam trawls do not sample where the larger croaker reside. The smallest individuals (less than 40 millimeters TL) were most abundant in the fall and winter (Jones et al. 2002, see Figure 3.10-12).



Source: Jones et al. 2002.

Figure 3.10-12. Seasonal Size Frequency Distributions for Atlantic Croaker in the Barataria Basin. Numbers in legend are the mean lengths (standard error); N = total number of individuals.

Atlantic croaker are opportunistic feeders. Smaller fish, such as those that are more abundant in Barataria Bay, feed on zooplankton and other small invertebrates. Adults feed predominately on bottom-dwelling organisms (crustaceans, mollusks, and fish; Mercer 1987, GSFMC 2017), although detritus was also common in studies of stomach contents (Roussel and Kilgen 1975, Darnell 1958, Reid et al. 1956). Atlantic croaker are also prey species (although not a primary prey species) for a number of fish, including sharks, spotted seatrout, red drum, black drum, flounder species, and larger Atlantic croaker (Pearson 1929, Darnell 1958, Klima and Tabb 1959).

Salinity tolerance is wide for the Atlantic croaker, although it varies by life stage. Pelagic larvae are found in salinities as high as 36 ppt, whereas juveniles and subadults generally occur in salinities of 20 ppt or less (Lassuy 1983, Eby and Crowder 2002). Some studies have indicated that juvenile growth rates are higher in low salinities (less than 5 ppt; Peterson et al. 1999, Searcy et al. 2007). Studies from the east coast of Florida indicate that survival of small fish (30 to 60 millimeters SL) was greatly reduced in temperatures of less than 37.4°F (3°C), with survival of Age-0 fish decreasing from 90 percent at 37.4°F (5°C), to 1.3 percent at 37.4°F (3°C) (Lankford and Targett 2001).

3.10.5.2.9 Southern Flounder

The southern flounder is a flatfish that occurs most commonly from Alabama to Texas. Adults spawn in offshore waters from November through January, with peak spawning occurring off Louisiana's coast in December (Shepard 1986). Eggs hatch offshore after about two days, and the larval stage is believed to last less than two months, during which passive movement towards inshore waters is driven by winds and currents (Arnold et al. 1977, GSFMC 2001). Post-larvae and juveniles move into the Barataria Basin, generally from December through February (Allen and Baltz 1997, Glass et al. 2008, GSFMC 2001), during which period, small (1/4- to 1/2-inch) fish settle to the bottom and begin the metamorphosis that results in the flat form typical of flounders (University of Southern Mississippi [USM] 2020). The newly metamorphosed juveniles tend to move towards the low-salinity regions of the estuary and even up freshwater tributaries and rivers (Nanez-James et al. 2009) where they stay for the first year of life (USM 2020). As the flounders age, they gradually move to deeper waters, until moving offshore to spawn (USM 2020). Adult females migrate back into the estuaries from approximately February through May, although males seldom return to the estuaries and bays.

The southern flounder life stages occurring in the Barataria Basin (predominantly juveniles and non-spawning adults) are eurythermal (reported range in occurrence of 2 to 30^{o}C) and euryhaline (range from 2 to 30 ppt), with temperature apparently having more of an effect than salinity on flounder consumption, growth, and cues for migrations in and out of the estuary (Peters 1971, Ward et al. 1980, Prentice 1989). Southern flounder are carnivorous, feeding on plankton as post-larvae, on small bottom animals (crustaceans, polychaetes, and small fish) as juveniles, and fish and shrimp as adults (USM 2020). Larvae and juveniles are preyed upon by many species of fish. The camouflaged adults are less susceptible to predators, but are known to be preyed upon by dolphins and sharks (USM 2020).

Although present in the Barataria Basin, the species is not considered abundant (Gunter 1936) and data from 373 beam trawls between October 1992 and September 1993 indicated that southern flounders represented only 0.1 percent of the total catch in the basin (Jones et al. 2002).

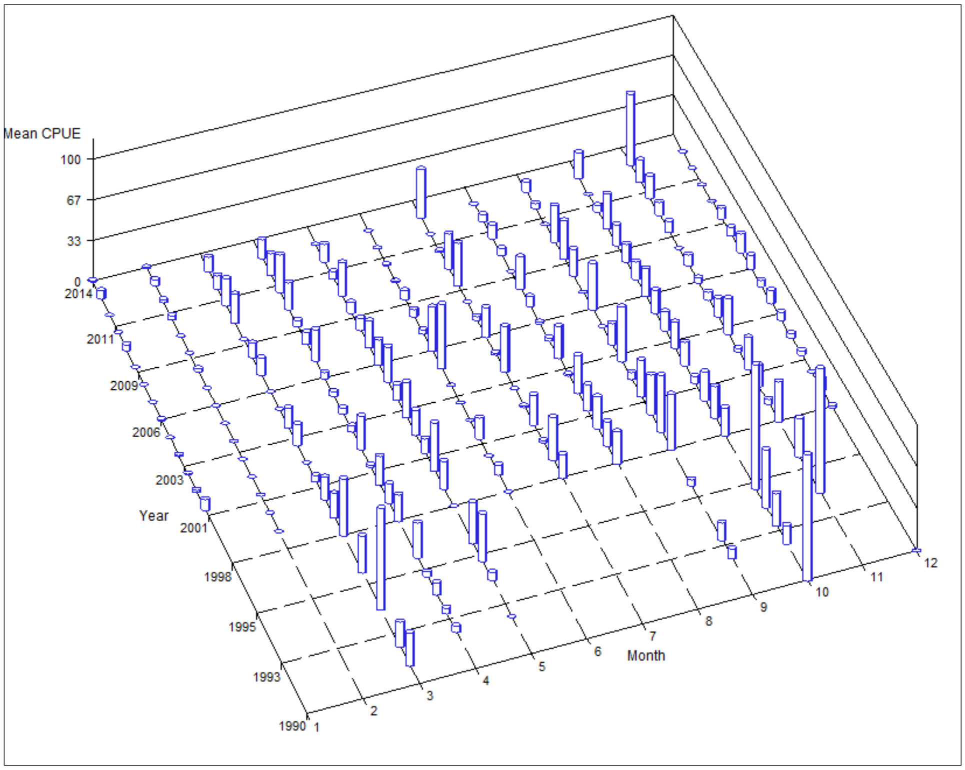
3.10.5.2.10 Largemouth Bass

Largemouth bass 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 between ages 1 and 2 and have an average life span of about 10-16 years in the southern U.S (Steed 2018, Boudreaux 2013, Davis and Lock 2011).. The average size of an age-2 female largemouth bass in the Louisiana recreational harvest data is typically 355 millimeters in total length, and an age-7 female is typically 508 millimeters TL (LDWF no date).

Largemouth bass are the most popular sportfish in the U.S. and are often stocked in lakes and reservoirs. LDWF has stocked the Florida strain largemouth bass in Barataria Basin waterbodies including Lakes Cataouatche, Salvador, Beouf, and des Allemands since 1993; however, the Florida strain has failed to establish itself for the region with the native northern strain largemouth bass still comprising 80 to 92 percent of the genomic make up in the lakes (LDWF 2017i).

Hijuelos et al. (2017a) summarizes the life cycle and habitat requirements of largemouth bass in coastal Louisiana, including the Barataria Basin. Largemouth bass tend to prefer lower salinity (less than 5 ppt) and less turbid waters since they are aggressive 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 freshwater 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 the Barataria Basin when temperatures climb above 60.8°F (16°C). Males build nests in sandy substrate or soft mud close to vegetative cover (Brown et al. 2009, Davis and 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 piscivorous feeding 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 still 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).

LDWF electrofishing samples conducted by the Inland Fisheries unit in the waterbodies of Upper Barataria Basin consistently collect more juvenile and adult largemouth bass than any of the coastal FIM gear types. Hijuelos et al. (2017a) reported the monthly average CPUE across years for coastal Louisiana where CPUE represents the number of fish collected per 15-minute electrofishing period. Electrofishing sampling is typically conducted one to four times a year in a waterbody with some instances of more frequent sampling. The monthly average CPUE shows that most bass are caught during March through November (see Figure 3.10-13). Largemouth bass CPUE was highest in the 1990s, and catch appears relatively low in the more recent period of record through early 2014; however, catch in the September through November samples increased a bit from previous years (see Figure 3.10-13). The LDWF has performed a series of stock assessments for the largemouth bass populations in the various waterbodies of southern Louisiana, including one for Lake Cataouatche (for example, Allgood and West 2017), that are under review at the department. The technical reports describe the status of the populations including estimated fishing mortality rates, size-at-age, and recruitment variability from year-to-year.



Source: Hijuelos et al. 2017a.

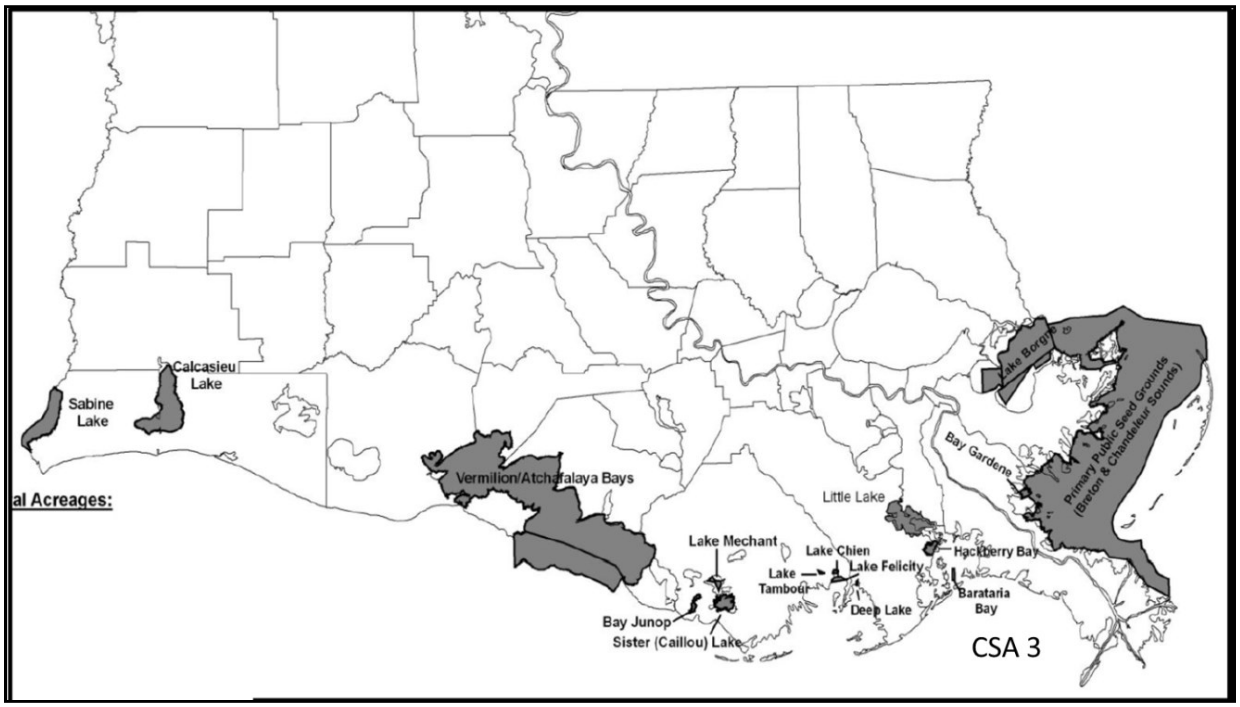
Figure 3.10-13. Monthly Mean CPUE of Large Juvenile and Adult Largemouth Bass in the LDWF Electrofishing Samples (1990 through early 2014).

3.10.5.2.11 Eastern Oysters

Eastern oysters are sessile filter feeders distributed from the Gulf of St. Lawrence (in Canada) 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). Sack oysters are mature adults larger than 75 millimeters 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. Along the Gulf Coast, oysters typically spawn when salinities are higher than 10 ppt and water temperatures exceed 68°F (20°C), with mass spawning initiated above 77°F (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).

Eastern oyster production zones have been identified for the Barataria Basin based on interacting temperature and salinity impacts promoting optimum oyster survival and growth (Melancon et al. 1998, Lowe et al. 2017). Low salinities (less than 5 ppt) result in notable increases in mortality and decreases in growth particularly when temperatures are high (that is, greater than 77 to 86°F [25 to 30°C]) (Lowe et al. 2017, Rybovich et al. 2016, La Peyre et al. 2009); however, oysters can survive extended periods of exposure to low salinity at lower temperatures (La Peyre et al. 2009, Leonhardt et al. 2017).

LDWF manages the statewide oyster fishery for the public oyster areas, separating the state into seven Coastal Study Areas (CSA). The public oyster grounds are monitored by the LDWF FIM program, and are primarily used as seed grounds for private leases located in the same CSAs. Although the public grounds do provide some harvest of market-sized oysters, most oyster landings come from private leases within the coastal basins (LDWF 2020a). Only about 3.6 percent of all Louisiana oysters landed in 2017 were from public grounds (LDWF 2020a). Figure 3.10-14 depicts the public oyster grounds along the Louisiana coast, including the Barataria Basin (CSA 3).



Source: LDWF 2018 Oyster Stock Assessment Report (LDWF 2020a).

Figure 3.10-14. Map of Public Oyster Areas for Louisiana. CSA 3 is labeled to reference the Little Lake and Barataria Bay public oyster grounds and the Hackberry Bay public seed reservation.

Changing salinities, through both long-term mechanisms (such as saltwater encroachment through sea-level rise) and short-term mechanisms (such as changes in annual rainfall) can allow for changes in the productivity and location of oysters. As discussed in Van Sickle et al. (1976, and references therein), there has been a trend of increasing salinity in Louisiana’s coastal zone, which has allowed for higher predation of seed oysters in the Lower Barataria Basin, but also an opportunity for additional inland areas to be leased as habitat conditions become more suitable for oyster growth. The lower half of Barataria Bay was the primary location for oyster culture into the 1940s; however, by 1950, the northern half of Barataria Bay was noted as becoming a reliable area for oyster spatfall and the most productive source of oyster seed, according to lease owners. Little Lake also began producing oysters in years of low rainfall, when salinity was higher. The use of these northern areas may have been a result of both changes in salinity and the expanding nature of the fishery. (Van Sickle et al. 1976, and references therein).

Construction and operation of the Davis Pond Freshwater Diversion (first opened in 2002) resulted in the movement or purchase of private oyster leases that were established in Little Lake during years of oyster productivity. However, since the diversion does not operate at maximum capacity, it allows oysters to propagate during periods of favorable environmental conditions (that is, higher salinity). Therefore, the Louisiana Wildlife and Fisheries Commission established the Little Lake Public Oyster Seed Ground (POSG) in 2007 to allow fishermen to harvest oysters and allow LDWF to manage the local reefs. LDWF does not have acreage estimates for reefs present in the Little Lake POSG and does not currently sample this area as part of the annual stock assessment (LDWF 2020a).

The Hackberry Bay Public Oyster Seed Reservation (POSR) was designated by the Louisiana Legislature in 1944 in the mid-basin (see Figure 3.10-14). Sampling results of this area drive the status of the oyster stock in the Barataria Basin, as the POSR is the most sampled of the three public oyster areas in the basin and includes the most productive sites. The POSR has one natural reef area but has received multiple cultch installations over time, some of which may no longer remain exposed above the mud surface. In 2018, the POSR was estimated to contain about 330 acres of reef habitat, and about 3,500 barrels of seed and sack oysters, about a 60 percent decrease compared to the 2017 stock assessment (LDWF 2020a).

The Barataria Bay POSG was designated in 2000 in response to possible changes in salinity from operation of the Davis Pond Freshwater Diversion, as LDWF indicated that it could be productive during years with high freshwater input. Only one known oyster reef, a 40-acre area in the northeast section, is present in the Barataria Bay POSG. LDWF indicates that the reef is vulnerable to predation and disease associated with higher salinities and that consistent production is not likely until salinity regimes in the basin change. No market-sized oysters have been identified at this site since construction of the cultch plant in 2004 and no spat have been identified since 2013 (LDWF 2020a). During the 2018 stock assessment sampling, two seed oysters were identified, only one of which was alive (LDWF 2020a).

As further discussed in Section 3.14.3 in Commercial Fisheries, eastern oysters are vitally important to Louisiana's economy and they are common in all of the Louisiana coastal basins. Total oyster landings in Louisiana have met or surpassed 11 million pounds of oysters every year since 2010. However, the annual total number of seed and sack oysters estimated from the statewide public oyster grounds has generally declined since the peak in the 1990s through 2001 (LDWF 2020a). The Barataria Basin public oyster grounds have not produced more than 13,000 barrels of seed oysters since the late 1990s, with the exception of 2011, 2013, and 2014, and account for only a small portion of the estimated annual statewide oyster stock (1.3 percent in 2018; LDWF 2020a).

Oyster reefs filter large volumes of water (a single mature oyster can filter about 1.5 to 2.1 gallons per hour) and can impact water quality and plankton abundance (La Peyre et al. 2014, zu Ermuggason et al. 2012, Wilber 2002, Henderson and O'Neil 2003, WHOI 2022). Oyster filtration impacts energy cycling and carbon transfer within the estuarine food web (La Peyre et al. 2013, Fulford 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. 2010, Humphries et al. 2011, Grabowski et al. 2005, Wilber 2002). Oyster reefs and bars can also help reduce wave stress and stabilize shorelines and unconsolidated bottom sediments to reduce marsh erosion and shoreline retreat rates within Barataria Bay (La Peyre et al. 2015, La Peyre et al. 2014, Piazza et al. 2005, Wilber 2002, Henderson and O'Neil 2003).

Most fringing oyster reef populations are not easily harvested and therefore can provide a stable source of larvae to oyster reefs in the deeper waters (Murray et al. 2015). Shoreline oiling and related clean-up efforts (that is, washing, raking, laying oil booms parallel to shoreline) caused large reductions in cover of fringing oysters within approximately 500 feet (152 meters) of marsh shorelines (Powers et al. 2015). Nearshore oyster cover was dramatically reduced over an estimated total of 155 miles of shoreline (Roman 2015). Reduction of oyster cover along the shoreline translates directly to fewer adult oysters that would be produced over time in the marsh habitats and reduced larvae to recruit to the harvestable subtidal beds (Roman 2015). Roman (2015) used the estimated numbers of dead oysters due to marsh oiling and clean-up actions to estimate a total of 8.3 million adult equivalent oysters lost, which translated to a total of 1.3 million pounds of oyster meat over their 5-year lifespan lost for the region (DWH NRDA Trustees 2016a).

3.10.5.2.12 Freshwater Fishes in the Lower Mississippi River below New Orleans

Freshwater fishes are present in the Project area, although they are generally restricted to the Mississippi River and areas of low salinity within the Upper Barataria Basin. Increases in the extent of freshwater within the Barataria Basin, and diversion of flow from the Mississippi River into the Barataria Basin, could allow for the introduction or expansion of freshwater species into the Barataria Basin. Blue catfish and flathead catfish are the most common species caught by recreational fishers in the main channels and along the banks of the Mississippi River. Freshwater drum (*Aplodinotus grunniens*), spotted gar (*Lepisosteus oculatus*), and smallmouth buffalo (*Ictiobus bubalus*) are also caught in the river (Lower Mississippi River Conservation Committee 2013). Skipjack herring (*Alosa chrysochloris*), gizzard shad (*Dorosoma cepedianum*), and threadfin shad (*Dorosoma petenense*) are forage fishes that form large schools and will move up the Mississippi River from the Gulf of Mexico. Pallid (*Scaphirhynchus albus*), shovelnose (*Scaphirhynchus platorynchus*), and Gulf sturgeons (*Acipenser oxyrinchus desotoi*) have been found in deep channels of the Atchafalaya, Red, and Mississippi Rivers (Reed and Ewing 1993).

3.10.6 Aquatic Invasive Species

Invasive species can alter biotic interactions (predation, competition, grazing) and indirectly impact 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, USEPA 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 EEZ 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 nonnative-native species that may become invasive (NOAA 2017a). Invasive aquatic species are also frequently introduced and established in Louisiana via recreational boating (transporting invasive species from one waterbody into another), aquaculture, plant nurseries, and the aquarium industry (Kravitz et al. 2005, NOAA 2017a).

3.10.6.1 Aquatic 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, common salvinia, and water hyacinth. Common invasive aquatic species in the basin can displace native 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.

A survey of the SAV in the Jean Lafitte National Historical Park and Preserve in the Upper Barataria-Terrebonne Estuary (Poirrier et al. 2010) included three invasive exotic species: Brazilian elodea (*Egeria densa*), hydrilla, and watermilfoil. Aquatic invasive plant species are listed in Section 3.6 Wetland Resources and Waters of the U.S., Table 3.6-3.

In 2017, public waterways within the Barataria Estuary included approximately 33,500 acres of nuisance aquatic vegetation, primarily water hyacinth (22,000 acres). Treatment of invasive species in the basin includes biological control using giant salvinia weevils (*Cyrtobagous salviniae*), implemented by the LDWF, USFWS, National Park Service (NPS), and private landowners since 2008. LDWF applied herbicides to more than 20,000 acres of nuisance SAV between 2012 to 2016, focusing primarily on giant salvinia. USACE funding towards the control of invasive species was discontinued in 2012 and LDWF is presently responsible for the continuation of both the biological and chemical control efforts.

3.10.6.2 Aquatic Invasive Animals

Of the 100 “worst invasive alien species in the world” (Lowe et al. 2000), Louisiana reports at least 13 of these in the state, including the Asian tiger mosquito (*Aedes albopictus*) and zebra mussel (*Dreissena polymorpha*). The zebra mussel is included in the list of 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 nonnative 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 (Zhan et al. 2015). Invasive species are often a problem for restoration and construction projects because of the newly cleared openings that create opportunities for their establishment and distribution.

A list of invasive aquatic animals (mollusks, crustaceans, and fishes) was compiled from the USGS NAS database, delineated by the six-digit HUC 080903 (Central Louisiana Coastal), data from the LDWF (Louisiana Aquatic Invasive Species Management Plan [LAISMP]; Kravitz et al. 2005), the BTNEP, and the Smithsonian Environmental Research Center (Fofonoff et al. 2018) and are listed in Table 3.10-4 (non-aquatic invasive species such as mammals and amphibians are presented with terrestrial wildlife in Section 3.9 Terrestrial Wildlife and Habitat).

Table 3.10-4
Potential Aquatic Invasive Animal Species Occurring within the Barataria Basin

Scientific Name	Common Name	Freshwater/Marine
Mollusks		
Corbicula fluminea[a]	Asian clam	Freshwater
Dreissena polymorpha[a]	Zebra mussel	Freshwater
Pomacea maculata	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

Source: USGS 2018b.

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

An extensive network of natural and constructed channels provides a mechanism for distribution of invasive mollusks in Louisiana and in the Barataria 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 crustacean Asian tiger prawn (*Penaeus monodon*) is considered invasive and the import, sale, and possession of this species is prohibited under Louisiana statute. The invasive shrimp was introduced into the U.S. for mariculture and has been reported in Vermilion and Barataria Bays. The 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 at any time to possess, sell, or transport live carp (all species of carp, including diploid and triploid grass carp [*Ctenopharyngodon idella*]) 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 [*Polyodon spathula*]), shad, and juveniles of recreational and commercial fish. Populations of silver carp, bighead carp, grass carp, and common carp (*Cyprinus carpio*) are established in the Davis Pond Freshwater Diversion Project outflow (USGS 2018b). In April 2009, large numbers of juvenile silver carp were collected from the pools of the Bonnet Carré Floodway (USACE 2009a).

3.11 MARINE MAMMALS

3.11.1 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. The Northern Gulf of Mexico includes 21 cetacean species managed as 59 discrete stocks (that is, demographically independent populations, see below) and one sirenian species, the West Indian manatee (*Trichechus manatus*). Although most cetacean species in the Gulf belong to oceanic stocks and are generally found in waters beyond the shelf break (greater than 656-foot [200-meter] isobath), the Atlantic spotted dolphin (*Stenella frontalis*) and 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, NMFS 2019d). Atlantic spotted dolphins occur primarily in continental shelf waters 33 to 656 feet (10 to 200 meters) deep to slope waters (less than 1,640 feet [500 meters deep]) and in greater densities in the eastern than the western Gulf of Mexico (Hayes et al. 2018). Bottlenose dolphins are currently managed as 37 distinct stocks within the Gulf of Mexico, most of which are only found in coastal waters (less than 66-foot [20-meter] isobath) (Hayes et al. 2019).

Because of the coastal and watershed focus of the proposed Project, 5 of the 37 bottlenose dolphin stocks were considered for their potential to be impacted by the proposed Project: three bay, sound, and estuary (BSE) stocks and two coastal stocks. However, the discussions herein focus primarily on bottlenose dolphins inhabiting Barataria Bay (see Figure 3.11-1), and secondarily on bottlenose dolphins of the Mississippi River Delta (MRD) Stock, Terrebonne Bay/Timbalier Bay Stock, Northern and Western Coastal stocks. 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 unimpacted by population fluctuations in other stocks. Coastal stocks tend to have larger ranges than their BSE counterparts and primarily inhabit nearshore coastal waters (generally to the 66-foot [20-meter] isobath) and larger sounds. In addition, we considered Atlantic spotted dolphins belonging to the Northern Gulf of Mexico stock.

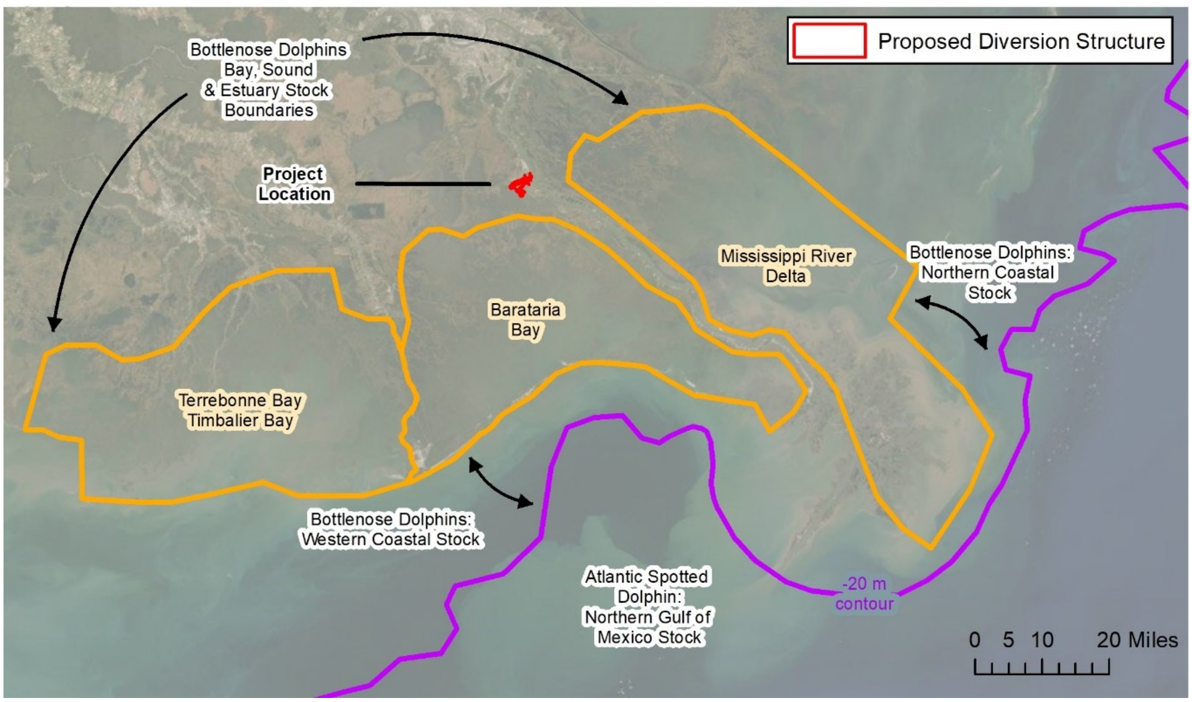


Figure 3.11-1. Geographic Extent of the Northern Gulf of Mexico Stocks Considered in the Proposed Project EIS. The location proposed for the Project diversion structure is shown in red. Depicted stock boundaries were provided by NMFS in May 2020.

While bottlenose dolphins and Atlantic spotted 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 level (PBR, 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 Barataria Bay Estuarine System (BBES) Stock, with an estimated population of 2,071 (95 percent Confidence Interval [CI]: 1,832 – 2,309), is considered as strategic because the estimate of human-caused mortality and serious injury exceeds PBR (Garrison et al. 2020; Hayes et al. 2018). The MRD stock is also listed as strategic due to small stock size (Hayes et al. 2018). In contrast, bottlenose dolphins of the Terrebonne/Timbalier Bay, Northern and Western Coastal stocks, and Atlantic spotted dolphins are not strategic stocks because the estimated population size is large (over 3,000, 7,000, 20,000 and 37,000 individuals, respectively) relative to the number of human-caused deaths (see Table 3.11-1; Hayes et al. 2019).

Table 3.11-1
Information on Dolphin Stocks Considered in the Proposed Project EIS[a]

Species	Stock	Abundance (N_{best} [CV]; N_{min})	MMPA Status[b]	PBR[c]
Common bottlenose dolphin	Barataria Bay Estuarine System (BBES)	2,306 (0.09); 2,138[d]	Strategic	17
	Terrebonne-Timbalier Estuarine System (TTES)	3,870 (0.15); 3,426	Not strategic	27
	Mississippi River Delta (MRD)	332 (0.93); 170	Strategic	1.4
	Northern Coastal	7,185 (0.21); 6,044	Not strategic	60
	Western Coastal	20,161 (0.17); 17,491	Not strategic	175
Atlantic spotted dolphin		Currently unknown, but previously 37,611 (0.28)	Not strategic	Undetermined

[a] Data are from NOAA Stock Assessment Reports, including the best-available abundance estimate (N_{best}) with the coefficient of variation (CV) and the minimum abundance estimate (N_{min}) (Hayes et al. 2019).

[b] Under the MMPA, all cetaceans are protected; however, some particularly threatened stocks are given additional protections and deemed "strategic." From Hayes et al. (2019): "Because a UME of unprecedented size and duration (March 2010 – July 2014) has impacted the Northern Gulf of Mexico, including Terrebonne-Timbalier Bay, and because health and reproductive success of dolphins within Terrebonne-Timbalier Bay has likely been compromised as a result of the DWH oil spill, NMFS finds cause for concern about this stock. The status of this stock relative to optimum sustainable populations is unknown. There is insufficient information to determine whether or not the total fishery-related mortality and serious injury is approaching a zero mortality and serious injury rate. There are insufficient data to determine population trends for this stock."

[c] PBR is the product of the minimum population size, one-half the maximum productivity rate, and a recovery factor (MMPA Sec. 3.16 USC 1362; Wade and Angliss 1997; Wade 1998). It is used to help determine the MMPA status of a stock.

[d] This value is from the most recent published NMFS stock assessment reports. The 2,071 identified in the text preceding the table is based on 2019 CMR, as referenced in Garrison et al. 2020.

Under the MMPA, Congress directed that the primary objective of marine mammal management should be to maintain the health and stability of the marine ecosystem and, when consistent with that primary objective, to obtain and maintain optimum sustainable populations of marine mammals. To achieve this objective, the MMPA prohibits, among other things, the taking and importation of marine mammals and marine mammal products unless the taking or importation is authorized or exempt.

Congress passed the Bipartisan Budget Act of 2018, Public Law 115-123 (BBA-18), which recognized the consistency of the proposed Project, among other CPRA projects, with the findings and policy declarations in Section 2(6) of the MMPA. The BBA-18 included a requirement that the Secretary of Commerce, as delegated to the Assistant Administrator of the NMFS, issue a waiver of the MMPA moratorium and prohibitions for the proposed Project. As directed by Congress, on March 15, 2018, NMFS issued the waiver pursuant to BBA-18 and Section 101(a)(3)(A) of the MMPA:

"National Marine Fisheries Service hereby issues this waiver pursuant to title II, section 20201 of the Bipartisan Budget Act of 2018 and section 101(a)(3)(A) of the MMPA for the three named projects, as selected by the 2017 Louisiana Comprehensive Master Plan for a Sustainable Coast. The requirements of sections 101(a) and 102(a) of the MMPA do not apply to any take of marine mammals caused by and for the duration of the construction, operation, or maintenance of the three named projects."

BBA-18 also required the State of Louisiana, in consultation with the Secretary of Commerce (delegated to NMFS), to the extent practicable and consistent with the purposes of the proposed Project, to minimize impacts on marine mammal species and population stocks, and monitor and evaluate the impacts of the proposed Project on such species and population stocks.

The West Indian manatee is generally restricted during winter to inland and coastal waters of the Florida panhandle (Laist and Reynolds 2005, Laist et al. 2013, USFWS 2014a), but could exhibit seasonal migration and greater dispersal during the summer months; as this species is further protected under the ESA, it is discussed in detail in Section 3.12.1, in Threatened and Endangered Species.

3.11.2 Marine Mammals in Barataria Bay and Surrounding Areas

3.11.2.1 Bottlenose Dolphins

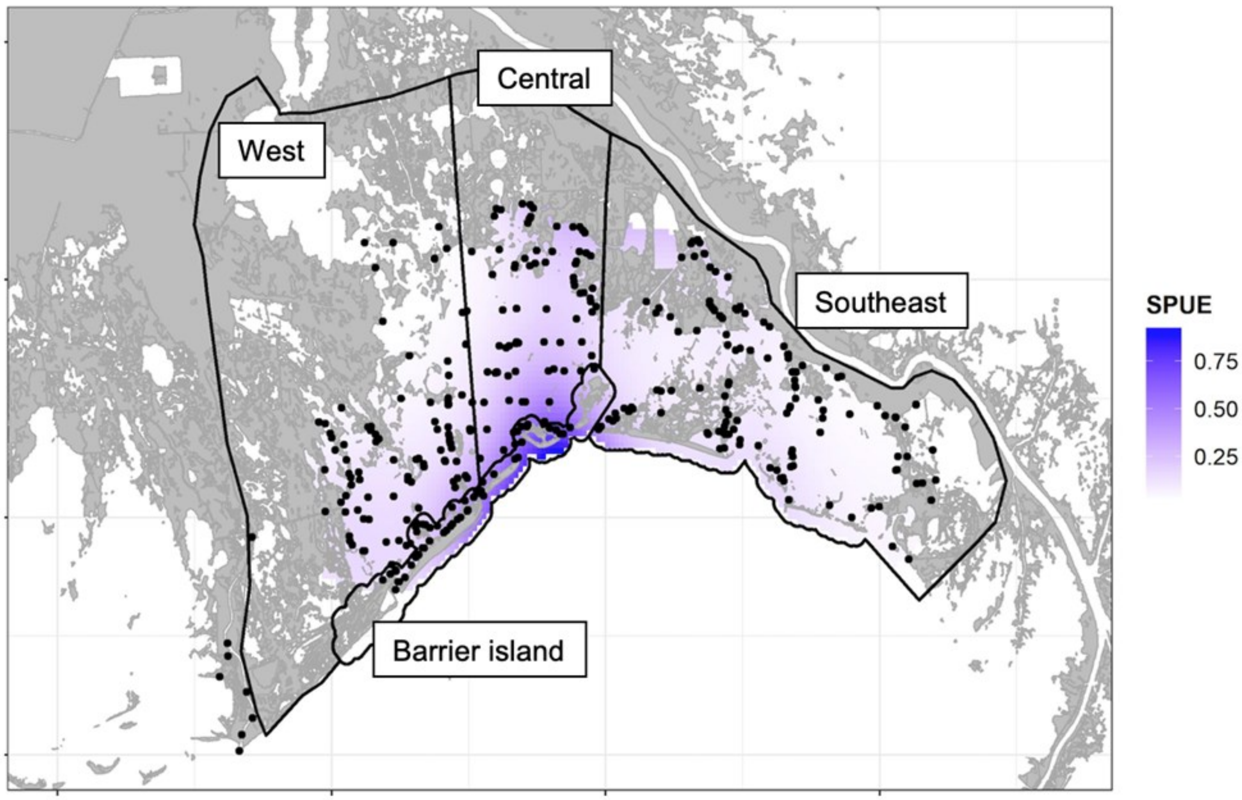
Bottlenose dolphins are found in tropical and temperate waters worldwide and are the most abundant coastal cetaceans from the U.S. Mid-Atlantic States to Texas. They are a slow maturating species with long life spans and low reproductive rates. Male bottlenose dolphins reach reproductive maturity between 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).

3.11.2.1.1 Barataria Bay Estuarine System Stock

Bottlenose dolphins in Barataria Bay belong to the BBES Stock, which has an estimated population of 2,071 (95 percent CI: 1,832 – 2,309) common bottlenose dolphins in the middle and lower portions of the basin (Garrison et al. 2020; see Figure 3.11-2). Based on surveys conducted in 2019, as depicted in Figure 3.11-2, the highest density of dolphins occurs near the barrier islands (0.40 dolphins/328 feet [100 meters] of survey trackline), with lower densities in the central portion (Central stratum) of the basin (0.20 dolphins/328 feet [100 meters] of trackline), and the lowest densities in the Southeast and West stratums (0.10 and 0.08 dolphins/328 feet [100 meters] of trackline, respectively; Wells et al. 2017, Garrison et al. 2020). Based on multi-year (2011 through 2019) photographic-identification data and fine-scale movements from satellite telemetry, individual movement patterns can be highly variable. In general, BBES dolphins are year-round residents that have localized, small usage areas (less than 43.5 square miles [70 square kilometers]), but some individuals can have ranges that extend throughout the middle/lower parts of the basin (Wells et al. 2017, Cloyed et al. 2021, Takeshita et al. 2021). Some BBES dolphins with ranges near the barrier islands also move into Gulf of Mexico waters up to 1 mile (1.6 kilometers) from shore (Wells et al. 2017) and may overlap with dolphins from the Western Coastal Stock. However, the BBES Stock represents a demographically independent population (Rosel et al. 2017). In the 2018 Stock Assessment Report, NOAA states that "it is plausible the BBES Stock contains multiple demographically independent populations, but further work is needed to better understand how the habitat is partitioned within the bay" (Rosel et al. 2017, Hayes et al. 2019).

The habitat within the BBES Stock's geographic boundaries is a mixture of open water near the barrier islands and in the middle of Barataria Bay proper, as well as marine and brackish wetlands. The entire system is relatively shallow (6.6 feet [2 meters] depth on average; Hayes et al. 2019), although some deeper water can be found, mostly at the passes to open ocean and along shipping channels. It is currently a highly productive environment, with breeding and nursery grounds for a variety of marine, brackish, and freshwater finfish and shellfish species. As seen in other BSE dolphins, BBES dolphins are likely flexible feeders, using a range of foraging tactics to capture different prey depending on their particular habitat (Cloyed et al. 2021).

In general, calving for BSE stocks in the Northern Gulf of Mexico typically peaks in the late winter to early spring (Urian et al. 1996). The gestation period is 12.5 months, and mothers will rear their calves for 3 to 6 years (Wells and Scott 2018). During this period, young dolphins learn about their home range and foraging/social behaviors, and lactating mothers require 76 percent more prey to adequately feed their calf (Bejarano et al. 2017). In 2010, the DWH oil spill had significant acute and long-term adverse impacts on the health, survival, and reproductive success of BBES dolphins (see Section 3.11.3.2, The Deepwater Horizon Oil Spill and Current Health Status).



Source: Garrison et al. 2020

Figure 3.11-2. Distribution of Common Bottlenose Dolphins during Photo-identification Surveys in the Barataria Basin in March and April 2019. Black points represent sightings of bottlenose dolphins during 2019 surveys (each point can represent anywhere from one to 30 dolphins; Garrison et al. 2020). Black lines and labels indicate the geographic strata biologists used to compare relative densities in each region of the BBES Stock area. The sightings per unit effort (SPUE; blue heat map) was calculated from the sightings along the vessel transects to create a continuous density surface across the BBES Stock area. Survey transect lines did not include areas south of the barrier islands, but the SPUE analysis extrapolates into this area. See Garrison et al. 2020 for more information.

3.11.2.1.2 Mississippi River Delta Stock

The MRD stock includes bottlenose dolphins occupying Breton Sound and extending north along the Mississippi River Delta (see Figure 3.11-1). Bottlenose dolphins from this stock likely exhibit a high degree of site fidelity like dolphins in Barataria Bay (Hayes et al. 2019). There is much less information available for the MRD stock, particularly for those dolphins that inhabit Breton Sound. Recent aerial survey line-transect population size estimates estimate an abundance of 332 (Garrison 2017). Because the stock size is small and relatively few mortalities and serious injuries would exceed the PBR, this stock is considered to be strategic (Hayes et al. 2019).

As described in Chapter 4, Section 4.11.5.3 in Marine Mammals, impacts on the MRD stock from the proposed Project is anticipated to be negligible. Therefore, a commensurate background on the stock is provided here, and more detailed information can be found in Hayes et al. (2019).

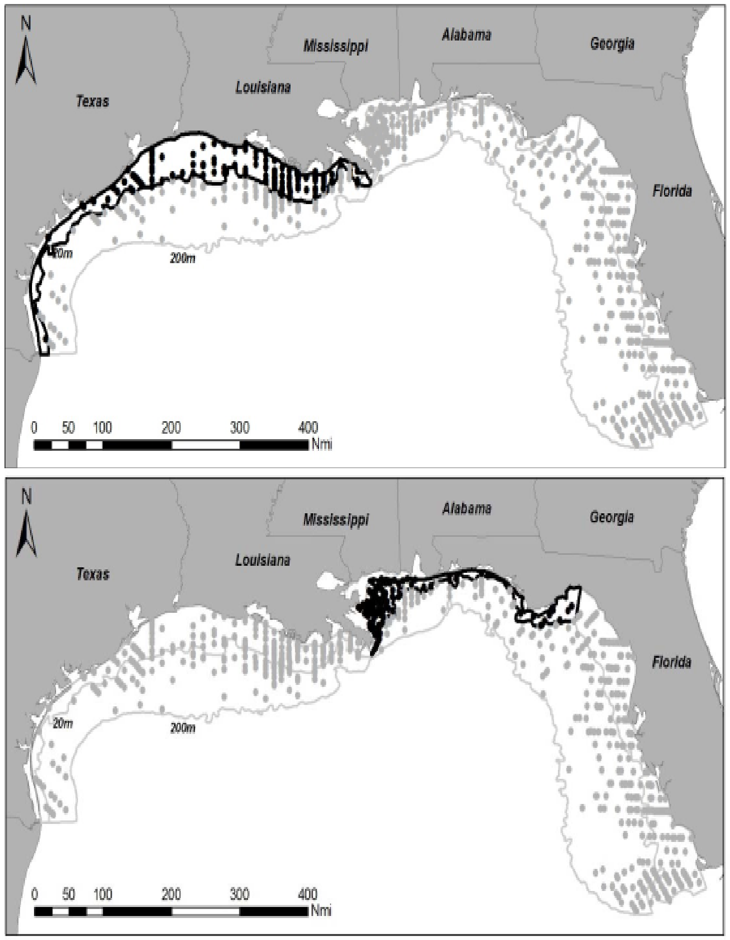
3.11.2.1.3 Terrebonne Bay/Timbalier Bay Stock

The Terrebonne Bay/Timbalier Bay Estuarine System stock (TTES) includes inshore waters from Port Fourchon west to Isles Dernieres, to the west of the Barataria Basin (see Figure 3.11-1; Hayes et al. 2019, Waring et al. 2016). Given this stock is also a BSE stock, it is also assumed to exhibit a high degree of site fidelity to this area (Hayes et al. 2019). A study conducted in 2018 comparing the photo-identification catalogs of the TTES and BBES stocks found that less than 2 percent of the individuals in each catalog overlapped between the two (Mullin et al. 2018). This study further indicates that there is very little overlap in these stocks in terms of number of individuals and their ranges, similar to the findings of the BBES satellite tagging studies (Wells et al. 2017). The current estimate of abundance for this stock is 3,870 dolphins (Hayes et al. 2019). Individuals from both the MRD Stock and TTES stock could be present in inshore waters as there could be occasional emigration or mixing with the BBES Stock, and possibly in areas around the outer boundary of the proposed Project area.

As described in Chapter 4, Section 4.11.5.3 in Marine Mammals, impacts on the TTES stock from the proposed Project is anticipated to be negligible. Therefore, a commensurate background on the stock is provided here, and more detailed information can be found in Hayes et al. (2019).

3.11.2.1.4 Coastal Stocks

Bottlenose dolphins of the Northern Coastal stock typically inhabit an area between the MRD and the 84°W longitude (in northern Florida), while those of the Western Coastal Stock typically inhabit an area between the Texas/Mexico border and the MRD (see Figure 3.11-3; Hayes et al. 2017). These coastal stocks are found in waters between the shore, barrier islands, or outer bay boundaries out to about 66-foot (20-meter) isobath, and in areas influenced by freshwater inputs. Because of the spatial distribution of these coastal stocks, they may have a common boundary with BSE stocks, and may occasionally overlap with the distribution of bottlenose dolphins in Barataria Bay. However, there is no significant mixing or interbreeding between these stocks. In addition, individuals from these stocks 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).



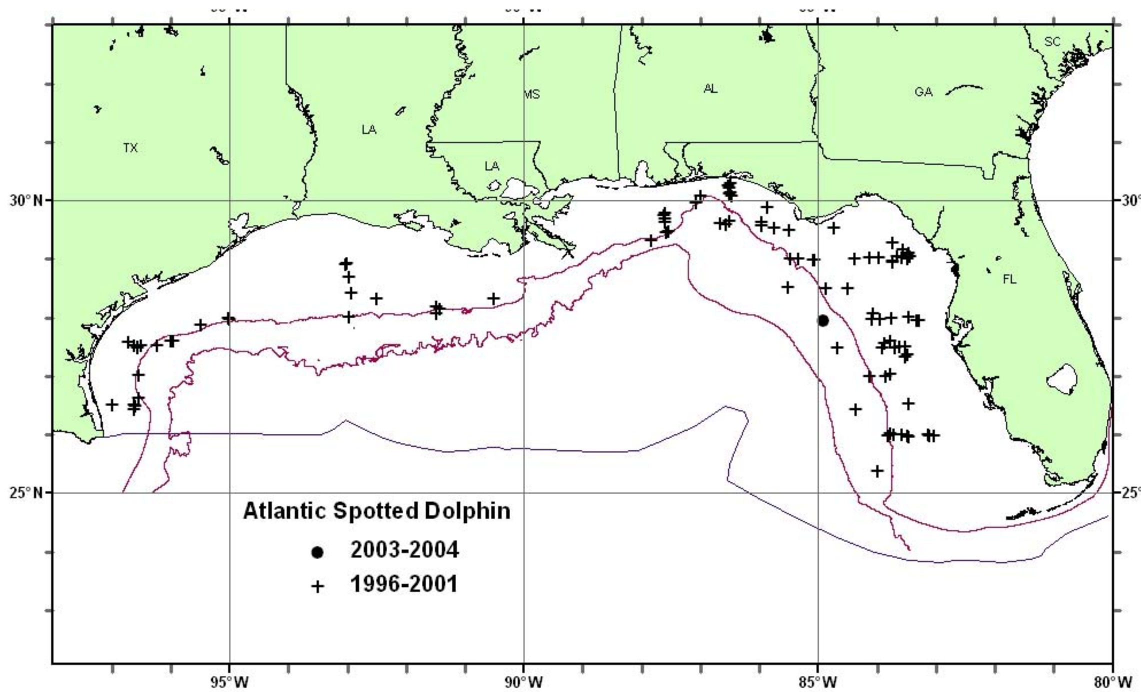
Source: Waring et al. 2016

Figure 3.11-3. **Range of Western Coastal and Northern Coastal Stocks.** Top and Bottom: Bottlenose dolphins in coastal and continental shelf waters. Dark circles indicate groups within boundaries of the Western and Northern Coastal Stocks, respectively. Maps display the 66-foot (20-meter) and 656-foot (200-meter) isobaths.

As described in Chapter 4, Section 4.11.5.3 in Marine Mammals, impacts on the coastal bottlenose dolphin stocks from the proposed Project is anticipated to be negligible. Therefore, we provide a commensurate background on the stock here, and more detailed information can be found in Waring et al. (2016).

3.11.2.1.5 Atlantic Spotted Dolphin

The Atlantic spotted dolphins occur primarily from continental shelf waters 33 to 656 feet (10 to 200 meters) deep to slope waters (Fulling et al. 2003; Mullin and Fulling 2004; Maze-Foley and Mullin 2006) (see Figure 3.11-4). This species becomes sexually mature and begins breeding between 8 and 15 years of age, with females giving birth every 1 to 5 years (Waring et al. 2016). This species could be seasonally present in inshore waters, and possibly in areas around the outer boundary of the proposed Project area, but only as a transient visitor, and particularly during spring.



Source: Waring et al. 2016.

Figure 3.11-4. Sightings of Atlantic Spotted Dolphins in the Gulf of Mexico. Solid lines indicate the 328-foot (100-meter) and 3,280-foot (1,000-meter) isobaths and the offshore extent of the U.S. EEZ.

As described in Chapter 4, Section 4.11.5.3 in Marine Mammals, impacts on the Atlantic spotted dolphin Northern Gulf of Mexico stock from the proposed Project is anticipated to be negligible. Therefore, a commensurate background is provided here, and more detailed information can be found in Waring et al. (2016).

3.11.3 Habitat Preferences and Environmental Requirements

Studies indicate that certain environmental factors that influence habitat use by bottlenose dolphins, such as salinity and temperature (Shane et al. 1986, Wells and Scott 1999, Miller and Baltz 2010, Hornsby et al. 2017, Takeshita et al. 2021), 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). 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). Miller and Baltz (2010) found that water temperature was a good indicator of their distribution and foraging activity in the Barataria Basin. The same study found that other habitat characteristics (for example, DO, turbidity, and salinity) were also associated with higher foraging activity. The model developed by that study indicated that optimum foraging suitability is water temperatures in the 68 to 75°F (20 to 24°C) range, about 6 mg/L DO, turbidity in the 20 to 28 NTU range, salinity of about 20 ppt, distance from shore in the 656- to 1,640-foot (200- to 500-meter) range, and water depths between 13 and 20 feet (4 to 6 meters) (Miller and Baltz 2010). However, as these are optimum values, bottlenose dolphins occur in a wider range of habitat characteristics. Group size was also positively related to increased number of observations with forage (Miller and Baltz 2010).

Although dolphins can be found in waters with a wide range of turbidity and DO, it is unclear how these parameters might directly impact dolphin behavior. Turbidity may impact BBES dolphins in terms of (1) exposure to contaminants that bind to sediment (in other words, remobilization of sediment-associated contaminants that may be ingested), or (2) dolphin/prey foraging behavior (in other words, higher turbidity may reduce visual capture success of prey by dolphins or conversely prey that rely on visual cues may have a greater likelihood of capture by dolphins; Miller and Baltz 2010). Over the last decade, studies have documented a drilling type of feeding behavior in BBES that has not been observed in the northern Gulf previously. However, with regard to the visual cues, given that the Barataria Basin typically has a high level of turbidity, it is unlikely that BBES dolphins rely heavily on vision for locating and/or capturing prey unless they are out in the open waters of the Gulf of Mexico just beyond the barrier islands, where water clarity increases.

HABs and associated biotoxins ingestion or inhalation may have direct impacts on dolphin health and may lead to mortality. Low DO associated with changes in the environment and/or HABs can also have indirect impacts on dolphin health and survival through loss of their prey (Flewelling et al. 2005, McHugh et al. 2011a, Twiner et al. 2012, Cammen et al. 2015, Wells et al. 2019). However, although low DO can impact aquatic organisms including dolphin prey, given the highly variable nature of DO trends in the Barataria Basin laterally and by depth in the water column, it would be difficult to establish a preferred DO range for BBES dolphins.

Although dolphins can tolerate a range of water quality conditions, photo-identification and satellite tagging studies indicate that most BSE individuals stay in relatively small usage areas (for example, see Hubard et al. 2004, Irwin and Würsig 2004, Balmer et al. 2008, 2018a, 2019, Urian et al. 2009, Mullin et al. 2017, Wells et al. 2017, Cloyed et al. 2021), often regardless of prolonged and/or drastic changes in environmental conditions (for example, low-salinity, severe red tide HABs, strong hurricanes, and oil spills; Bassos-Hull et al. 2013, Wells 2014, Mullin et al. 2015, Aichinger-Dias et al. 2017, Fazioli and Mintzer 2020, Takeshita et al. 2021). Researchers conducted telemetry studies of BBES dolphins over multiple years since 2011, targeting different seasons and locations within the basin (Hornsby et al. 2017, Wells et al. 2017, Takeshita et al. 2021). Here, we briefly compare the analyses associated with these telemetry studies (Hornsby et al. 2017, Wells et al. 2017, Takeshita et al. 2021).

Hornsby et al. (2017) used salinity models and satellite-linked telemetry location data from BBES dolphins tagged in August 2011 (a subset of the data used by Wells et al. 2017) to estimate the area of potential dolphin habitat in the Barataria Basin for purposes of extrapolating abundance from density estimates. However, all of the dolphins in this study were captured south of Bassa Bassa Bay (see Figure 3.11-5), and by August 2011, the salinities in the basin did not reflect the effect of the freshwater spring/summer runoff. They report that over the study period: (1) 95 percent of all BBES dolphin telemetry locations were in waters above 7.89 ppt (based on their salinity model); (2) when dolphins did move into waters with salinity below 8 ppt, they tended to stay for less than 24 hours; and (3) dolphins found in lower-salinity waters remained in the vicinity of the 8-ppt isohaline and did not often move into waters much below that isohaline. However, the Hornsby et al. (2017) dataset is limited to dolphins captured, tagged, and released south of Bassa Bassa Bay (mainly in the Island stratum). Eight of these dolphins did spend time in waters north of Caminada Bay, with usage areas consistent with BBES dolphins in the west stratum; however, the satellite tags collected data starting in August 2011, when salinities were already increasing after the spring/summer runoff, so this does not provide information about how those individuals may have moved in relation to changes in salinity.

Researchers conducted additional tagging studies (Wells et al. 2017, Takeshita et al. 2021) from 2013 to 2016, capturing dolphins exclusively along the barrier islands except for one individual in Bassa Bassa Bay (see Figure 3.11-5) Because salinity values were generally high in the area and during the time period of those tagged dolphins' movements (hindcasted Delft3D Basinwide Model salinity estimates during these tag deployments remained in the 20 to 30 ppt range), these telemetry data do not provide information about how dolphins may move in relation to changes in water salinity.

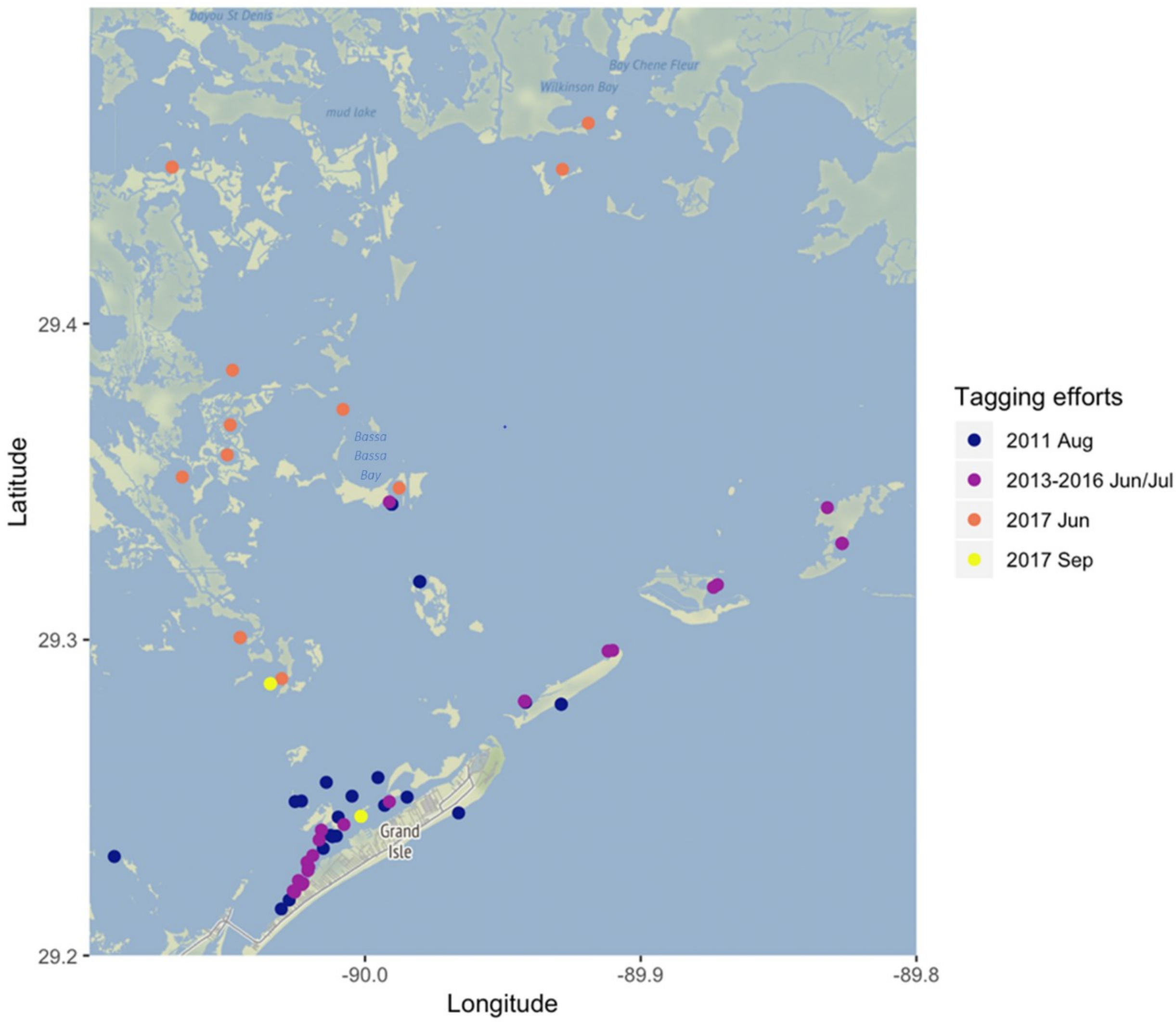


Figure 3.11-5. Capture Locations for Barataria Bay Satellite-linked Tagging Efforts. From 2011 to 2017, researchers conducted a series of capture-release efforts to attach satellite tags to BBES dolphins. Each field effort was designed to inform a variety of questions about the health and movements of BBES dolphins, and therefore the locations and selection of dolphins changed from year-to-year. In June 2017, Takeshita et al. (2021) specifically targeted dolphins in the northern part of the BBES Stock area during low-salinity conditions in the basin to assess how dolphins moved in relation to changes in salinity. The other field efforts were not specifically designed to address questions about salinity and BBES dolphin movements.

In another study from June 2017, Takeshita et al. (2021) specifically targeted dolphins in the northern part of the BBES Stock area in June when salinities were lower in the basin due to the spring/summer runoff, with the goal of understanding how dolphins may or may not move in relation to changes in salinity. Despite low-salinity conditions compared to previous years (due to high spring/summer freshwater runoff), most dolphins maintained a limited range (averaging 2.1 miles net movement per day within 6.2 to 12.4 miles of their capture locations). The 10 dolphins caught, tagged, and released north of Caminada Bay experienced waters under 5 ppt (as estimated by hindcasted Delft3D Basinwide Model output) at least once during the lifetime of their tag; in aggregate, these dolphins spent 271 out of 561 (48 percent) of the tagged days in waters less than 5 ppt. In the northern portion of the BBES Stock area, two dolphins near Little Lake spent 68 of 85 (80 percent) of their tagged days in waters less than 5 ppt, and two dolphins near the CRMS 0224 (central basin) water quality monitoring station (central basin) spent at least 86 of 126 days (68 percent) in waters less than 5 ppt salinity, including one individual that spent at least 34 consecutive days below 5 ppt. Two dolphins had extended movement patterns (compared to the other dolphins in the 2017 study) across the Barataria Basin (averaging 4.7 miles of net movement per day). However, despite these extended ranges, their movements were not associated with salinity gradients. In aggregate, they spent a total of 73 out of 153 days (48 percent) in waters below 5 ppt. Despite the range of individual behaviors, Takeshita et al. (2021) found no evidence that any of the dolphins moved in response to low salinity during the study period, in spite of available pathways to higher-salinity waters.

In summary, although Hornsby et al. (2017) identified dolphin locations that by visual inspection seemed to correlate with the 8-ppt isohaline, their 2011 dataset was limited to (1) a subset of BBES dolphins that tended to use the southern part of the BBES Stock area and (2) a time of the year when Barataria Bay was at relatively high-salinity levels after the spring/summer runoff. The purpose of their study was to estimate the area of Barataria Bay across which to extrapolate density estimates to reach an overall abundance estimate. Takeshita et al. (2021) uses 2017 telemetry data, including dolphins in the northern portion of the BBES Stock area (where salinities tend to be lower compared to the rest of Barataria Bay), and during a time when the Barataria Basin was near the lowest-salinity levels associated with the spring/summer runoff. The purpose of this study was to explicitly compare dolphin movements in response to changes in salinity. Therefore, based on the comparisons across the aggregated 2011 to 2017 telemetry dataset presented in Takeshita et al. (2021), in the analyses that follow, the 2017 telemetry data were relied upon as the best-available information about the relationship between BBES dolphin movements and low-salinity trends. Study results demonstrate that during the study period, there was no evidence that dolphins moved due to low salinity or salinity changes in the Barataria Basin.

Although bottlenose dolphins can tolerate exposures to low salinities for short periods of time, prolonged exposures (days to weeks) to freshwater and low-salinity conditions result in biological and physiological responses including skin lesions, tissue necrosis, changes in blood chemistry parameters, and physiological stress, and also contribute to secondary infections (Ewing et al. 2017, Colbert et al. 1999, Holyoake et al. 2010, Mullin et al. 2015, Deming et al. 2020, Duignan et al. 2020). 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 ppt (range 1.4 to 9.2 ppt), developed severe skin lesions and likely died from the detrimental impacts of reduced salinity or the combined impact of salinity and low water temperatures (Mullin et al. 2015). Similarly, in a coastal bay in Texas, exposures to salinities of less than 10 ppt may have contributed to dolphin deaths (Colbert et al. 1999). A study of bottlenose dolphins in Galveston Bay after Hurricane Harvey, which caused a rapid decline (over 3 days) from an average of 14 to less than 1 ppt, indicated that fewer dolphins used the shallower, upper bay habitats following the storm (many leaving the upper bay or moving to the deeper channels with higher salinity at depth), and those that did developed skin lesions potentially indicative of underlying health issues. The prevalence of lesions remained elevated for at least 4 months after Hurricane Harvey, and at least 2 months after salinities returned to levels above 11 ppt (Fazioli and Mintzer 2020).

In contrast, out-of-habitat bottlenose dolphins in Louisiana impacted by Hurricane Rita survived exposures to low salinities (less than or equal to 15 ppt) for 3 weeks (Rosel and Watts 2007), 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 freshwater discharges or regular changes in salinity, and thus may be less likely exposed to reduced salinity conditions.

3.11.3.1 Food Web and Ecological Interactions

Dolphins are top-level predators that feed on a wide variety of prey. In Sarasota Bay, Florida, they actively select soniferous prey species (those producing or conducting sound) and primarily rely upon estuarine and marine finfish (Berens McCabe et al. 2010), with adults consuming 34 plus or minus 5 kg/kg/year, meaning they consume 34 plus or minus 5 kilograms of prey per kilogram of the individual dolphin's body weight per year (Bejarano et al. 2017). The coastal marshes of Louisiana are an important nursery for dolphin prey species from marine, brackish and freshwater habitats. Thus, although changing environmental conditions can have direct impacts on dolphin health, survival, and reproduction, the same fluctuations can also have indirect impacts through impacts on dolphin prey availability and quality. Stomach contents of bottlenose dolphins have generally shown that less than 10 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, Bowen 2011); a study specific to BBES dolphins indicates a similar diet (Bowen-Stevens et al. 2021; see Table 3.11-3). In contrast, little is known about the preferred prey of the Atlantic spotted dolphin, but it generally consists of small fish, benthic invertebrates, squid, and octopus.

Table 3.11-3
BBES Dolphin Prey Species Based on Stomach Contents

Prey[a]	Common Name	Number of Stomachs Analyzed	Frequency (%)[b]	Numerical (%)[b]	Impacts on Taxon Evaluated in EIS? (or reasonable proxy)
Micropogonias undulates	Atlantic croaker	32	86.5	34.2	Yes
Unknown fish		32	86.5	14.4	
Cynoscion sp.	Seatrout	28	75.7	11.1	Yes
Sciaenidae other	Croaker and drum	14	37.8	7.8	Yes
Penaeidae	Penaeid shrimp	18	48.6	2.2	Yes
Anchoa sp.	Anchovy	17	45.9	12.8	Yes
Clupeidae other	Herring and menhaden	16	43.2	2.1	Yes
Leiostomus xanthurus	Spot	14	37.8	3	Yes (Atlantic croaker)
Mugil sp.	Mullet	11	29.7	3.3	Yes
Ariidae other	Catfish	10	27	2.4	Yes
Menticirrhus sp.	Kingfish	9	24.3	1.1	No
Lolliguncula brevis	Brief squid	8	21.6	1.1	Yes
Synodontidae other	Lizardfish	6	16.2	0.4	No
Urophycis sp.	Hake	5	13.5	1	No
Lagodon rhomboides	Pinfish	5	13.5	0.1	No
Stellifer lanceolatus	Star drum	5	13.5	0.5	No
Bairdiella chrysoura	Silver perch	4	10.8	0.2	No
Peprilus alepidotus	Harvestfish	4	10.8	0.4	No
Crustacea	Crab	2	5.4	< 0.1	Yes
Bothidae other	Flatfish	2	5.4	< 0.1	No
Larimus fasciatus	Banded drum	2	5.4	0.8	No
Pogonias cromis	Black drum	2	5.4	0.6	No
Loliginidae other	Inshore squid	1	2.7	< 0.1	No
Paralichthys	Flounder	1	2.7	< 0.1	Yes
Orthopristis sp.	Grunts	1	2.7	0.3	No
Lutjanus sp.	Snapper	1	2.7	< 0.1	Yes
Prionotus sp.	Searobin	1	2.7	< 0.1	No
Trinectes maculatus	Hogchoker	1	2.7	< 0.1	No

Source: Bowen-Stevens et al. 2021

[a] Prey were classified to the lowest possible taxonomic unit (genus or species).

[b] Frequency of occurrence and numerical abundance for prey identified from whole stomachs of 37 common bottlenose dolphins collected as stranded animals from Barataria Bay, Louisiana, from 2010 to 2012. Stomach contents from stranded, dead dolphins may be different than contents in living healthy dolphins, and prey species can be digested at different rates. It is also possible that stranded dolphins are not representative of the geographic extent of the BBES Stock area (in other words, it is possible that barrier island-associated dolphins are more likely to be recovered and analyzed for stomach contents compared to dolphins in the northern part of the stock area).

BBES dolphins have flexible feeding strategies to take advantage of the suitable prey available in a given habitat (Cloyed et al. 2021). However, it is unclear how well dolphins can thrive if their overall prey diversity (see Table 3.11-3) decreases due to any combination of sudden or long-term changes to their habitat (for example, subsidence, sea-level rise, storms, winds and tides, shifts from marine to freshwater marsh-edge availability, and human activities). Two severe red tide events in Sarasota Bay resulted in a 71 to 95 percent decline in local dolphins' primary prey fish (Gannon et al. 2009), which changed dolphin behavior (including fatal interactions with fishing gear), reduced the trophic level at which they fed, decreased body condition, and increased the occurrence of skin lesions (McHugh et al. 2011a, Wells et al. 2019). Cetaceans with high site fidelity (such as BBES dolphins) tend to be the least resilient against changes to their habitat and are more likely to be listed as threatened or endangered (Cloyed et al. 2021).

3.11.3.2 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 (DWH 2016c, Hayes et al. 2019). Following the spill, in the areas where surface and coastline oiling occurred, cetacean stranding rates rose significantly above baseline (Litz et al. 2014) and NOAA declared an Unusual Mortality Event (UME) in December 2010 to retrospectively address an increase in mortality from the spring of 2010 (NOAA 2020a). A series of studies confirmed that the DWH oil spill was the primary cause of this UME (Venn-Watson et al. 2015a, Colegrove et al. 2016, DWH NRDA Trustees 2016a).

A suite of live animal studies (such as capture-release health assessments, photo-identification) and investigations of strandings provided strong evidence of the severe adverse health impacts 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 2016c, Kellar et al. 2017, Schwacke et al. 2017, Smith et al. 2017). Dolphins in Barataria Bay showed evidence of unusually high rates of chronic lung disease with individuals being three to six times more likely to have moderate to severe lung disease when compared to those in the reference site (Schwacke et al. 2014, DWH 2016c, Smith et al. 2017). Severe cases were found only in oiled locations, and the severity and prevalence of lung disease showed a decreasing trend from 2011 to 2014 (Smith et al. 2017).

In addition, Kellar et al. (2017) reported that less than one in five (less than 20 percent) pregnancies detected in Barataria Bay resulted in a viable calf. This rate was much lower than the expected rate (60 percent) based on previous work in non-oiled reference areas (Kellar et al. 2017). Similarly, Lane et al. (2015) monitored 10 pregnant dolphins in Barataria Bay and determined that only 20 percent produced viable calves, as compared with a reported pregnancy success rate of 83 percent in a reference population. 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 and found that 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) and 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 2016c, Smith et al. 2017) likely contributed to the high rate of failed pregnancies and to dolphin deaths. Other adverse health impacts included anemia, excessive tooth loss, and liver injury (Schwacke et al. 2014, DWH 2016c).

Related analyses reported an estimated annual survival rate of bottlenose dolphins in Barataria Bay (period 2011 to 2013) ranging between 80 and 85 percent, which is lower than the survival rate in reference sites (greater than or equal to 95 percent) (McDonald et al. 2017). Given the indication of site fidelity of bottlenose dolphins in Barataria Bay from the study by Wells et al. (2017), and thus, the low potential that a dolphin would permanently leave the area, it was estimated that the excess mortality from the DWH oil spill for dolphins in the area was 8 to 9 percent annually above the expected mortality based on other BSE stocks (Lane et al. 2015). Most oil-related adverse health impacts continue to be seen in the cohort alive at the time of the spill (pre-spill animals; Schwacke et al. 2022). Modeling efforts based on dolphin studies in the Barataria Basin from 2010 to 2016 projected that the BBES Stock would experience a 32 to 72 percent maximum reduction in population size following the DWH spill, and that it will take multiple decades to recover to a pre-spill population trajectory (Schwacke et al. 2017).

3.11.3.3 Unusual Mortality Events

The MMPA defines an 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). The BBES Stock and others may have been impacted by three Gulf of Mexico bottlenose dolphin UMEs. The first reported UME which may have impacted this BBES Stock occurred from January through May 1990 and included 344 bottlenose dolphin strandings in the Northern Gulf of Mexico (Litz et al. 2014), with some strandings reported along the coastlines of the Barataria Bay area during this timeframe. 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 mortalities (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 (extending from the Texas/Louisiana border to Franklin County, Florida) beginning March 1, 2010 and ending July 31, 2014 (Litz et al. 2014). This UME included cetaceans that stranded prior to, during, and after the DWH oil spill (see Section 3.11.3.2 regarding impacts of the spill). The pre-spill cluster was concentrated in Lake Pontchartrain and the western Mississippi Sound, and was most likely caused by a combination of prolonged exposure to low salinity and cold temperature (Mullin et al. 2015; discussed further in Chapter 4, Section 4.11.5 in Marine Mammals). The excess strandings outside of the Lake Pontchartrain/western Mississippi Sound cluster (including all the stranded BBES dolphins) occurred after DWH oil made landfall and were focused in areas exposed to DWH oil (Litz et al. 2014, Mullin et al. 2015, Venn-Watson et al. 2015a). Therefore, any concerns with the impacts of this UME with regard to the current proposed Project are likely limited to those discussed in the previous section on the impacts (chronic health effects, reduction in fecundity, reduction in survival) from the DWH oil spill.

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 (for example, Schwacke et al. 2014, Venn-Watson et al. 2015a, Colegrove et al. 2016, DWH NRDAT 2016). During 2011 through 2014, nearly all stranded dolphins from the Barataria Bay stock were considered to be part of the NGUME (Litz et al. 2014, Venn-Watson et al. 2015b). Most cetaceans stranded during the NGUME were primarily common bottlenose dolphins (87 percent), with over half of the stranded animals clustered along the Louisiana shoreline and in Barataria Bay (Carmichael et al. 2012, Litz et al. 2014, Venn-Watson et al. 2015b). Rosel et al. (2017) conducted genetic analysis of 131 dead stranded bottlenose dolphins that were recovered in the vicinity of Barataria Bay (primarily along ocean-facing beaches of barrier islands, but also those recovered within the Bay); 93 to 94 percent of the stranded individuals were determined to come from the BBES Stock, while the remainder (6 to 7 percent) came from the Western Coastal Stock. In contrast, a relatively small number of animals (13) among all stranded cetaceans during the NGUME were Atlantic spotted dolphins. However, documented strandings of this species are rare because mortalities likely occur in offshore environments away from shorelines, where the detection of mortality is low (Williams et al. 2011).

NOAA declared the most recent Northern Gulf of Mexico UME in May 2019 based on increased strandings from February through November 2019 (peaking in May), and covering the coastal waters from the Florida panhandle to Louisiana (a region that was also impacted by the NGUME) (NOAA 2020b). Most of the increased strandings were found east of the MRD, along the Louisiana, Mississippi, and Alabama coastlines (NOAA 2020b). This event coincided with an extremely wet year for the Mississippi River watershed and to a lesser extent other watersheds along the Northern Gulf of Mexico, and extreme flooding occurred over the time period of this UME. The unprecedented amount of freshwater discharge resulted in a drop in salinity levels that was most pronounced and prolonged in the western Mississippi Sound due to the massive freshwater discharge from the Mississippi River, including its various spillways and diversions (for example, Caernarvon Diversion, Bohemia Spillway, Bonnet Carré Spillway). Fresh water from these, and other, sources moved into the areas east of Lake Pontchartrain, reducing the salinity in Lake Borgne, the western Mississippi Sound, and nearby coastal waters. After evaluating the available data, the UME Working Group determined, “These findings strongly support the cause of this UME to be low-salinity waters, due to unusually high precipitation in 2019, that resulted in above average levels of freshwater discharge into associated watersheds that serve as habitat for bottlenose dolphins.”

3.11.4 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 impacts of these threats vary spatially and temporally, making assessments of their impacts challenging. Bottlenose dolphins, including individuals of the BBES 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 (including chemical spills), marine debris, habitat loss and degradation, vessel strikes, intentional harm/injury (that is, gunshots), extreme weather events (floods and hurricanes), and underwater noise from increased boat traffic and industrial development (Soldevilla et al. 2016, Vollmer and Rosel 2013, Phillips and Rosel 2014, Waring et al. 2016). Mean human-caused mortality and serious injury for the BBES Stock between 2011 and 2015 was 160 animals per year, most of which was due to fishery research, at-sea entanglements, gunshot wounds, and the DWH oil spill (Hayes et al. 2019).

Marine mammals rely on their hearing ability to communicate, maintain group structure, socialize, carry out daily or migratory movements, and detect predators and prey. Existing anthropogenic noise sources in the Project area are discussed in Section 3.8, Noise. Not all marine mammal species have equal hearing capabilities (for example, Richardson et al. 1995, Wartzok and Ketten 1999, Southall et al. 2007, Au and Hastings, 2008). To better reflect marine mammal hearing capabilities, Southall et al. (2007) recommended that marine mammals be divided into three cetacean and two pinniped hearing groups. NMFS (2016) subsequently modified those hearing groups and present generalized hearing ranges (see Table 3.11-4). Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall et al. (2007) retained. The marine mammal hearing group likely to occur in the Project area is mid-frequency cetaceans, which include dolphins. Section 3.8.3.2, Existing Conditions in Noise describes ambient underwater sound sources in the Project area and their frequency ranges.

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 2007, Mullin et al. 2015) and extreme flood events. With regard to pollution, other than the DWH oil spill, numerous (about 1,500) smaller oil and chemical spills are reported to Louisiana agencies each year, representing an average annual volume of about 330,000 gallons of oil (LOSCO 2020). In addition, persistent organic pollutants (POPs) have been measured in blubber and blood samples of BBES dolphins (Balmer et al. 2015, 2018b), although most of these contaminant concentrations are generally in the lower range compared to many other southeastern U.S. field sites.

Table 3.11-4 Marine Mammal Hearing Groups	
Hearing Group	**Generalized Hearing Range[a]**
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz

kHz = kilohertz

[a] Represents the generalized hearing range for the entire group as a composite (that is, all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on approximately 65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007) and PW pinniped (approximation).

The Barataria Basin is also suffering from significant wetland loss due to a combination of subsidence, sea-level rise, storms, winds and tides, and human activities, including levee construction, loss of sediment input, and channelization (CPRA 2017a; see Section 3.6.2.2 Causes of Wetland Loss). While the impacts on BBES dolphins are unknown, many prey species rely upon marine and/or freshwater marsh habitat. Restoration projects to address wetland loss (such as the proposed Project) may provide benefits to resources (including dolphins) in the Barataria Basin; however, Project activities and outcomes could simultaneously result in adverse changes to aspects of the BBES dolphin habitat/environment.

3.12 THREATENED AND ENDANGERED SPECIES

3.12.1 Federally Listed Threatened and Endangered Species

The purposes of the ESA are to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve [these] purposes" (16 USC 1531). 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 lead agencies for implementing the ESA are the NMFS and the USFWS; NMFS is responsible for (nonbird) marine species and anadromous fish while the USFWS is responsible for terrestrial flora and fauna, including freshwater 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 ESA requires the designation of critical habitat (habitat areas essential to the conservation of the species) unless designation would not be prudent or the critical habitat is not determinable.

Review of the federal databases and correspondence with the USFWS and NMFS indicate that there are 17 federally listed threatened and endangered species that are known to occur, or have the potential to occur, in the Project area, which includes (sometimes small) portions of Ascension, Assumption, Jefferson, Lafourche, Plaquemines, Orleans, St. Bernard, St. Charles, St. James, and St. John the Baptist Parishes (see Table 3.12-1). Species that were identified as species of concern by the USFWS or NMFS, as well as those that are state-listed as threatened or endangered are discussed in Section 3.12.2. Protected species groups, such as birds protected under the MBTA and marine mammals protected under the MMPA (that are not also covered under the ESA) are discussed in Section 3.9 Terrestrial Wildlife and Habitat and Section 3.11 Marine Mammals, respectively.

Five federally listed species occur offshore and are not expected to occur in the Project area based on known habitat usage. These include four whales (the fin whale [*Balaenoptera physalus*], sei whale [*Balaenoptera borealis*)], sperm whale [*Physeter macrocephalu]*), and Gulf of Mexico Bryde’s whale [*Balaenoptera edeni*]), and the oceanic whitetip shark (*Carcharhinus longimanus*). These species are not anticipated to occur within, or immediately adjacent to, the Project area based on their typical depths of occurrence and they are not discussed further. Similarly, based on the known distribution of the Gulf sturgeon and its critical habitat (see Figure 3.12-1), it is not anticipated to occur in the Barataria Basin and is not discussed further.

The 11 federally listed species with the potential to occur in the Project area are discussed below; however, further discussion and background on each species is provided in the Project Biological Assessment, which is included as Appendix O[17].

[17] The giant manta ray (*Manta birostris*) was identified with a “no effect” determination in the Biological Assessment issued with the Draft EIS; however, the species was further evaluated in Section 7 consultation with the NMFS. Discussion of the giant manta ray has been added to the Final EIS as a result. The NMFS Biological Opinion for the Project, included as Appendix O4 to the Final EIS, discusses Project impacts on the giant manta ray.

Table 3.12-1
Special Status 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					
Giant manta ray	*Manta birostris*	T	--	Tropical, subtropical, and temperate waters worldwide. Commonly found in oceanic waters, and in productive coastal areas.	Louisiana offshore waters
West Indian manatee	*Trichechus manatus*	T (CH)	E	Inland freshwater; coastal estuarine: tidal rivers and streams, springs, salt marshes, lagoons, canals	Ascension, Jefferson, Lafourche, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist
Marine Reptiles					
Green sea turtle	*Chelonia mydas*	T (CH)	--	Coastal beaches, marine areas	Jefferson, Lafourche, Plaquemines, St. Bernard
Hawksbill sea turtle	*Eretmochelys imbicata*	E (CH)	--	Coastal beaches, marine areas	Jefferson, Lafourche, Plaquemines, St. Bernard
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	--	Coastal beaches, marine areas	Jefferson, Lafourche, Plaquemines, St. Bernard
Leatherback sea turtle	*Dermochelys coriacea*	E (CH)	--	Coastal beaches, marine areas	Jefferson, Lafourche, Plaquemines, St. Bernard
Loggerhead sea turtle	*Caretta*	T (CH)	--	Coastal beaches, marine areas	Jefferson, Lafourche, Plaquemines, St. Bernard
RIVERINE SPECIES					
Pallid sturgeon	*Scaphirhynchus albus*	E	E	Inland freshwater: rivers with moderate to swift currents and turbid waters	Ascension, Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist
TERRESTRIAL SPECIES					
Piping plover	*Charadrius melodus*	T (CH)	T/E	Coastal beaches	Jefferson, Lafourche, Plaquemines, St. Bernard
Red knot	*Calidris canutus rufa*	T (PCH)	--	Coastal beaches	Jefferson, Lafourche, Plaquemines, St. Bernard
Eastern black rail	*Laterallus jamaicensis*	T	--	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

Sources: USFWS 2017c, USFWS 2017d, NMFS 2020a, NMFS 2022a

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

[a] Parish of potential occurrence for federally listed species indicates the parish in which a species is listed in the Information, Planning, and Consultation (IPaC) system and/or USFWS-developed parish lists. A parish

Table 3.12-1 Special Status Species Potentially Occurring in the Project Area					
Common Name	Scientific Name	Federal Status	State Status	Habitat	Parish of Potential Occurrence[a]
listing does not necessarily indicate that the species would or could occur within the footprint of proposed MBSD Project structures in that parish as the Project area does not encompass the entirety of each parish. Parishes in the basin include: Ascension, Assumption, Lafourche, Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, and St. John the Baptist. The giant manta ray is fully under the purview of NMFS and is not included in USFWS species lists.					

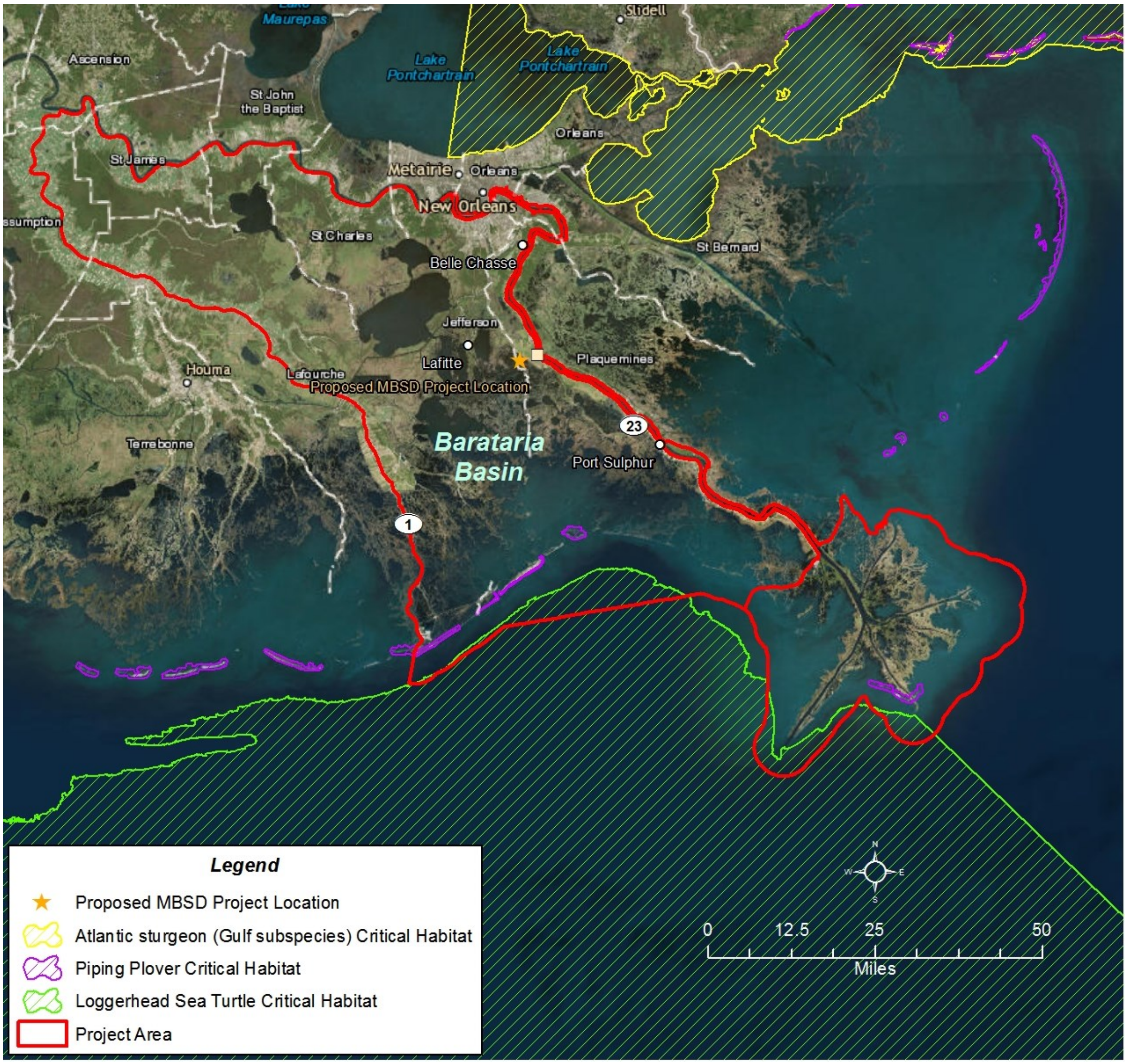


Figure 3.12-1. Critical Habitat for Federally Listed Species in the Project Area. Proposed critical habitat for the red knot (not depicted) occurs along the barrier islands of the Barataria Basin.

3.12.1.1 Marine/Estuarine Species

3.12.1.1.1 Giant Manta Ray

The NMFS published a final rule to list the giant manta ray, a large migratory ray, as threatened in January 2018 (83 FR 2916). The main threat to the species is commercial fisheries, in which they are both targeted and caught as bycatch. Although the global population of manta rays is unknown, regional populations range from about 100 to 1,500 individuals (NMFS 2022a).

The giant manta ray is often solitary, but will aggregate at cleaning sites, to mate, and during feeding (which is predominantly on plankton). Habitat is variable as the species is found in tropical, subtropical, and temperate waters worldwide, in oceanic waters and in productive coastal areas, and in depths of less than 33 feet down to more than 3,280 feet. They may live up to 40 years but typically give birth to one pup every 2 to 3 years (NMFS 2022a). No critical habitat has been designated for the species (84 FR 66652), although the Flower Garden Banks National Marine Sanctuary (more than 250 miles west-southwest of the Project area) is considered to be a nursery habitat (Weinburg 2018). Within the Project area, giant manta rays are also expected to occur around the barrier islands and river outlets, and possibly a short ways up into the Barataria Basin, although they are not expected to occur up in the shallow marsh habitats of the mid-Basin (NMFS 2021).

3.12.1.1.2 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 2017e). 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 2008a). 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 2019a). Manatees are tolerant of brackish and marine environments only if they have access to fresh water regularly (Fertl et al. 2005); however, sightings have occurred throughout the Barataria Basin over time (Slone et al. 2017). Temperature is the dominant factor determining their range, and they respond to cold weather (less than 68°F [19°C]) by moving to warmer waters, which may be associated with industrial areas such as power plants (USFWS 2008a). Manatees' primary feeding habitat is in seagrass beds, which do not occur in the Project area, but also feed on mangroves and green algae, and also water hyacinth when in the vicinity of coastal rivers (USFWS 2008a, and references therein).

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 warmwater refuges) to 6,350 manatees (based on models) (Laist et al. 2013, Martin et al. 2015). Between 1990 and 2020, LDWF documented 269 reported sightings of one or more manatees in Louisiana waters, only 14 of which were reported in the Barataria Basin; however, because manatee sighting records depend heavily on citizen reporting and limited agency surveys, LDWF notes that the actual number of manatees present is likely higher than the number of reported sightings (LDWF 2020b). 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).

3.12.1.1.3 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 and lay eggs. After 2-3 months 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 in the Project area. Although sea turtle nesting is rare in the Project area for any species (limited to two loggerhead sea turtles [*Caretta*] nesting on Grand Isle in 2015), all but the hawksbill sea turtle (*Eretmochelys imbicata*) have been identified as using areas in and around the Barataria Bay (Fuller et al. 1987). Sea turtles are most likely restricted to areas near, or outside of, the barrier islands, with the exception of the Kemp's ridley sea turtle (*Lepidochelys kempii*), which may occur further inshore in Barataria Bay (Coleman et al. 2017, Pulver et al. 2012, Scott-Denton et al. 2014). Green and Kemp's ridley sea turtles are considered more likely to occur in the inshore waters of the Project area (inside of the barrier islands) whereas the loggerhead sea turtle is likely present only in low abundance, and the hawksbill and leatherback sea turtles (*Dermochelys coriacea*) are considered unlikely to occur.

Threats to sea turtles include interactions with fishing gear, military operations, and dredging operations; habitat alterations (including channel construction); vessel operations; marine debris and pollution; poaching; global climate change; cold-stunning; and predation (NMFS 2016).

Because of their global distribution, some species of sea turtles are assigned Distinct Population Segments (DPS) for conservation and management purposes. The DPS is the smallest division of a taxonomic species protected under the ESA. The green sea turtle (*Chelonia mydas*) has eight DPSs, one of which is the North Atlantic

DPS, encompassing the Gulf of Mexico, although sea turtles from the South Atlantic DPS will also transit the Gulf of Mexico. The loggerhead sea turtle also has eight DPSs, one of which is the Northwest Atlantic DPS, which includes the Gulf of Mexico.

3.12.1.1.3.1 Green Sea Turtle

The North Atlantic DPS of green sea turtles, which is listed as threatened, is distributed throughout inshore and nearshore waters from Texas to Massachusetts, although most nesting occurs on Florida's southeast coast (NOAA 2020c). With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. After emergence, hatchlings swim to offshore areas where they remain pelagic for several years. Critical habitat is designated for the North Atlantic DPS within coastal waters of Culebra Island, Puerto Rico (63 FR 4699), outside of the Project area.

The South Atlantic DPS is less than half the size of the North Atlantic DPS, with their total nester abundance estimated at over 63,000 adult females from 51 nesting sites. The South Atlantic DPS boundary adjoins the North Atlantic DPS boundary near the north coast of South America; however, green sea turtles from the South Atlantic DPS can and do travel into the Northern Gulf of Mexico (Foley et al. 2007) and could occasionally be present within the Gulf of Mexico portion of the Project area. Long-term monitoring data for this DPS is relatively scarce, but existing data suggest an overall trend of increasing abundance at primary nesting sites (Seminoff et al. 2015).

3.12.1.1.3.2 Hawksbill Sea Turtle

The endangered 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 2018a). 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. Critical habitat is designated in the coastal waters of Mona Island, Puerto Rico, outside of the Project area (63 FR 46693).

3.12.1.1.3.3 Kemp's Ridley Sea Turtle

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 Kemp's ridley sea turtle occurs in the marine portion of coastal Louisiana that includes Jefferson, Lafourche, and Plaquemines Parishes in the Barataria Basin (NMFS 2017c). The turtle feeds on crab, fish, jellyfish, clams, and small invertebrates along the Gulf Coast from southern Florida to the Yucatan. No critical habitat is designated for Kemp's ridley sea turtle.

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 United States is concentrated primarily in south Texas where the number of recorded nests ranged from 6 in 1996 to a record high of 353 in 2017 (NPS 2020, USFWS 2020). Kemp's ridleys are not known to nest in Louisiana; however, juveniles have been identified in inshore bays and offshore waters (Fuller et al. 1987).

Northern Gulf of Mexico waters including in and around the Project area are important foraging and migratory pathway areas for juvenile and post-nesting Kemp's ridley sea turtles, and are identified as "core use" areas for the species (Coleman et al. 2017). Use of satellite telemetry showing foraging sites selected by different turtles over a 13-year tracking period indicates that these areas represent critical foraging habitat, particularly in waters off Louisiana. Furthermore, the wide distribution of foraging sites indicates that a foraging corridor exists for Kemp's ridleys in the Gulf (Shaver et al. 2013). Through analysis of the largest and longest-term satellite-tracking data set for the species, Shaver et al. (2013) demonstrated the importance of nearshore Gulf of Mexico waters as foraging habitat for post-nesting Kemp's ridleys; they suggest that critical foraging habitat exists for the species in the Northern Gulf of Mexico, particularly off Louisiana, to which turtles show fidelity over time. Furthermore, concentration of core-use foraging areas for turtles tracked from both Rancho Nuevo and Padre Island National Seashore supports our assertion and underscores the importance of this habitat for these imperiled marine turtles.

3.12.1.1.3.4 Leatherback Sea Turtle

The endangered leatherback sea turtle has the widest global distribution of all reptile species and circumnavigates the Atlantic Ocean (NOAA 2020d). 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 loggerheads are reported throughout the U.S. Atlantic, Gulf of Mexico, and Caribbean Sea. Critical habitat is designated for the leatherback sea turtle in the coastal waters of the U.S. Virgin Islands (44 FR 17710), outside the Project area and the Northern Gulf of Mexico.

3.12.1.1.3.5 Loggerhead Sea Turtle

The Northwest Atlantic Ocean DPS of loggerhead sea turtles is listed as threatened. 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. This DPS nests along the U.S. East and Gulf Coasts, but most nesting occurs from southern Virginia to Alabama (NOAA 2017c). 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 7 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 (see Figure 3.12-1); critical habitat related to *Sargassum* is present adjacent to the Project area.

3.12.1.2 Riverine Species

3.12.1.2.1 Pallid Sturgeon

The pallid sturgeon, listed as endangered, has a primary range that includes the Mississippi River downstream of the junction with the Missouri River, and is documented as occurring within parishes that make up the Barataria Basin (USACE 2017b). The pallid sturgeon has historically occupied rivers and streams with moderate to swift currents, turbid waters, and depths between 3 and 25 feet (USFWS 2017d). In the Mississippi River, the pallid sturgeon migrates originally from sandy substrates to gravel in May, possibly for spawning (Koch et al. 2012). It appears to use submerged sand dunes and gravel dunes/flats as resting and/or feeding habitat (USFWS 2014b, Bramblett and White 2001, Hurley et al. 2004, Garvey et al. 2009, Koch et al. 2012). No critical habitat has been designated for the pallid sturgeon.

As few as 6,000 to as many as 21,000 pallid sturgeon may still exist throughout its entire range (Krentz et al. 2004). A total of 279 different pallid sturgeons were collected from the Mississippi River (below its confluence with the Missouri River) between 1990 and 2004 (USFWS 2014b). The Lower Mississippi River population is poorly documented and likely low in abundance (Duffy et al. 1996). To date, more than 1,100 pallid sturgeon have been captured in the Coastal Plain Management Unit which includes the Lower Mississippi River extending from the confluence of the Ohio River in Illinois, to the Gulf of Mexico, Louisiana (Kilgore et al. 2007). Although the southern extent of *Scaphirhynchus* occurrence was previously thought to be RM 85, the USACE collected two YOY *Scaphirhynchus* sturgeon with a trawl in the Lower Mississippi River in November 2016 between RM 33 and 85 (USACE 2017b).

The current distribution of pallid sturgeon is reduced and fragmented relative to its historical range. The Coastal Plains Management Unit of pallid sturgeon contains spawning populations in the Mississippi River from the Missouri River confluence downstream to the Gulf of Mexico (USFWS 2014b). Pallid sturgeon are documented as occurring in the Lower Mississippi River adjacent to the Barataria Basin (USACE 2017b). No spawning sites have been documented, but spawning habitat use by this species is poorly understood and sampling efforts in this specific area to date are too limited to draw conclusions. The low numbers observed south of RM 85 may be due to low abundance, but they could also reflect the limited sampling effort in this area to date (J. Kilgore, USACE Research Fisheries Biologist pers. comm. 2018). Critical habitat has not been designated for the pallid sturgeon.

3.12.1.3 Terrestrial Species

3.12.1.3.1 Piping Plover

The piping plover (*Charadrius melodus*) is a migratory shorebird that breeds in the northern United States and Canada and winters in the southern United States 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, 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 non-breeding wintering areas, including coastal beaches and barrier islands of the Northern Gulf of Mexico (USFWS 2017g). Critical habitat in the Project area occurs at West Belle Pass (Lafourche Parish), Elmer's Island, Grand Isle, and East Grand Terre (Jefferson Parish), and at South Pass (Plaquemines Parish) (see Figure 3.12-1). With regards to the Project area, piping plovers would be expected to occur predominantly in the beach and barrier island habitat along the Gulf of Mexico (its critical habitat). Although not preferred habitat, potential exists for piping plovers to occur infrequently during migration within mudflats and estuarine habitat in the Barataria Basin. Piping plovers begin arriving on their wintering grounds between late July and September, and sightings are rare by late May (Haig 1992).

3.12.1.3.2 Red Knot

The rufa red knot (*Calidris canutus rufa*) is a migratory shorebird species that migrates from breeding grounds in the Canadian Arctic to wintering grounds along the Gulf Coast, southeast United States, 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 2014c). No critical habitat has been designated for this species; however, in July 2021 critical habitat was proposed along the barrier islands of the Barataria Basin, within the Project area (86 FR 37645, July 15, 2021).

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. 2013b); within the Project area, this habitat may be present along beaches and barrier island habitat along the Gulf of Mexico (NatureServe 2017). The species is considered rare to uncommon along the Louisiana coast and barrier islands, although it has been considered a regular visitor to Grande Isle (Fontenot and DeMay 2014).

3.12.1.3.3 Eastern Black Rail

The eastern black rail (*Laterallus jamaicensis*) is the smallest of the North American rail species. Threats to the species include loss and degradation of habitat, and invasion by nonnative plant species (NatureServe 2017). The black rail was federally listed as threatened on October 8, 2020 (85 FR 63764) is protected under the MBTA, and is on the LNHP list of rare species in Louisiana (USFWS 1994, USFWS 2013, LDWF 2017j).

The species is exceedingly elusive, making accurate assessment of its range and habits difficult. 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). The species' range extends from North America to South America, but populations are relatively small and highly localized. Partially migratory, the eastern subspecies winters in the southern part of its breeding range. Along the Gulf Coast, however, eastern black rails can be found year-round, with a potential year-round distribution in the Lower Mississippi River and the Mid-Barataria area (USFWS 2018). In Louisiana, eastern black rails are known to winter in the marshes of Cameron and Vermilion Parishes, outside of the Project area. However, given their elusive nature, the species is considered to be potentially present in all high marshes of coastal Louisiana. Between 2010 and 2017 only a small number of observations were recorded in Louisiana (USFWS 2018).

3.12.2 State-listed and Special Status Species

Aside from species that are also federally listed, as indicated in Table 3.12-1 and discussed in Section 3.12.1, three state-listed threatened or endangered species occur within the impacted parishes (LDWF 2017j). Although LDWF did not identify any species of particular concern in its scoping comments on the proposed Project, these species (peregrine falcon, bald eagle, and brown pelican [*Pelecanus occidentalis*]) occur, or have the potential to occur, within the impacted parishes and are therefore included in Table 3.12-2. Bald eagle is discussed further below, while peregrine falcon and brown pelican are considered in Section 3.9 Terrestrial Habitat and Wildlife.

In addition to the federally listed or proposed species under its purview, the USFWS also identified two species of concern[18] including the bald eagle (federally delisted) and the saltmarsh topminnow (*Fundulus jenkinsi*; under review for federal listing); both of these species is discussed below. While state-listed species and federally identified species of concern were considered during Project planning and 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.

[18] The USFWS also identified the Louisiana eyed silkmoth, which was under review for federal listing. The petition to list this species was withdrawn on June 8, 2018. As it is no longer under federal review, it is not discussed further.

Table 3.12-2
State-listed Species and Species of Concern Potentially Occurring in the Mid-Barataria Sediment Diversion

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.	Ascension, Assumption, Jefferson, Lafourche, Orleans, Plaquemines, St. Charles, St. James, St. John the Baptist
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. Colonial waterbirds are further discussed in Section 3.9 Terrestrial Wildlife and Habitat.	Jefferson, Lafourche, Plaquemines
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. Migratory birds are further discussed in Section 3.9 Terrestrial Wildlife and Habitat.	Lafourche, Plaquemines

UR = under review; D = delisted; E = endangered; T = threatened

[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 footprint of Project facilities in that parish. Where the parish is “not available,” the LNHP database lists the species, but not the parish of occurrence.

3.12.2.1 Saltmarsh Topminnow

In its scoping comments on the proposed Project, the USFWS identified the saltmarsh topminnow as an at-risk species that should be considered during the planning and activities for the proposed Project and recommended consultation if the species becomes listed in the future. The saltmarsh topminnow 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 Barataria Basin (Peterson et al. 2016).

3.12.2.2 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is state-listed as endangered (LDWF 2017j). 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 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. Nesting habitat requires large trees (most commonly used are cypress) in or near waterbodies with sufficient prey. Bald eagles are generally 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 Barataria Basin and nest in the Project area.

3.13 SOCIOECONOMICS

This section describes the affected environment for seven categories of socioeconomic resources:

- economy, employment, business, and industrial activities;
- population;
- housing and property values;
- tax revenue;
- public services and utilities;
- community cohesion; and
- protection of children.

Socioeconomic data in this section are drawn from the U.S. Census Bureau, Bureau of Labor Statistics, and other state and local data sources. Where possible, the data are specific to census block groups that intersect the Project area, (see Figure 3.13-1 for census block group boundaries). However, some data, such as median household income, are only available at the parish level, and noted as such throughout this section.

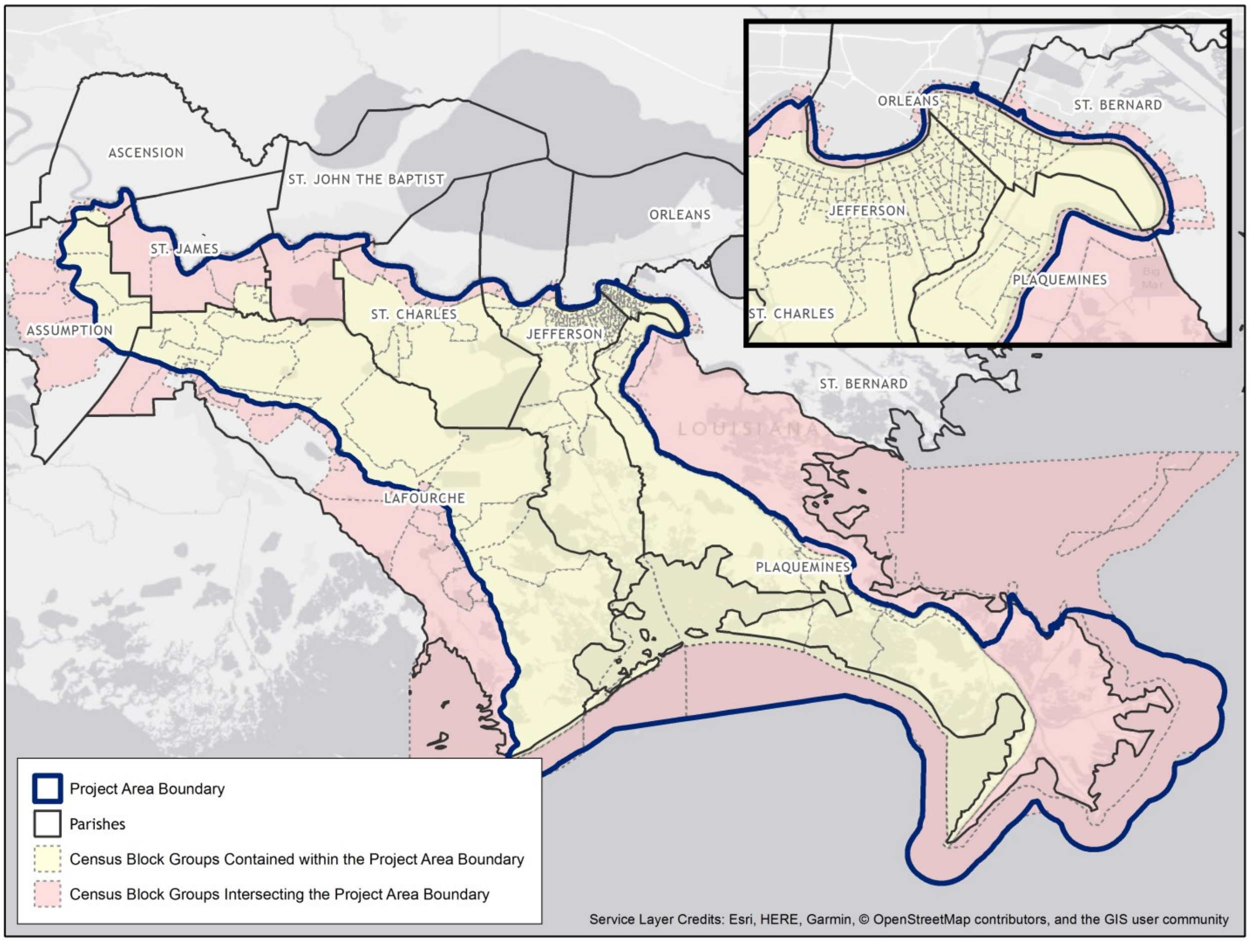


Figure 3.13-1. Map of Census Block Group Boundaries within or Intersecting the Project Area.

3.13.1 Economy, Employment, Businesses, and Industrial Activity

The following discussion is based on data obtained from the Bureau of Labor Statistics, which are available only at the parish level. Therefore, the actual composition of the labor force and employment characteristics for the population in the Project area may differ.

There are just under 600,000 people in the labor force across the 10 parishes, which had an average unemployment rate of 4.8 percent in 2019, equal to the statewide percentage (Bureau of Labor Statistics 2020). Assumption Parish (6.1 percent), St. James Parish (6.0 percent), St. John the Baptist Parish (5.6 percent), Orleans Parish (4.9 percent) and St. Bernard Parish (4.9 percent) had unemployment rates higher than that of the state.

Table 3.13-1 presents average annual establishment count, employment, and pay by industry based on the Bureau of Labor Statistics' Quarterly Census of Employment and Wages for the parishes intersecting the Project area. Just over 36,000 establishments employ roughly 515,000 employees in the 10 parishes. The largest industry by both number of establishments and employment is "Trade, transportation, and utilities," which accounts for nearly a quarter (23 percent) of establishments and employment in the parishes. Average annual pay in the parishes is about $53,000, which varies considerably across industries, ranging from about $28,000 for the "Leisure and Hospitality" industry to over $115,000 for the "Natural Resources and Mining" industry (Bureau of Labor Statistics 2020). Specific large business and industries located in the Project area are discussed further in Appendix H.

Table 3.13-1
Average Annual Establishment Count, Employment, and Pay by Industry for All Parishes Intersecting the Project Area[a,b] (2019)

Ownership	Industry	Annual Average Establishment Count	Annual Average Employment	Annual Average Pay
Private	Natural resources and mining	324	5,973	$115,434
Private	Construction	2,783	34,016	$60,543
Private	Manufacturing	1,120	36,249	$92,124
Private	Trade, transportation, and utilities	8,329	110,801	$47,207
Private	Information	562	6,554	$59,652
Private	Financial activities	3,665	24,931	$72,497
Private	Professional and business services	7,283	67,991	$59,666
Private	Education and health services	4,004	82,347	$50,347
Private	Leisure and hospitality	4,354	85,525	$27,694
Private	Other services[c]	2,812	14,246	$38,975
Private	Unclassified[d]	70	10	$30,346
Local Government	Total, all industries	165	12,532	$81,397
State Government	Total, all industries	705	22,551	$48,693
Federal Government	Total, all industries	203	11,075	$58,805
Total	Total, all industries	36,377	514,801	$53,251

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2020

[a] The Quarterly Census of Employment and Wages does not include data for unincorporated self-employed individuals. As a result, this data source underestimates annual average employment, particularly in industries such as commercial fishing, which includes many self-employed individuals in the Project area. The U.S. Census Bureau's American Community Survey tracks unincorporated self-employment and indicates that 11 percent of individuals employed in "agriculture, forestry, fishing and hunting, and mining" in Project area parishes are unincorporated self-employed. Section 3.14 Commercial Fisheries provides additional information on commercial fishing, including the number of licensed fishers in Barataria and Mississippi River Basins, and reports that approximately 3,000 commercial fishing licenses are issued to fishermen in the Project area.

[b] Annual average establishment count and employment are aggregated across parishes. Annual Average Pay reflects the arithmetic mean of the annual average pay in each parish in the Project area.

[c] "Other services" corresponds to the North American Industry Classification System (NAICS) 81: Other Services (except Public Administration). Establishments in this grouping include repair and maintenance services, personal and laundry services, and religious, grantmaking, civic, professional, and similar organizations.

[d] "Unclassified" refers to establishments that are not assigned any NAICS code.

3.13.2 Population

As discussed in Section 3.1 Introduction, the Project area is defined as the Barataria and Lower Mississippi River Basins, which include all or portions of the following parishes: Ascension, Assumption, Lafourche, Jefferson, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, and St. John the Baptist. About two-thirds of the population in these parishes reside in Jefferson and Orleans Parishes, reflecting the high population density in and around the City of New Orleans (see Table 3.13-2).

Table 3.13-2
Population of Parishes within or Partially in the Project Area[a]

Parishes Located Within Project Area	Parish Population (average 2014 to 2018)	Population Within Project Area (average 2014 to 2018)	Percent of Total Project Area Population (2014 to 2018)	Population Density in Parish (per square mile of land area) (2014 to 2018)	Population Change in Parish (2000 to 2018)	Projected Parish Population Growth (2015 to 2030)
Ascension	121,176	10,410	2%	418	58%	54%
Assumption	22,714	13,855	3%	67	-2.9%	-10%
Jefferson	435,300	187,076	43%	1,472	-4.4%	2%
Lafourche	98,214	79,215	18%	92	9.2%	1%
Orleans	389,648	67,990	16%	2,300	-20%	1%
Plaquemines	23,373	23,373	5%	30	-13%	21%
St. Bernard	45,694	9,677	2%	121	-32%	3%
St. Charles	52,724	27,573	6%	189	9.7%	8%
St. James	21,357	8,523	2%	88	0.7%	-7%
St. John the Baptist	43,446	2,994	1%	204	0.9%	22%
Parishes Total Population[b]	**1,253,646**	**430,686**	**100%**	**309**	**-6.2%**	**9%**
Louisiana Total Population	**4,663,616**	**N/A**	**N/A**	**108**	**4.4%**	**7%**

Sources:

U.S. Census Bureau 2020. 2014-2018 American Community Survey (ACS) 5-year estimates.

U.S. Census Bureau 2017c. Tigerweb. Used 2010 square mileage by Parish from the U.S. Census (2010a) to calculate population densities.

Blanchard 2007. Used in projected Parish growth statistics.

[a] Populations include entire parish, including both Project area and non-Project area.

[b] The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends.

Most of the 10 parishes only partially overlap with the Project area boundaries; approximately 431,000 people lived in census block groups intersecting the Project area (see Figure 3.13-1), which represents about 35 percent of the combined parishes' population. The majority (74 percent) of the population living in census block groups intersecting the Project area live in Jefferson, Lafourche, and Orleans Parishes. As shown in Figure 3.13-2, this northern portion of the Project area is much more densely populated than the southern portions of the Project area.

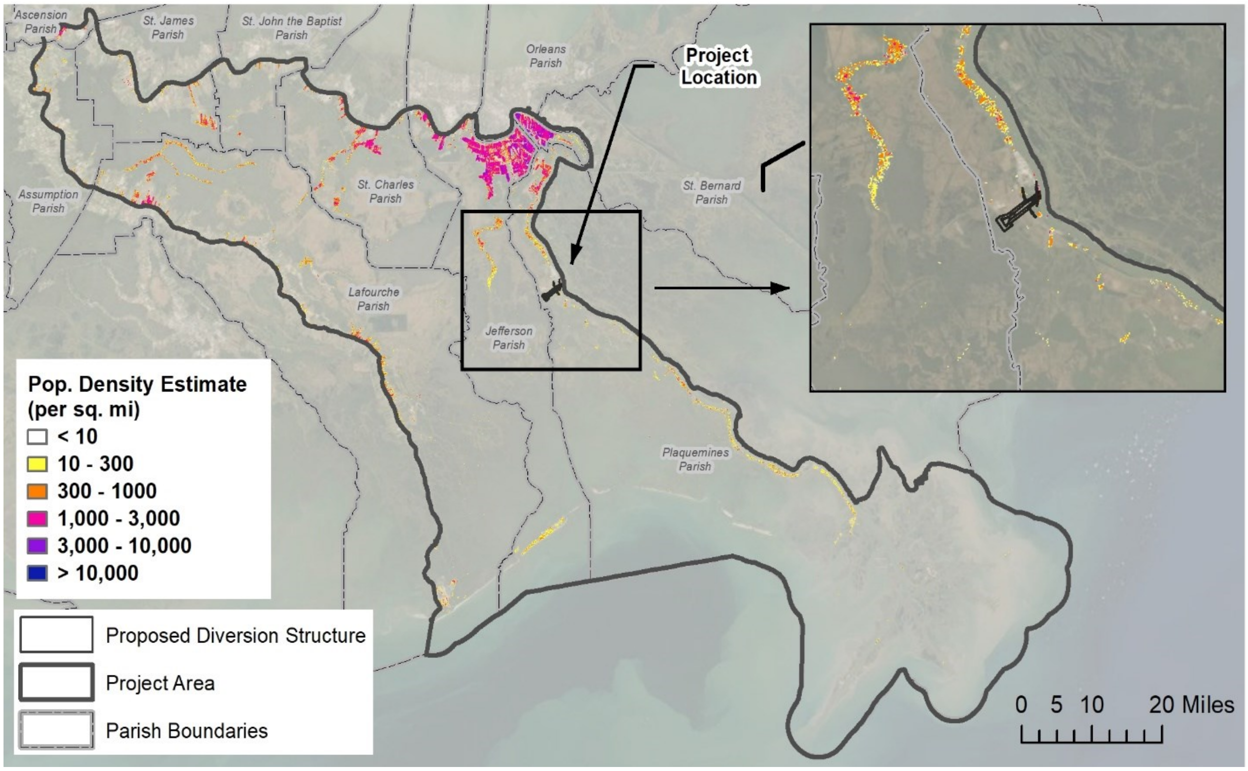


Figure 3.13-2. Population Density within the Project Area.

The overall population in these 10 parishes declined by 6 percent between 2000 and 2018 (U.S. Census Bureau 2020). There has been a general decreasing trend in population in the coastal areas over time, in particular. This decrease was driven by a large (about 30 percent) population decline in Orleans Parish following Hurricane Katrina in 2005, primarily related to job loss and relocation after the storm (Plyer and Ortiz 2011). Between 2000 and 2018, the population of Plaquemines Parish declined by 13 percent (U.S. Census Bureau 2020). The more-inland parish of Ascension showed substantial growth over this period (58 percent).

Louisiana State University (LSU) forecast that the Project area population would grow by 9 percent between 2015 and 2030 (Blanchard 2007). LSU estimated that each of the Project area parishes will experience population increases over this time period, except for Assumption and St. James Parishes, which are projected to experience population declines of 10 and 7 percent, respectively.[19] For additional information on municipality specific populations, and demographics see Appendix H. Additional demographic details on the population of the Project area are presented in Section 3.15 Environmental Justice.

[19] The LSU population projections are based on two primary assumptions: (1) rates of birth and death from 2000 to 2004 will remain constant through 2030, and (2) the observed rate of migration between 2000 to 2005 will remain constant through 2030.

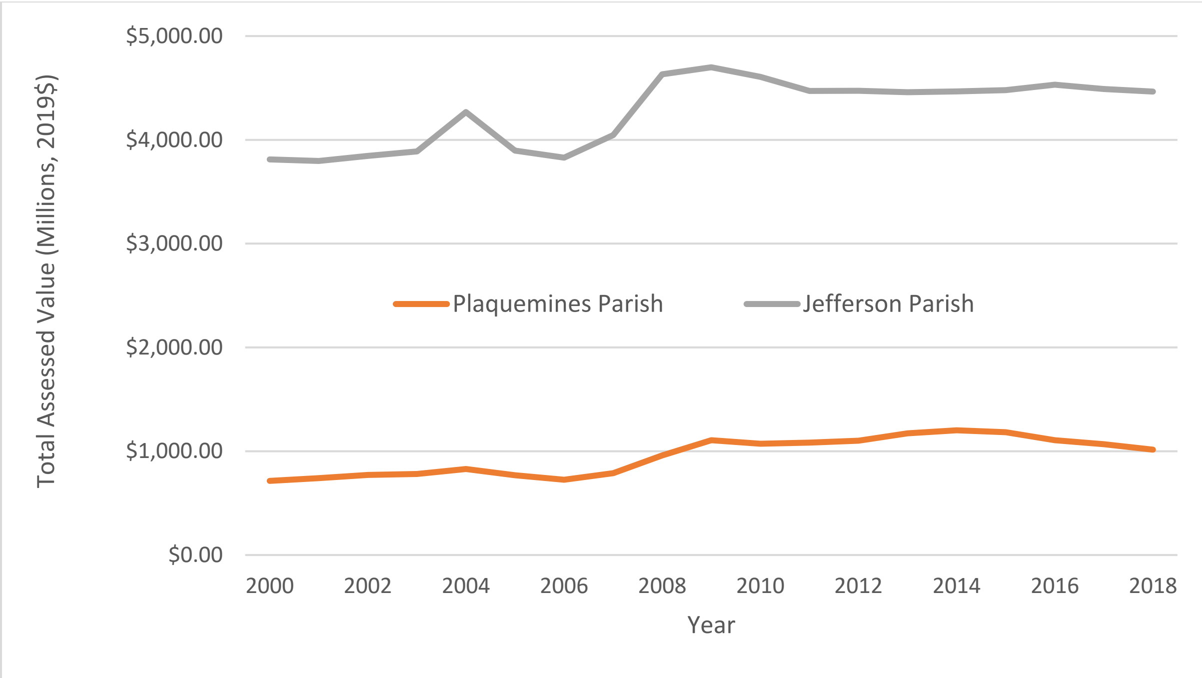
3.13.3 Housing and Property Values

This section presents housing characteristics in the Project area based on U.S. Census data at the census block group-level. However, data on property values are only available at the parish level.

About 180,000 housing units are within the Project area (U.S. Census Bureau 2017a), with about 42 percent of the housing units located in Jefferson Parish (76,491 units). Approximately 14 percent of housing units in the Project area are vacant. The housing units within the Project area account for roughly a quarter of all housing units in the 10 parishes. These vacancy rates vary considerably by parish ranging from a low of 10 percent in Lafourche and St. Charles parishes to a high of 20 percent in Orleans Parish.[20] Sixty-six percent of the occupied housing units are owner-occupied, which is similar to the state occupancy rate (65 percent).

Median property values in the parishes range from a low of $113,100 in Assumption Parish to a high of $219,600 in Orleans (U.S. Census Bureau 2020). Five out of the 10 parishes have median property values greater than the statewide median of $157,800 (U.S. Census Bureau 2020). After growing between 2000 and 2010, assessed property values have stayed relatively flat since 2010 when adjusting for inflation (Louisiana Tax Commission 2019). The assessed value represents only 10 percent of the fair market value for residential properties and undeveloped parcels (Plaquemines Parish Assessor 2022). Figure 3.13-3 shows the total assessed values for all properties in the parishes closest to the Project footprint, Plaquemines and Jefferson Parishes, where values increased by 17 percent and 42 percent, respectively, between 2000 and 2018 (in 2019 dollars). Total assessed value in both parishes have decreased by approximately 4 percent after 2010. In Jefferson Parish, the drop in total assessed value occurred in 2010 and has remained relatively stable through 2018. In Plaquemines Parish most of the decline in total assessed value occurred since 2014 from an average of roughly $1.2 billion in 2014 to $1 billion in 2018.

[20] Approximately 22 percent of vacant housing units within the Project area are for seasonal, recreational, or occasional use (approximately three percent of all housing units).



Source: Louisiana Tax Commission 2019

Figure 3.13-3. Total Assessed Value of Homes in Plaquemines and Jefferson Parishes over Time in 2019 dollars.

Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) provides the majority of residential flood insurance in the United States (CRS 2022). FEMA generates flood insurance rate maps (FIRM) for communities that opt to join the program. Section 3.20.2.1 Floodplains describes the FIRM zones for the Project area. Much of the Project area falls in Zone A or AE (See Figure 3.20-1 for a map of Project area flood zones), meaning they are Special Flood Hazard Areas (SFHA) within the 100-year floodplain (FEMA 2021a). Property owners within SFHAs must purchase flood insurance as a condition of receiving federally backed mortgages (FEMA 2021b).

FEMA recently implemented changes to its insurance risk rating system under the NFIP, which has resulted in premium changes for the majority of policyholders (CRS 2022). These revisions, called Risk Rating 2.0, are the first update to NFIP risk ratings in over four decades (FEMA 2021b). The aim of Risk Rating 2.0 is to create premiums that are more equitably distributed across policyholders as well as to improve the communication of flood risk for individual properties and current or prospective policyholders (FEMA 2021b).

Under Risk Rating 2.0, insurance rates are not defined by the zone the property is in and instead are based on a variety of property specific measures (CRS 2022). These risk ratings are intended to better reflect actual risk and types of risk for an individual property (FEMA 2021b). The zones will still be used to determine whether a property owner must acquire flood insurance (that is, properties located in the SFHA fall under the mandatory purchase requirement). Risk Rating 2.0 premium rates took effect for new NFIP policies on October 1, 2021 and for existing NFIP policyholders on April 1, 2022 (CRS 2022). FEMA is also now recognizing homeowner mitigation actions that could result in premium credits. These include installing flood openings, elevating properties, and elevating machinery and equipment above the lowest floor (FEMA 2021b).

As of 2022, the average NFIP policy premium in Louisiana was $675 per year (in 2019 dollars). Pre-Risk Rating 2.0, premiums for NFIP flood insurance policies vary based on flood zone, ranging from approximately $500 per year in Zone X (outside 100-year flood) to over $3,000 per year in Zone VE (areas closest to the shoreline at base flood elevation [BFE] levels subject to wave action, high-velocity flow, and erosion during the 100-year flood) (FEMA 2022a, FEMA 2021a).[21] As of 2022, the majority (61 percent) of NFIP policies in Louisiana were in Zone X, with another 31 percent in Zone AE (FEMA 2022a). Less than 1 percent of policies are in the highest risk zones. Table 3.13-3 lists the parishes within the Project area with their NFIP policies and average policy premiums.

Table 3.13-3
NFIP Flood Insurance Premiums as of 2022

Parish [a]	NFIP Policies	Average Premium [b]
Ascension	14,270	$657
Assumption	1,440	$510
Jefferson	78,281	$621
Lafourche	10,676	$651
Orleans	79,076	$665
Plaquemines	5,107	$692
St. Bernard	11,135	$565
St. Charles	11,742	$613
St. James	1,227	$500
St. John the Baptist	6,915	$753
Parishes Total	**219,869**	**$642**
State Total	**295,597**	**$675**

Source: FEMA 2022a, FEMA 2022b

[a] These totals are for the entirety of the listed parishes (not just the portions of the parishes found within the Project area).

[b] Premiums include the Federal Policy Fee (FPF). FPF is a flat charge for each new or renewed policy.

FEMA anticipates that approximately 85 percent of policyholders will experience increases in policy premiums under Risk Rating 2.0 (FEMA 2021b). Plaquemines Parish is the only parish in the study area where over 10 percent of existing policies are anticipated to increase by over $20 per month (FEMA 2021b). Table 3.13-4

[21] BFE is the elevation of flood waters and wave effects during the 100-year flood (also known as “base flood”) (FEMA 2021a). Under Risk Rating 2.0, BFE will no longer be a rating criteria for premiums but is a factor for determining compliance with other NFIP regulations.

summarizes FEMA estimates of anticipated premium changes by parish using Risk Rating 2.0.

Table 3.13-4
FEMA Estimates of Increases in Flood Insurance Premiums under Risk Rating 2.0

Parish [a]	Decrease	Increase up to $10/month	Increase $10 to $20/month	Increase over $20/month
Ascension	34%	56%	8%	2%
Assumption	8%	80%	8%	4%
Jefferson	13%	73%	11%	3%
Lafourche	3%	81%	8%	8%
Orleans	18%	76%	4%	2%
Plaquemines	3%	73%	11%	13%
St. Bernard	11%	87%	1%	0%
St. Charles	7%	78%	10%	4%
St. James	7%	90%	2%	1%
St. John the Baptist	12%	68%	14%	5%
Parishes Total	**15%**	**74%**	**8%**	**3%**
State Total	**20%**	**69%**	**7%**	**3%**

Source: FEMA 2021b

[a] These totals are for the entirety of the listed parishes (not just the portions of the parishes found within the Project area).

3.13.4 Tax Revenue

Between fiscal years 2015 and 2019, tax revenues in Louisiana have increased from 7.9 to 9.6 billion dollars (Louisiana Department of Revenue 2020). Sales and income taxes are the largest sources of revenues in the state, each accounting for more than two-thirds of revenues during this period.

Sales taxes in the 10 parishes total about $773 million, property taxes total $1.7 billion, and state income taxes total $900 million (see Table 3.13-5) (Louisiana Department of Revenue 2020).[22] Combined, these taxes reflect an average tax burden of about $3,000 per capita. Local property taxes generate greater revenue in these parishes than state sales and income taxes combined. The majority of sales, property, and state income tax revenues in the parishes are generated in Orleans and Jefferson Parishes. However, on a per capita basis, the average tax burden is highest in St. James, St. Charles, and Plaquemines Parishes.

[22] 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 tax data presented at the parish level represents 60 percent of total sales tax revenues in Louisiana in FYE (fiscal year end) 2019.

Table 3.13-5
Sales, Property, and Income Tax Revenues by Parish

Parish[a]	Gross Sales Tax Due (FYE 19[b])	Sales Tax (Per Capita) (FYE 19)	Local Property Taxes (2018)	Property Taxes (Per Capita) (2018)	LA Adjusted Individual Income Tax (FYE 19)	LA Adjusted Income Tax (Per Capita) (FYE 19)
Ascension	$87,906,249	$705	$142,464,019	$1,143	$113,635,633	$911
Assumption	$3,244,625	$145	$21,088,124	$946	$13,302,464	$597
Jefferson	$310,768,262	$716	$389,189,208	$897	$314,423,813	$724
Lafourche	$34,313,345	$350	$117,540,435	$1,198	$63,795,196	$650
Orleans	$224,141,057	$573	$584,477,481	$1,495	$274,402,480	$702
Plaquemines	$10,755,565	$459	$64,989,262	$2,776	$18,151,150	$775
St. Bernard	$15,409,249	$330	$49,929,688	$1,069	$18,399,852	$394
St. Charles	$35,057,812	$663	$167,306,269	$3,164	$42,828,580	$810
St. James	$28,325,652	$1,346	$64,416,324	$3,062	$15,967,168	$759
St. John the Baptist	$22,741,155	$527	$56,243,438	$1,302	$25,481,172	$590
Parish Total[a]	**$772,662,971**		**$1,657,644,248**		**$900,387,508**	
State Total[c]	**$3,958,134,085**	**$757**			**$3,318,578,955**	**$712**

Source: Louisiana Department of Revenue 2020. Parish Comparisons of Various & Per Capita Tax Collections (pp. 13-14).

[a] These totals are for the entirety of the listed parishes (not just the portions of the parishes found within the Project area).

[b] FYE is fiscal year ending in June.

[c] State total Gross Sales tax includes out-of-state collections and all parishes (pp 50-51, Louisiana Department of Revenue 2020). State total Adjusted Individual Income Tax includes intrastate totals, out-of-state, and foreign (pp. 42-43 Louisiana Department of Revenue 2020).

3.13.5 Public Services and Utilities

Public services include public schools, healthcare facilities, emergency response and law enforcement facilities, post offices, and libraries. Utilities include electric power plants, and water supply and treatment facilities. See Section 3.21 Navigation and 3.22 Land-Based Transportation for discussions of water- and land-based transportation.

Ninety-seven schools located within the Project area serve over 45,000 students, although information on the numbers of students was not available for 14 of these schools. More than half of these schools (51) and students (25,804) are located in the northern portion of Jefferson Parish near New Orleans (National Center for Education Statistics 2017).

There are 109 healthcare facilities located within the Project area, including eight hospitals and three ambulatory surgical centers (Louisiana Department of Health

2016).[23] Almost half of these facilities (51) are located in Jefferson Parish. These facilities are also concentrated near New Orleans.

Three electric utility companies and cooperatives serve the Project area: Entergy Corporation, South Louisiana Electric Cooperative Association, and Dixie Electric Membership Corporation (U.S. Department of Homeland Security 2017a). Additionally, 10 power plants located within the Project area include nine fossil fuel electric power generation plants and one nuclear plant (U.S. Department of Homeland Security 2017b).

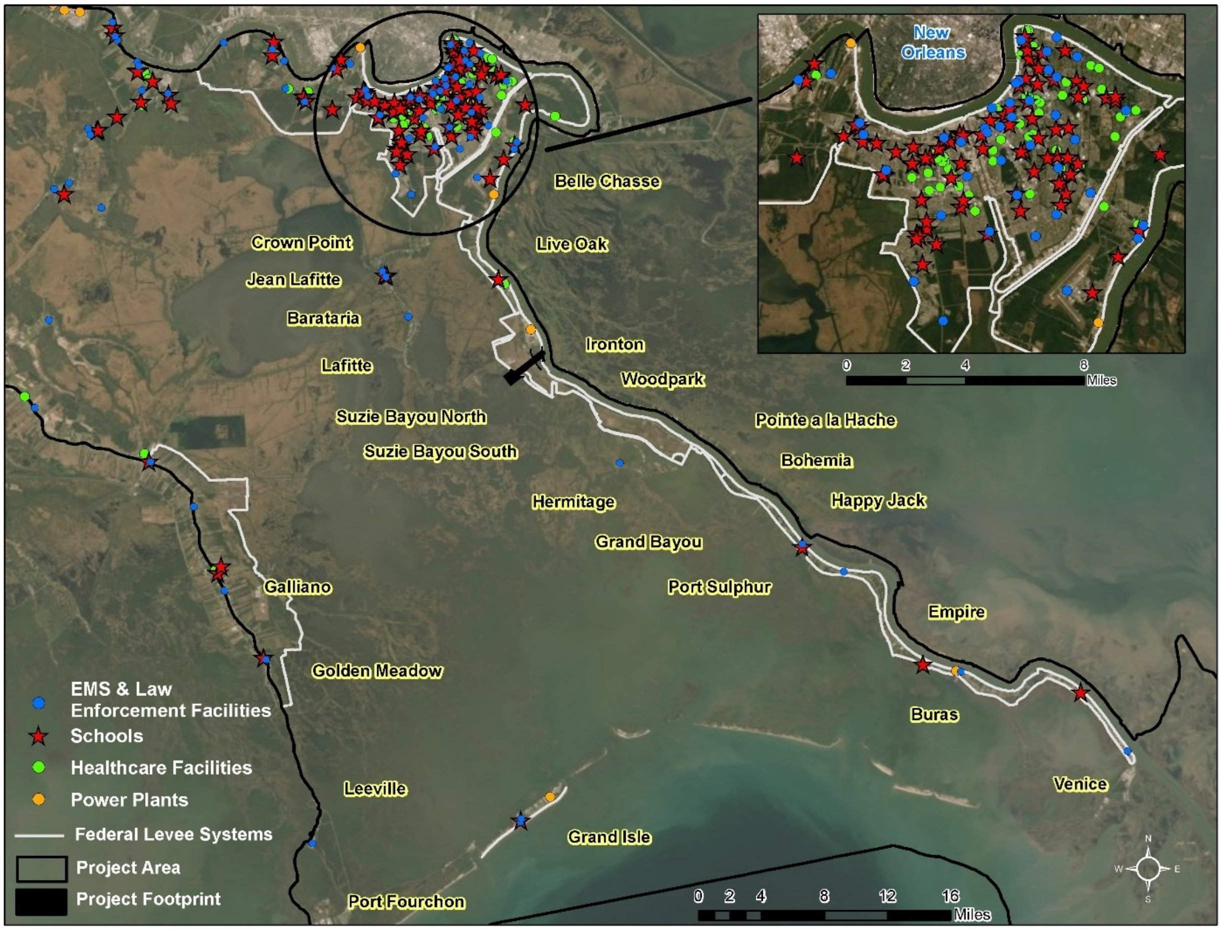
As with schools and hospitals, other public service facilities are generally located near populated areas within the parishes and clustered most heavily in Jefferson Parish, near New Orleans. There are 82 fire/Emergency Medical Service stations, 22 law enforcement facilities (including police stations, sheriff's offices, and state trooper offices), and 45 wastewater treatment plants located throughout the 10 parishes (USGS 2017e).

Figure 3.13-4 shows the locations of public service and utility facilities that fall within the Project area. As the figure shows, most of these facilities are located near the northern boundary of the Project area.

3.13.6 Community Cohesion

Communities are places where people reside and share daily activities. Community cohesion is the ability of people to communicate and interact with each other in ways that lead to a sense of community (Clark and Canter 1997). Measures of community cohesion are based on characteristics that keep members of a community together long enough to establish meaningful interactions, common institutions, and agreed upon behaviors. The level of cohesion reflects the degree to which a community is recognized as and functions as a singular unit. Ethnicity, neighborhood character, the availability of public and private facilities and services, and the shared values and perceptions of local residents all contribute to community cohesion. Appendix H provides additional details about demographics and community history.

[23] The Louisiana Department of Health data source includes the following types of facilities: Adult Day Health Care Providers, Adult Residential Care Providers, Ambulatory Surgical Centers, Adult Brain Injury Facilities, Dialysis Centers, Federally Qualified Health Centers, Home and Community Based Service Providers, Hospices, Hospitals, Intermediate Care Facilities for the Developmentally Disabled, Nursing Homes, Parish Health Units, Pediatric Day Health Care Facilities, Rural Health Clinics, School Based Health Centers.



Source: Map prepared using power plants from the U.S. Department of Homeland Security (2017b), healthcare facilities from Louisiana Department of Health (2016), schools from the National Center for Education Statistics (2017) and EMS and law enforcement facilities from the U.S. Geological Survey (2017) National Structured Dataset.

Figure 3.13-4. Location of Public Service Facilities and Flood Protection Surrounding the Project Footprint.

The Project area includes communities with long histories and established public and social institutions, including locally owned businesses, schools, religious institutions and community associations. As discussed in Section 3.13.5 Public Services and Utilities, numerous public facilities, including schools and medical care facilities, are located in communities throughout the parishes. Not every community supports its own public schools; nor does every community have its own public library (Publiclibraries.com 2018). However, religious institutions exist even in very small communities such as Venice and Buras. As described in Section 3.14 Commercial Fisheries and Section 3.16 Recreation and Tourism, a variety of marinas, boat ramps, and businesses support both commercial and recreational fishing activities in communities throughout the Project area. These sections also present indicators of commercial and recreational fishing engagement at the community level for coastal communities within the Project area; communities with greater reliance on fishing activity may be more vulnerable to disruptions in those industries.

Based on an analysis of coastal community well-being prepared by NOAA, in 2012, much of the Project area scored low for several key indicators analyzed, as shown in Table 3.13-6. In particular, four of the 10 parishes in the Project area had a well-being score of low for indicators including access to social services, safety, and social connectedness (Buck et al. 2015). The eight indicators assessed are:

- Access to social services: accessibility of social and health support services to achieve an intermediate level of well-being;
- Basic needs: availability, accessibility, and consumption of necessities to sustain human life such as housing, water, and food;
- Economic security: the extent to which a county can support basic needs, now and in the future, measured using population;
- Education: educational attainment and expenditures;
- Governance-planning and management: measured through the FEMA Community Rating System county scores and the time since a county comprehensive plan was adopted;
- Health: physical and mental health of population via proxies for disease burden and general quality of life (for example, fertility, life expectancy, mortality due to chronic disease, and recreational opportunities);
- Safety: the safety of both person and property from actions or events that cause damage, harm or impede access to needed resources, measured by crime rates and exposures to severe storm events, and population density in the SFHA zone; and,
- Social connectedness: a community’s ability to exchange resources, engage in activities to build and maintain social cohesion, and respond and recover from perturbations, measured by charitable giving, access to telephone services, participation in democracy (voter turnout), tenure in community, number of religious organizations per 1,000 people, and others.

Table 3.13-6
Coastal Community Well-being Indicators by Parish, 2012[a]

Parish	Access to Social Services	Basic Needs	Economic Security	Education	Governance	Health	Safety	Social Connected-ness
Ascension	Low	High	High	Medium	Medium	High	Low	Low
Assumption	Low	Medium	Low	Medium	Low	Low	Low	Medium
Jefferson	High	High	Medium	Medium	Medium	Medium	Low	Low
Lafourche	Low	High	High	Low	High	High	Medium	Low
Orleans	High	High	Low	High	Medium	Medium	Low	Medium
Plaquemines	Low	High	High	High	Low	High	Low	Low
St. Bernard	Low	High	Medium	Medium	Low	Medium	Low	Medium
St. Charles	Low	High	Medium	High	Medium	High	Low	Medium
St. James	Low	High	Medium	High	Medium	Medium	Low	High
St. John the Baptist	Low	High	Medium	High	Medium	High	Medium	Medium

Sources: Buck et al. (2015) and Dillard et al. (2013).

[a] Well-being scores assigned are: High (blue), Medium (yellow), Low (red).

3.13.7 Protection of Children

In 1997, EO No. 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 Project area, and for comparison purposes, in Louisiana and the United States. Table 3.13-7 presents information about children living in poverty by parish. When considering all children, Orleans, St. James, and St. John the Baptist Parishes have percentages of children living in poverty that are at or above the statewide percentage, while eight of the 10 parishes have percentage equal to or higher than that of the nation.

Section 3.15 Environmental Justice provides information on unemployment, and median household income, which are indicators of the economic circumstances of the households of which children are a part (see Table 3.15-2).

Table 3.13-7
Percentage of Children in Poverty by Parish (2014 to 2018)[a]

Parish	Under 5 years	15 to 17 years	Total Under 18 years
Ascension	16%	14%	15%
Assumption	22%	28%	26%
Jefferson	29%	24%	25%
Lafourche	18%	23%	22%
Plaquemines	34%	19%	23%
Orleans	39%	36%	37%
St. Bernard	22%	18%	19%
St. Charles	22%	14%	16%
St. James	25%	29%	31%
St. John the Baptist	39%	23%	27%
Comparison Areas			
Louisiana	31%	26%	27%
U.S.	22%	18%	19%

Source: U.S. Census Bureau 2018. American Community Survey (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.

3.14 COMMERCIAL FISHERIES

3.14.1 Overview

Commercial fisheries comprise a multi-billion-dollar industry in the northern Gulf Coast region, and include large volumes of finfish, shrimp, oysters, and crab catch. Approximately one billion pounds of seafood, on average, is landed in Louisiana each year for commercial sale, with an estimated dockside value of $300 million (Louisiana Fisheries Forward 2017). Louisiana was the largest producer of shrimp in the United States in landings by weight and the second largest in terms of value, behind Texas (NOAA 2020e). Shrimping is the largest commercial fishery in the Project area by value and volume as well (excluding Gulf menhaden). The seafood processing and sales sectors are also important to the Louisiana economy. Excluding imports, these industries are estimated to have supported nearly 27,000 jobs and contributed $1.5 billion in sales to the economy of Louisiana in 2019 (NMFS 2022b). The Project area includes numerous coastal communities that rely heavily on commercial fishing activities. Community members are employed as captains or crew on fishing boats, as seafood dealers, or as employees of businesses serving the commercial fishing industry.

The Project area includes two major basins for fishing (the Barataria Basin and a portion of the Mississippi River Basin) and overlaps with 13 commercial fishing sub-basins delineated by the LDWF, as shown in Figure 3.14-1. Fishing data provided in this section are based on sub-basin level data, where available, and basin-level data otherwise, as noted throughout the section.[24]

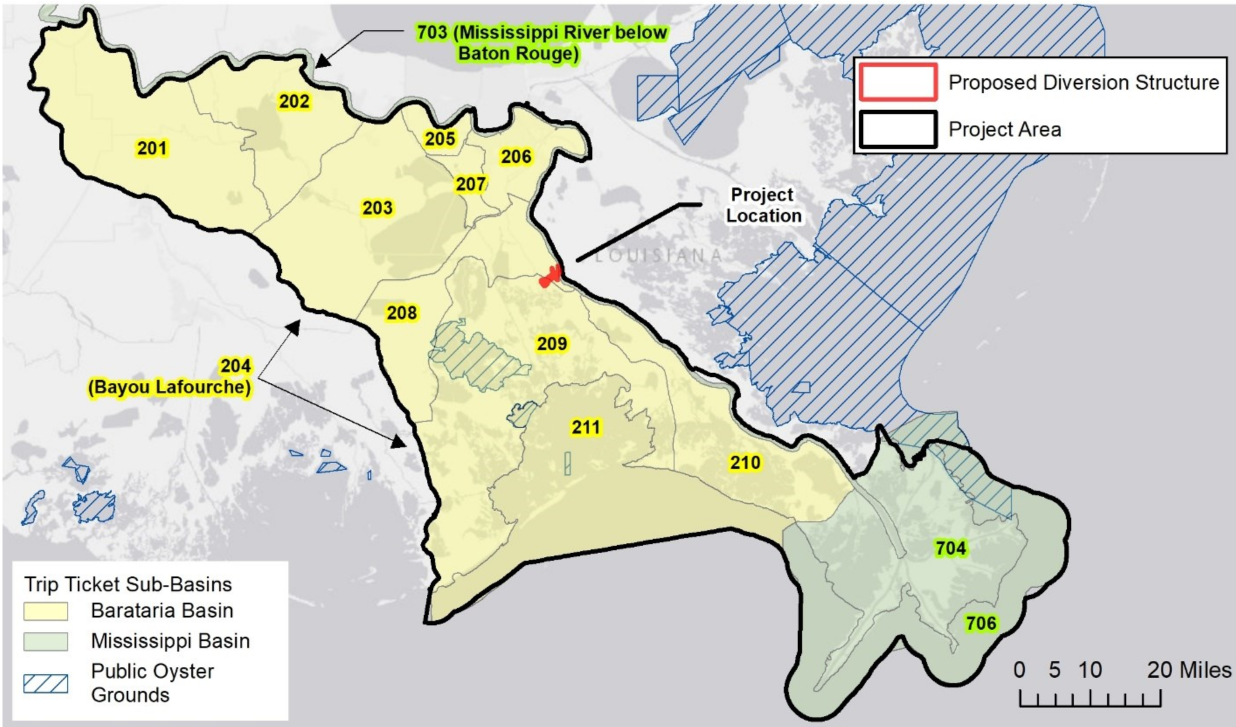


Figure 3.14-1. Trip Ticket Sub-basins and Public Oyster Seed Grounds in and near the Project Area.

General commercial fishing trends in the Project area across species groups are presented in Table 3.14-1 and Figures 3.14-2 to 3.14-6. Table 3.14-1 and Figures 3.14-2 and 3.14-3 show the number of licensed commercial fishers actively fishing in the Project area over time by species group.[25] As shown, more licensees were actively fishing for shrimp than any other species type (crab, oyster, and finfish) in both the Barataria and Mississippi River Basins. The number of active shrimp fishers in the Barataria Basin declined from over 2,600 in year 2000 to under 1,000 in year 2018 (see Figure 3-14.2). While the number of active licensed fishers in the Mississippi River

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[24] Information provided at the sub-basin level includes the entirety of sub-basin 703, which is only partially included in the Project area (see Figure 3.14-1).

[25] There are two important caveats related to the commercial fishing license data presented in this section. First, in order to maintain confidentiality, any data point supported by fewer than three unique licensed fishers is reported in the data as “<3” licensed fishers. The “<3” data points have been replaced with an average value of 1.5 in order to calculate numbers of licensed fishers. Second, we note that the Mississippi River Basin is split into two geographically separate areas. Only the southern area (704, 706), along with parts of the Mississippi River (703) are within the boundaries of the Project area. However, because license data are only available by basin, not sub-basin, for 2014 through 2018, the northern area (0701, 0702, and 0705) was also included in the count of licensed fishers for the Mississippi River Basin.

Basin declined slightly from years 2000 to 2005 for all species landed, the number of active licensed fishers was relatively stable from years 2005 to 2018.

Table 3.14-1
Number of Licensed Commercial Fishers Active in the Barataria and Mississippi River Basins, Average 2014 to 2018[a]

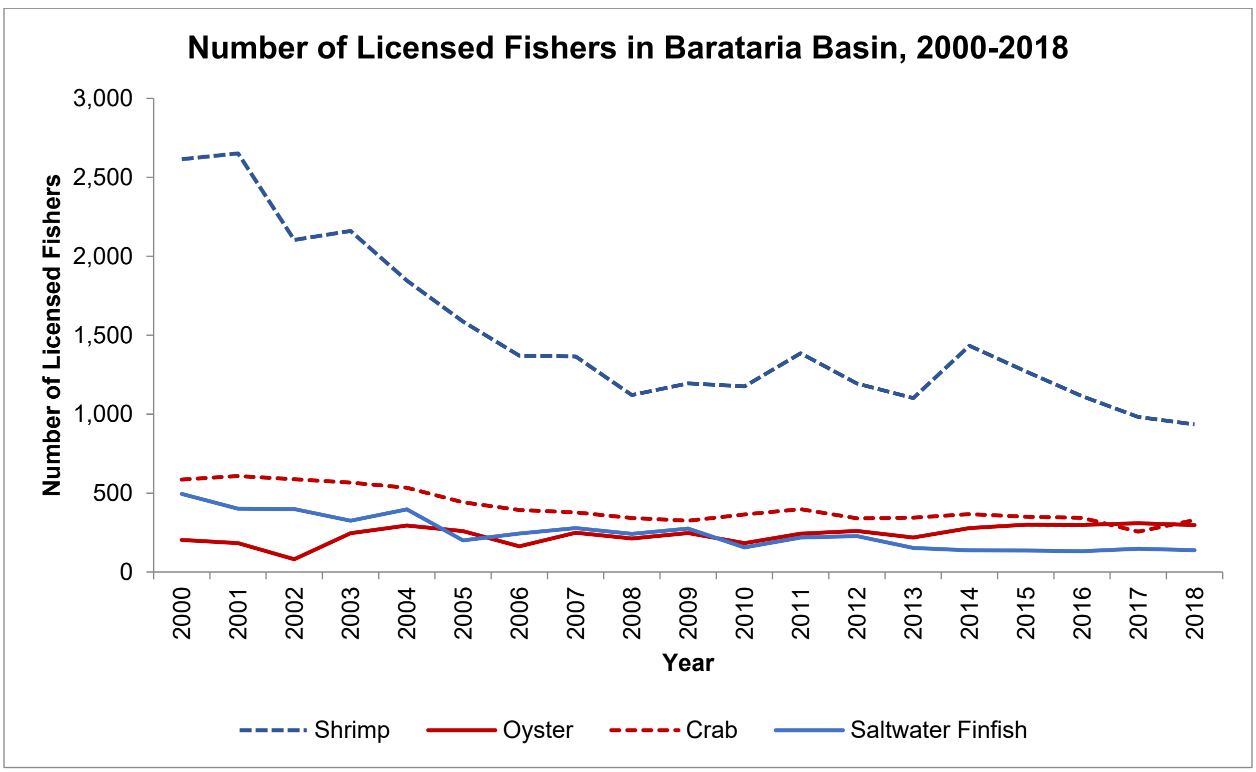
Basin	Shrimp[b] Fishers	Oyster Fishers	Crab Fishers	Saltwater Finfish Fishers	Freshwater Finfish Fishers
Louisiana State Total	**4,512**	**1,075**	**1,865**	**818**	**943**
Barataria Basin	1,147	297	313	130	143
Barataria Basin as Percent of State Total[c]	25%	28%	17%	16%	15%
Mississippi River Basin	258	4	108	133	79
Mississippi River Basin as Percent of State Total[c]	6%	0%	6%	16%	8%

Source: LDWF 2019g

[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.

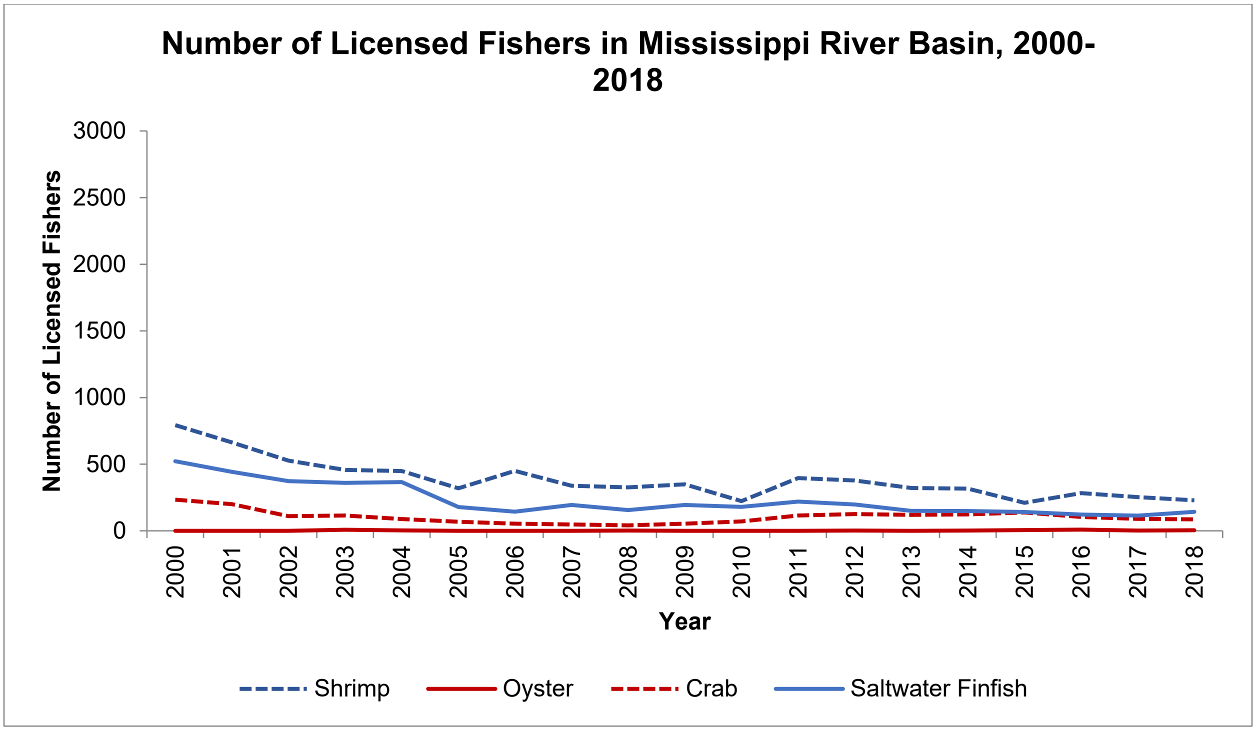
[b] "Shrimp" includes a small portion of other shellfish. Shrimp make up over 95 percent of all shellfish caught.

[c] State total is based on all areas fished, and may include a single license fishing in multiple areas. If license holders are more likely to have landings from both the Barataria and Mississippi River Basins, than other combinations of two basins in the state, this may overestimate the percentages of landings in these basins.



Sources: LDWF 2019g and Barnes et al. 2017

Figure 3.14-2. Total Number of Licensed Fishers Active in the Barataria Basin, 2000 to 2018.



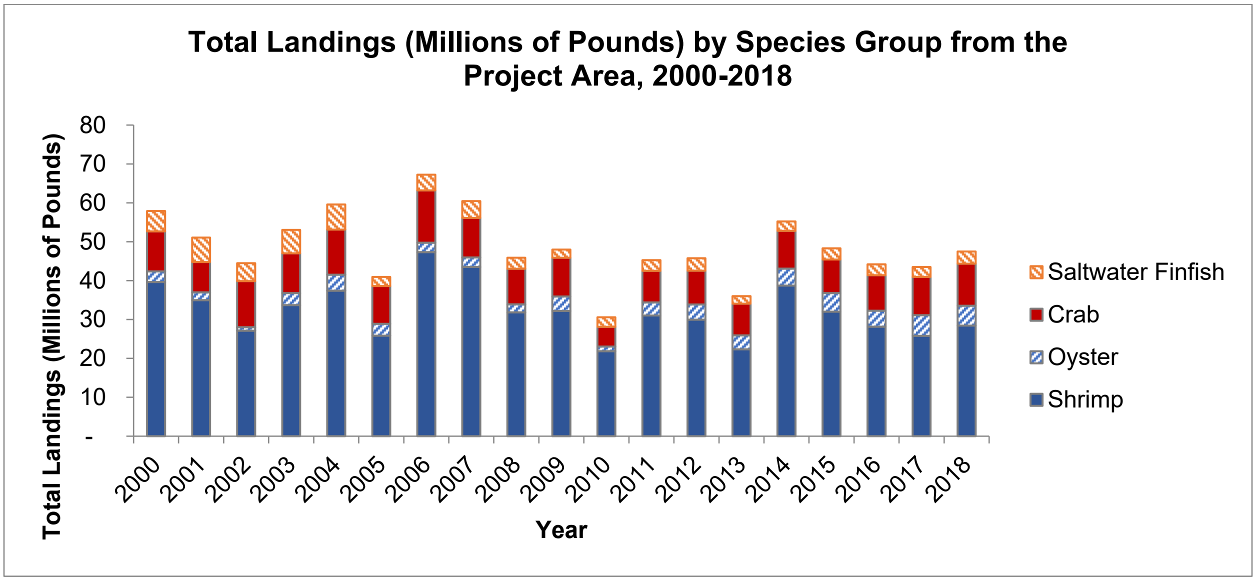
Sources: LDWF 2019g and Barnes et al. 2017

Figure 3.14-3. Total Number of Licensed Fishers Active in the Mississippi River Basin, 2000 to 2018.

According to LDWF regulations, any person who operates a commercial fishing vessel is required to have a commercial fishing license. Other workers on commercial fishing vessels do not need licenses (LDWF 2017k). As such, the number of commercial fishing licenses is not equivalent to employment in the industry (Barnes et al. 2017). However, licensing data combined with trip ticket data can provide a useful indicator of the level of employment from commercial fishing occurring in the Project area. These data provide information on the number of active fishing licenses associated with fishing activity in the Project area. As such, these figures may include licenses for fishers who reside outside the Project area that harvest product within the area. Moreover, it should be noted that some of the license holders who land catch from the Project area may also land catch from other areas in Louisiana and elsewhere along the Gulf Coast.

Far more license holders operating in the Project area are landing shrimp than other species. Approximately one-fourth of the number of licensed fishers reporting shrimp landings in the state reported shrimp landings in the Barataria Basin. Approximately five times as many commercial license holders operate in the Barataria Basin as in the Mississippi River Basin for shrimp, and three times as many for crab (see Table 3.14-1). Within the Project area, the average number of licensed fishers reporting saltwater finfish catch is similar in both basins, while the amount of license holders targeting freshwater finfish is slightly higher in the Barataria Basin. The only basin in the Project area with a substantial number of licensed fishers reporting oyster harvest was the Barataria Basin.

Figure 3.14-4 presents the total landings from the Project area over time for the different species groups.[26] From 2000 to 2018, the majority of landings from the Project area were comprised of shrimp for all years (see Figure 3.14-4).[27] The data also reflect the impact of natural and human-induced disasters on total landings. The small quantity of landings in 2005 coincides with Hurricane Katrina and the smallest quantity of landings in 2010 coincides with the DWH oil spill.



Sources: LDWF 2019b and Barnes et al. 2017

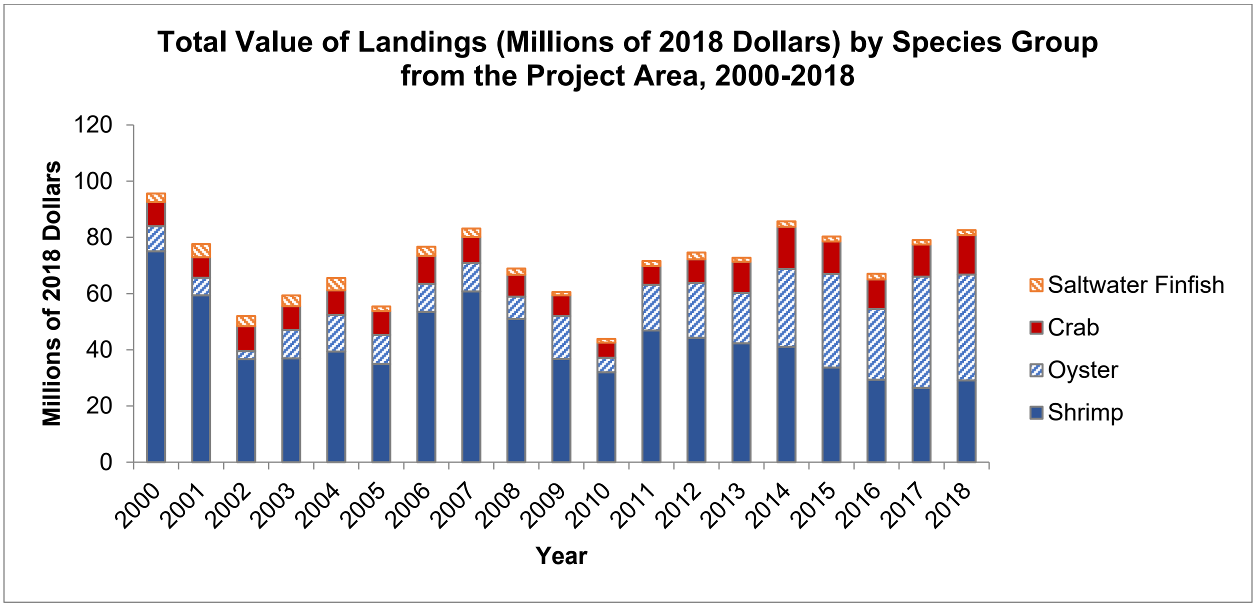
Figure 3.14-4. Total Landings (millions of pounds) by Species Group from the Project Area (landings by area fished). Saltwater finfish, crab, and shrimp are measured in whole weight pounds while oysters are measured in meat pounds. "Shrimp" includes a small portion of other shellfish. Shrimp make up over 95 percent of all shellfish caught. Saltwater finfish totals exclude menhaden. Freshwater finfish are not included in this figure due to limited data availability for years prior to 2014; see Table 3.14-2 for data.

Figure 3.14-5 presents the total value of commercial fishing landings in areas fished in the Project area over time by species group. Between 2000 and 2018, the highest value of landings (2018 dollars) was approximately $95 million in 2000, followed by $85 million 2014. In 2018, total commercial fishing landings in areas fished in the Project area were 47.3 million pounds, valued at $82.6 million (2018 dollars), as reported by area fished within the Project area. Shrimp was the highest value fishery in the Project area in all years until 2017, when oyster landings value surpassed shrimp, a

[26] Landings are reported 'by area fished,' which are landings where the license holder reported harvesting the majority of the seafood on a given trip. This is a different value than landings reported by dealers within the Project area (which can include seafood caught outside of the Project area).

[27] Note that LDWF 2020f includes a different date range and area than those described in this EIS. Specifically, LDWF statistics cited in this EIS include 2018 data, while LDWF 2020f includes data from 2000 to 2017. Also, LDWF 2020f focuses on the Barataria Areas 209, 210, and 211, while this EIS also includes reported landings in the Mississippi River Basin in Areas 701, 702, and 703.

trend that continued in 2018. Commercial fishing values were acutely affected by both Hurricane Katrina in 2005 and the DWH oil spill in 2010, with effects potentially lingering in the following years and compounded by the economic recession during the intervening years. In particular, the commercial fishing sector was directly affected by area closures after the DWH oil spill; small businesses in the industry lost income and employment and the extent to which these effects continue is unclear (Impact Assessment 2013). Prior to the DWH oil spill, the industry had been fundamentally altered due in part to storm-induced out migration and the attrition of marine-related businesses across the region (Impact Assessment 2013).



Sources: LDWF 2019b and Barnes et al. 2017

Figure 3.14-5. Total Value of Landings by Species Group from the Project Area (landings by area fished). "Shrimp" includes a small portion of other shellfish; however, shrimp make up over 95 percent of all shellfish caught. Saltwater finfish totals exclude menhaden. Freshwater finfish are not included in this figure due to limited data availability for years prior to 2014; see Section 3.14.5 for data.

Table 3.14-2 presents average landings by weight and species group from 2014 to 2018. During this time period, landings (by weight) from the Project area account for approximately a third of statewide shrimp, oyster, and saltwater finfish landings.

Table 3.14-2
Project Area Landings by Species Group (lbs), Average 2014 to 2018[a]

Basin	Shrimp[b]	Oyster	Crab	Saltwater Finfish	Freshwater Finfish
Barataria Basin	**24,740,927**	**4,735,731**	**6,453,820**	**786,666**	**1,234,825**
201	310,616	10,756	20,915	5,792	15,160
202	16,643	0	83,998	374	613,844
203	3,647	0	335,110	0	79,525
204	400,167	3,716	894,939	8,452	10,083
205	0	0	120,273	0	2,920
206	3,856	0	6,592	544	34,778
207	3,735	12,205	422,676	2,392	148,920
208	49,067	0	315,511	5,658	9,056
209	3,532,087	113,003	2,188,764	44,366	20,961
210	7,644,161	4,364,545	667,257	212,761	264,480
211	12,776,949	231,506	1,397,785	506,326	35,097
Mississippi River Basin	**5,855,601**	**0**	**3,155,584**	**1,914,403**	**157,456**
703[b]	159,111	0	1,478,286	69,536	59,601
704	2,743,773	0	1,650,995	848,572	89,937
706	2,952,717	0	26,303	996,294	7,918
Project Area Total	**30,596,528**	**4,735,731**	**9,609,405**	**2,701,068**	**1,392,281**
Percent of State Total[c]	**32%**	**36%**	**22%**	**33%**	**14%**

Source: LDWF 2019b.

[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.

[b] Sub-basin 703, the Mississippi River, is partially located outside of the Project area, so these counts slightly overestimate the landings in the Project area for that sub-basin.

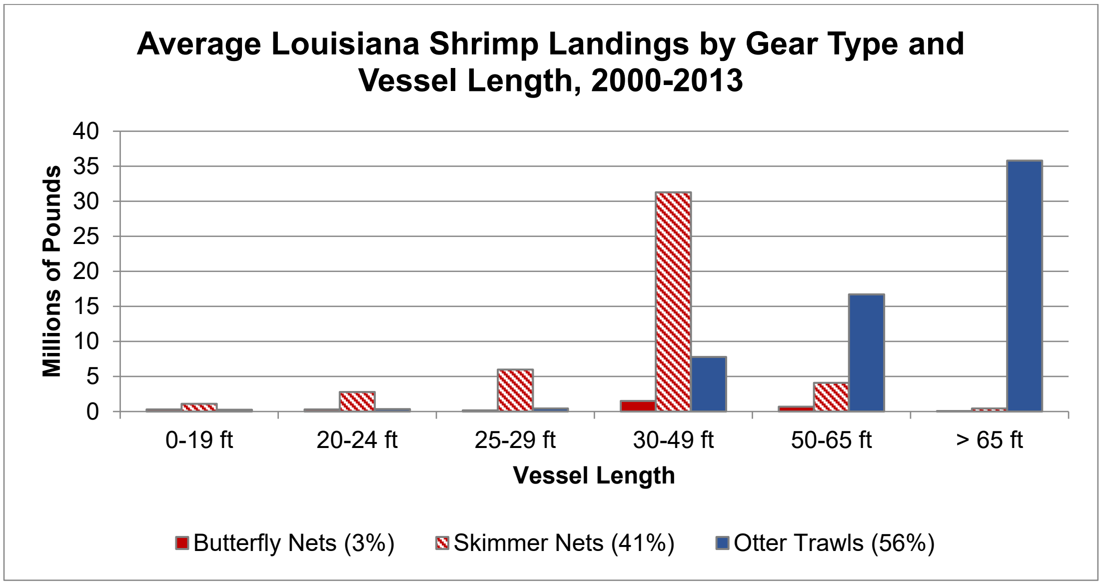
[c] Statewide data not available for 2018, so percent of statewide total relies on 2014 to 2017 averages.

3.14.2 Shrimp Fishery

3.14.2.1 Overview of the Fishery

The shrimp fishery is the dominant fishery in the northern Gulf of Mexico. Louisiana's shrimp fishery is primarily comprised of two estuarine-dependent shrimp species – brown shrimp and white shrimp. Louisiana has led the United States in shrimp landings every year since 2000 (Bourgeois 2016). Shrimp landed in Louisiana are caught primarily in the Barataria and Terrebonne Basins, as well as in the deeper waters offshore (Barnes et al. 2017). Of the total 112.2 million pounds of shrimp landed in Louisiana on average between 2000 to and 2013, two-thirds of shrimp landings were caught in Louisiana state waters, with a large proportion (roughly one-third) coming from the Project area, while remaining landings were caught in federal waters (Bourgeois 2016). Between 2000 through 2013, the Barataria Basin had the highest brown shrimp catch (averaging 13.7 million pounds annually, representing 44 percent of the state total), and the second highest white shrimp catch (averaging 13 million pounds annually, representing 31 percent of the state total) among Louisiana trip ticket basins and NMFS grid areas landed in Louisiana (Bourgeois 2016).

The 2016 Louisiana Shrimp Fishery Management Plan reported an average of fewer than 5,600 licensed resident and non-resident shrimp fisherman in the state based on gear license sales; however, these license data may include recreational or subsistence shrimp fishers who utilize the same types of gear (Bourgeois 2016). The inshore shrimp fleet includes a relatively large number of small vessels (Bourgeois 2016). Figure 3.14-6 provides an overview of Louisiana shrimp landings by gear type and vessel length for 2000 to 2013. As shown, over half of the shrimp catch was landed by otter trawls, most of which was landed by vessels larger than 65 feet. Skimmer nets are the preferred gear of smaller vessels (less than 50 feet).



Source: Bourgeois et al. 2016

Figure 3.14-6. Average Louisiana Shrimp Landings by Gear Type and Vessel Length, 2000 to 2013. Percentage in parentheses indicates portion of annual catch attributed to that gear type.

3.14.2.2 Description of the Regulatory Environment

The LDWF is charged with regulating the shrimp fishery in state waters under the rules established by the Louisiana Wildlife and Fisheries Commission (LWFC). In addition, the Louisiana Shrimp Task Force was established by the Louisiana Legislature to study and monitor the shrimp industry and to make recommendations to the LWFC, to LDWF, and to other state agencies for enhancement of the domestic shrimp industry (Bourgeois 2016). The shrimp fishery in federal waters (Gulf of Mexico shrimp fishery) is managed by NOAA under the Shrimp Fishery Management Plan and management measures developed by the GMFMC. The Gulf States Marine Fisheries Commission (GSMFC) coordinates management actions with state management programs. Gulf of Mexico shrimp fishery is presently subjected to a moratorium on new permits, which the GSMFC says will assist the economic recovery of the fishery (USDOI 2014). The Gulf shrimp fishery also currently has two effort thresholds directly related to bycatch that affect the fishery if the thresholds are exceeded: a threshold for sea turtle bycatch (Shrimp Biological Opinion, NMFS 2014) and a threshold for juvenile red snapper bycatch in a specific area of the Gulf (Amendment 14, GMFMC 2007).

3.14.2.3 Catch Statistics and Trends

Table 3.14-3 presents a summary of average annual shrimp fishing activity in the Project area by area fished between 2014 and 2018. As shown, the total average activity for shrimp caught in the Project area was approximately 30.6 million pounds, with a value of $41.5 million. During 2014 to 2018, shrimp activity in the Project area accounted for 32 percent of total Louisiana shrimp landings by weight and 30 percent of total value from shrimp landings in Louisiana.

The sub-basins providing the highest quantity of shrimp landings on average between years 2014 and 2018 were sub-basins 211 and 210 which are located in the southern Barataria Basin (see Figure 3.14-1). It should be noted that sub-basin 211 includes a significant area beyond the barrier islands and outside of the analysis area for assessing aquatic resource impacts.

The northern sub-basins of the Barataria Basin, such as 202 and 203, had much lower shrimp fishing activity. Each sub-basin in the Mississippi River Basin also had substantial commercial shrimping activity (Barnes et al. 2017).

Figure 3.14-7 presents total shrimp landings over time for all sub-basins that overlap the Project area by area fished. The small quantity of landings in 2005 coincides with Hurricane Katrina and the smallest quantity of landings in 2010 coincides with the DWH oil spill. After Hurricane Katrina, the quantity of landings recovered to above pre-hurricane levels immediately. The quantity of landings did recover to pre-oil spill levels after DWH; however, there was a downward trend in shrimp landings beginning after 2011, although landings spiked in 2014. It should be noted that a variety of factors influence landings and these comparisons over time do not attempt to predict what landings would have been in subsequent years absent major events like Hurricane Katrina and the DWH oil spill.

Table 3.14-3
Average Annual Shrimp Activity by Area Fished, 2014 to 2018[a]

Area Fished[b]	Landings by Weight[c] (lbs)	Landings Value[d] (2018 dollars)
Barataria Basin	**24,740,927**	**$31,977,235**
201	310,616	$420,673
202	16,643	$30,109
203	3,647	$5,710
204	400,167	$426,708
205	0	$0
206	3,856	$2,915
207	3,735	$7,851
208	49,067	$74,318
209	3,532,087	$4,611,182
210	7,644,161	$9,903,569
211	12,776,949	$16,494,201
Mississippi River Basin[e]	**5,855,601**	**$9,521,696**
703[f]	159,111	$270,484
704	2,743,773	$4,801,022
706	2,952,717	$4,450,190
Total Average Annual Activity	**30,596,528**	**$41,498,931**
Percent of State Total[g]	**32%**	**30%**

Source: LDWF 2019b.

[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. Averages were calculated over the years 2014 to 2018. "Shrimp" includes a small portion of other shellfish. Shrimp make up over 95 percent of all shellfish caught.

[b] See Figure 3.14-1.

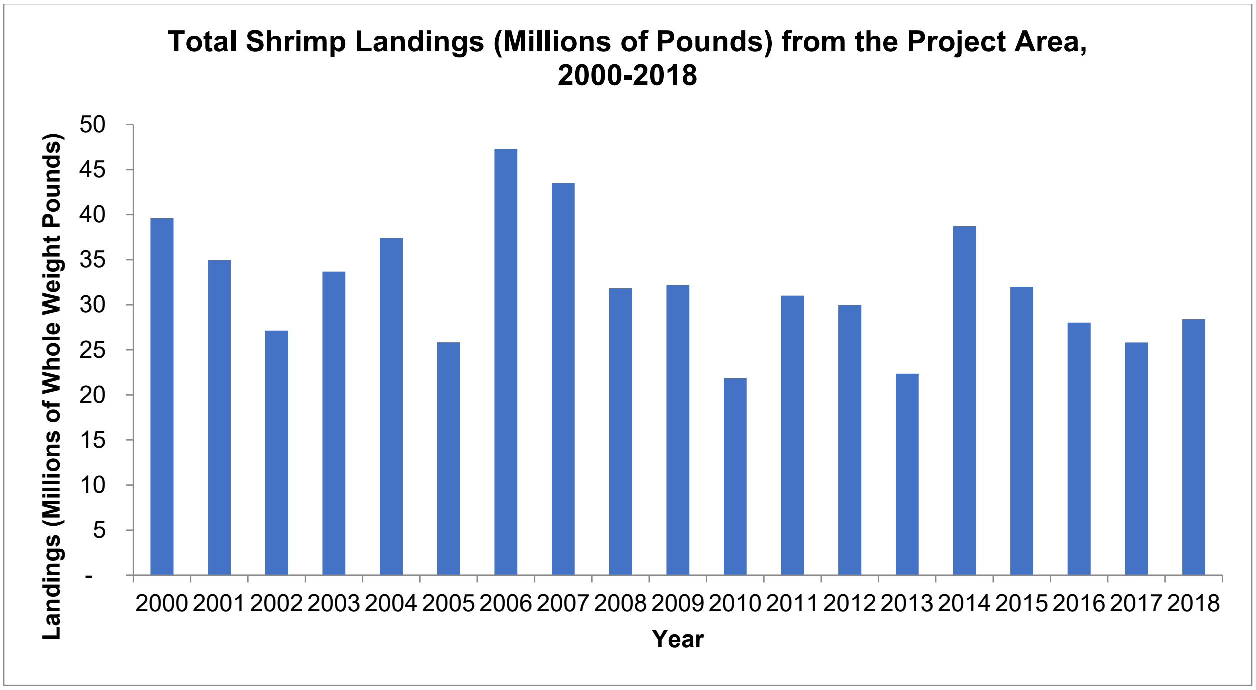
[c] Landings for shrimp are reported in whole weight pounds.

[d] Values reported in 2018 dollars.

[e] Mississippi River Basin excludes sub-basins outside of the Project area (701, 702, and 705).

[f] Sub-basin 703, the Mississippi River, is partially located outside of the Project area, so these counts slightly overestimate the landings in the Project area for that sub-basin.

[g] Statewide data not available for 2018, so percent of statewide total relies on 2014 to 2017 averages



Sources: LDWF 2019b and Barnes et al. 2016

Figure 3.14-7. Total Shrimp Landings from the Project Area (landings by area fished). "Shrimp" includes a small portion of other shellfish. Shrimp make up over 95 percent of all shellfish caught.

3.14.3 Oyster Fishery

3.14.3.1 Overview of the Fishery

The Gulf Coast region typically produces more than half of the total United States commercial oysters by volume, and over 45 percent by value (Banks et al. 2016). The State of Louisiana itself is among the largest oyster producers in the United States. Between 2000 and 2014, Louisiana accounted for an average of over 11 million pounds, annually, or 34 percent of the oysters harvested in the United States. Louisiana's commercial oyster industry accounts for almost 4,000 jobs and has an economic impact of $317 million annually (Louisiana Fisheries Forward 2017).

3.14.3.2 Description of the Regulatory Environment

The Louisiana oyster fishery operates exclusively in state waters. The LDWF is charged with regulating the oyster fishery in state waters. In addition, the Louisiana Oyster Task Force was established by the Louisiana Legislature to study and monitor the oyster industry and to make recommendations to the LWFC, to LDWF, and to other state agencies (Banks et al. 2016).

In Louisiana, some areas of state-owned water bottoms are managed as public oyster reefs or leased to commercial harvesters. Lessees have exclusive use of the water bottom at their leases, and are allowed to harvest year-round, without restrictions on the harvest methods (for example, dredge size) used. There is no minimum size for oysters harvested on a private lease, but all sacks of oysters must be tagged with the lease number prior to sale. Areas that have been set aside as public oyster beds or for coastal protection, conservation, or restoration are not leased (USDOI 2014).

The LDWF manages approximately 1.7 million acres of public oyster seed grounds (Louisiana Fisheries Forward 2017). Public oyster seed grounds in the Project area are shown in Figure 3.14-1. Approximately 8,040 private water bottom leases are located in Louisiana waters, totaling 400,000 acres. Currently, while the oyster industry utilizes public seed grounds as a source of seed oysters (less than 3 inches) to transplant to private leases, the majority of commercial oysters harvested in Louisiana are from privately leased bottomlands. Preliminary data indicates that 90 percent of commercially harvested oysters landed in 2014 in Louisiana came from private leases (LDWF 2015d). Approximately one-third of Louisiana's private oyster leases are located in the Barataria Basin (LDWF 2017l).

3.14.3.3 Catch Statistics and Trends

Table 3.14-4 provides a summary of activity for commercial oyster harvest in the Project area. As shown, oyster landings from 2014 to 2018 averaged 4.7 million pounds at a value of $32.7 million in the Project area (see Table 3.14-4). Oyster activity in the Project area accounted for 36 percent of total Louisiana oyster landings by weight and 42 percent of total value from oyster landings in Louisiana.

The sub-basin with the largest quantity of oyster landings on average from years 2014 to 2018 was sub-basin 210, a southern sub-basin in the Barataria Basin, which had average landings of 4.4 million pounds valued at $30 million during this period (see Figure 3.14-1). Sub-basin 211 also accounted for $1.4 million in average value of oyster landings during this period. Annual oyster landings were not reported for a number of sub-basins or were listed as confidential because there were fewer than three unique fishers/dealers in the sub-basin (Barnes et al. 2017).

As shown in Figure 3.14-8, oyster landings decreased substantially in 2002, which may have been related to Hurricane Lili which hit the Louisiana coast and caused major flooding. In 2010, in an attempt to keep oil from the DWH oil spill from entering coastal marshes, the state opened freshwater diversions and siphons along the Mississippi River, including those at the Davis Pond Freshwater Diversion in the Barataria Basin, which affected the salinity levels in the Barataria Basin (GSMFC 2012). As a result of the DWH oil spill and related fishery closures, oyster landings declined sharply in 2010 but have rebounded and continue to increase beyond pre-spill levels. However, it should be noted that a variety of factors influences landings and these comparisons over time do not attempt to predict what landings would have been in subsequent years absent major events like Hurricane Katrina and the DWH oil spill.

Table 3.14-4
Average Annual Oyster Activity by Area Fished, 2014 to 2018[a]

Area Fished[b]	Landings by Weight[c] (lbs)	Landings Value[d] (2018 Dollars)
Barataria Basin	**4,735,731**	**$32,680,076**
201	10,756	$51,577
202	0	$0
203	0	$0
204	3,716	$24,786
205	0	$0
206	0	$0
207	12,205	$44,904
208	0	$0
209	113,003	$715,567
210	4,364,545	$30,485,564
211	231,506	$1,357,678
Mississippi River Basin[e]	**0**	**$0**
703[f]	0	$0
704	0	$0
706	0	$0
Total Average Annual Activity	**4,735,731**	**$32,680,076**
Percent of State Total[g]	**36%**	**42%**

Source: LDWF 2019b.

[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. Averages were calculated over the years 2014 to 2018.

[b] See Figure 3.14-1.

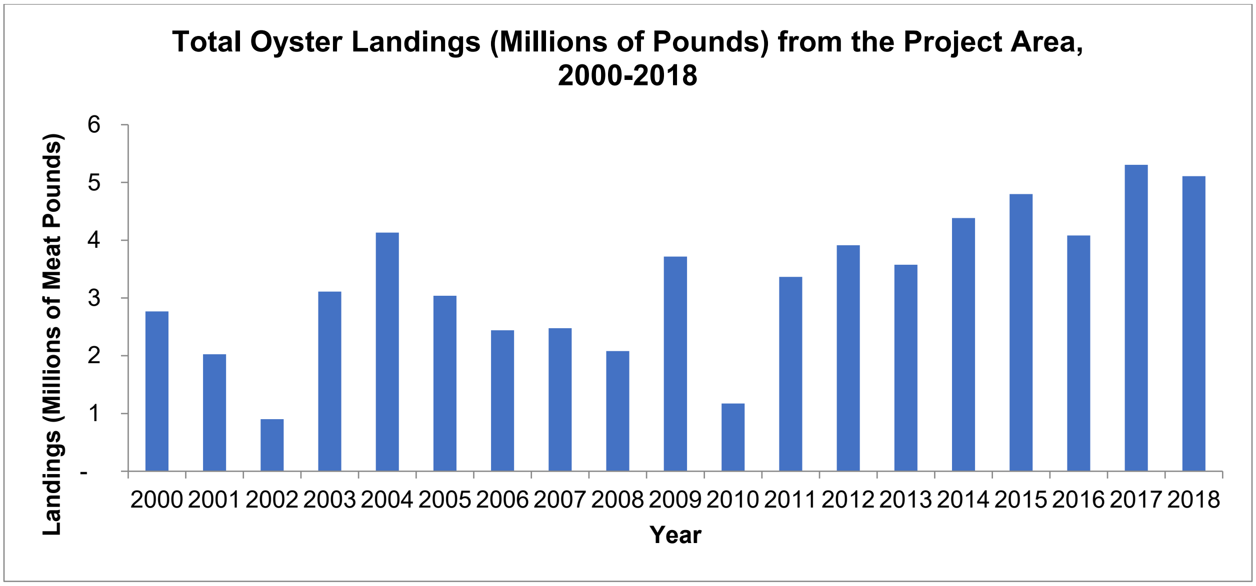
[c] Landings for oysters are reported in meat pounds.

[d] Values reported in 2018 dollars.

[e] Mississippi River Basin excludes sub-basins outside of the Project area (701, 702, and 705)

[f] Sub-basin 703, the Mississippi River, is partially located outside of the Project area, so these counts slightly overestimate the landings in the Project area for that sub-basin.

[g] Statewide data not available for 2018, so percent of statewide total relies on 2014 to 2017 averages



Sources: LDWF 2019b and Barnes et al. 2016

Figure 3.14-8. Total Oyster Landings from the Project Area (landings by area fished). Oyster landings are measured in millions of meat pounds.

3.14.4 Crab Fishery

3.14.4.1 Overview of the Fishery

Louisiana's blue crab fishery is the largest blue crab fishery in the United States. Blue crab supports a valuable commercial fishery in Louisiana, with landings of 42.8 million pounds and a dockside value of $53 million in 2017. Nearly 90 percent of crab landings from 2000 to 2013 were from the state's four estuarine basins: Terrebonne, Lake Pontchartrain, Barataria, and Atchafalaya/Vermilion/Teche Rivers. In the Barataria Basin, blue crab landings averaged 8.2 million pounds annually from 2000 to 2013 (Bourgeois et al. 2014).

3.14.4.2 Description of the Regulatory Environment

The crab fishery operates exclusively in state waters. The LDWF, in coordination with the LWFC, is charged with regulating the crab fishery in state waters. In addition, the Louisiana Crab Task Force was established by the Louisiana Legislature to study and monitor the crab industry and to make recommendations to the commission, to LDWF, and to other state agencies to enhance the domestic crab industry (Bourgeois et al. 2014).

3.14.4.3 Catch Statistics and Trends

A summary of activity for crab fishing in the Project area is shown in Table 3.14-5. As shown, the total average activity for crab caught in the Project area was approximately 9.6 million pounds, with a value of $12.1 million between 2014 and 2018 (see Table 3.14-5). Crab activity in the Project area accounted for 22 percent of total

Louisiana crab landings and 20 percent of the total value from crab landings in Louisiana.

Table 3.14-5
Average Annual Crab Activity by Area Fished, 2014 to 2018[a]

Area Fished[b]	Landings by Weight[c] (lbs)	Landings Value[d] (2018 Dollars)
Barataria Basin	**6,453,820**	**$8,452,302**
201	20,915	$31,480
202	83,998	$108,733
203	335,110	$446,581
204	894,939	$1,227,019
205	120,273	$178,066
206	6,592	$10,233
207	422,676	$529,606
208	315,511	$428,501
209	2,188,764	$2,899,888
210	667,257	$856,618
211	1,397,785	$1,735,576
Mississippi River Basin[e]	**3,155,584**	**$3,622,585**
703[f]	1,478,286	$1,786,618
704	1,650,995	$1,804,556
706	26,303	$31,411
Total Average Annual Activity	**9,609,405**	**$12,074,887**
Percent of State Total[g]	**22%**	**20%**

Source: LDWF 2019b.

[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. Averages were calculated over the years 2014 to 2018.

[b] See Figure 3.14-1.

[c] Landings for crab are reported in whole weight pounds.

[d] Values reported in 2018 dollars.

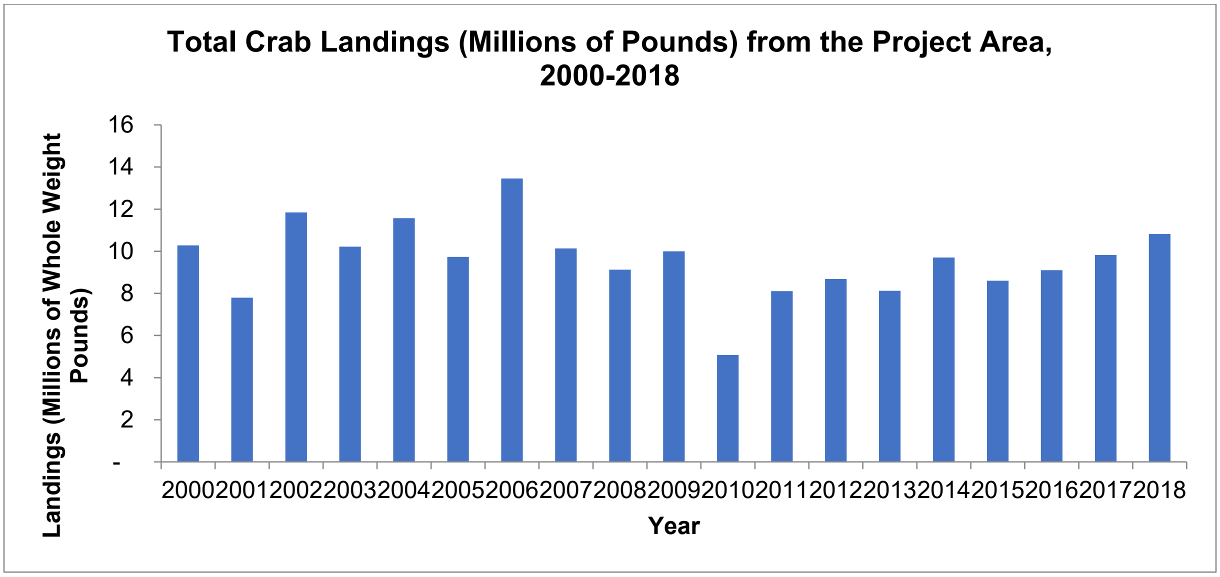
[e] Mississippi River Basin excludes sub-basins outside of the Project area (701, 702 and 705).

[f] Sub-basin 703, the Mississippi River, is partially located outside of the Project area, so these counts slightly overestimate the landings in the Project area for that sub-basin.

[g] Statewide data not available for 2018, so percent of statewide total relies on 2014 to 2017 averages.

The sub-basins with the highest average crab landings between 2014 and 2018 were 209 in the Barataria Basin and 704 in the Mississippi River Basin (see Figure 3.14-1). Sub-basins 204, 211, and 703 also had substantial crab fishing activity (Barnes et al. 2017).

Figure 3.14-9 shows total crab landings in the Project area which were generally between eight and 12 million pounds annually. The quantity of crab landings decreased slightly in 2005, due to Hurricane Katrina, and was substantially impacted by the DWH oil spill in 2010. After the spill, the quantity of crab landings recovered to near pre-oil spill levels by 2017. It should be noted that a variety of factors influence landings and these comparisons over time do not attempt to predict what landings would have been in subsequent years absent major events like Hurricane Katrina and the DWH oil spill.



Sources: LDWF 2019b and Barnes et al. 2017

Figure 3.14-9. Total Crab Landings from the Project Area (landings by area fished). Crab landings are measured in millions of whole weight pounds.

3.14.5 Finfish Fishery

3.14.5.1 Overview of the Fisheries

Louisiana's commercial finfish industry is dominated by the menhaden harvest; more than 97 percent of commercial finfish landings are menhaden, which are primarily harvested in offshore waters, although juvenile menhaden do utilize the Project area for rearing habitat (see Section 3.10 Aquatic Resources). Louisiana ranks second in the nation for the harvest of finfish (including both fresh water and salt water) (Louisiana Fisheries Forward 2017). In 2016, the Louisiana harvest of menhaden was nearly 1.1 billion pounds, at a value of $132 million. In 2015, landings of menhaden had an ex-vessel price of $0.12 per pound (NMFS 2017d). However, because it is harvested offshore, most of Louisiana's finfish harvest occurs outside of the Project area. Note that menhaden have been excluded from the figures reported for the Project area in this section in order to provide insights into the finfish species caught in the Project area.

The sub-basins with the highest quantity of saltwater finfish landings (excluding menhaden) were 704 and 706 in the Mississippi River Basin (see Figure 3.14-1). The southern sub-basins of the Barataria Basin such as 210 and 211 (birdfoot delta area) also had saltwater finfish activity, but substantially less than in the Mississippi River Basin (Barnes et al. 2017).

3.14.5.2 Description of the Regulatory Environment

Finfishing regulations depend on the location of the activity and the species being fished. Louisiana state waters generally extend to 3 nautical miles from the shoreline, though they extend to 9 nautical miles for certain reef fish fisheries. However, gear that is restricted in Louisiana state waters is restricted only out to 3 nautical miles. The federal government currently claims waters beginning at three nautical miles for many fisheries, meaning the area from three to nine nautical miles may be enforced differently by each entity, and depending on the fishery.

3.14.5.3 Catch Statistics and Trends

Table 3.14-6 provides a summary of activity for saltwater finfish landings in the Project area. The top three saltwater finfish species (excluding menhaden) landed commercially in the Project area include black drum, red mullet (most of the value is associated with the roe [eggs]), and sheepshead. As shown, on average from 2014 to 2018 the total volume and value of saltwater finfish landings (excluding menhaden) in the Project area (2.7 million pounds and a value of $1.8 million) was smaller than other commercially fished species groups discussed above (see Table 3.14-6). Saltwater finfish activity in the Project area accounted for 33 percent of total Louisiana saltwater fish landings (excluding menhaden) and 18 percent of the total value of saltwater fish landings in Louisiana (excluding menhaden).

Figure 3.14-10 presents total saltwater finfish landings (excluding menhaden) in the Project area over time by area fished. As demonstrated by the sudden decrease in catch, LDWF indicates that the hurricanes in 2005 (Katrina and Rita) and 2008 (Gustav and Ike) devastated the Louisiana finfish fishery. Hurricanes affect not only natural resources needed to conduct fishing activity (for example, fish, water quality), but also the infrastructure needed to conduct fishing activity, including damage to boats, docks and ramps, gas docks, seafood processors, and more. The quantity of saltwater finfish landings has not recovered to pre-hurricane levels (Bharadwaj et al. 2012).

Table 3.14-6
Average Annual Saltwater Finfish Activity by Area Fished, 2014 to 2018[a]

Area Fished[b]	Landings by Weight[c] (lbs)	Landings Value[d] (2018 dollars)
Barataria Basin	**786,666**	**$630,776**
201	5,792	$13,509
202	374	$234
203	0	$0
204	8,452	$8,532
205	0	$0
206	544	$391
207	2,392	$2,978
208	5,658	$3,460
209	44,366	$39,282
210	212,761	$161,205
211	506,326	$401,184
Mississippi River Basin[e]	**1,914,403**	**$1,130,842**
703[f]	69,536	$53,659
704	848,572	$492,493
706	996,294	$584,690
Total Average Annual Activity	**2,701,068**	**$1,761,618**
Percent of State Total[g]	**33%**	**18%**

Source: LDWF 2019b.

[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. Averages were calculated over the years 2014 to 2018. Saltwater Finfish species included here excludes menhaden.

[b] See Figure 3.14-1.

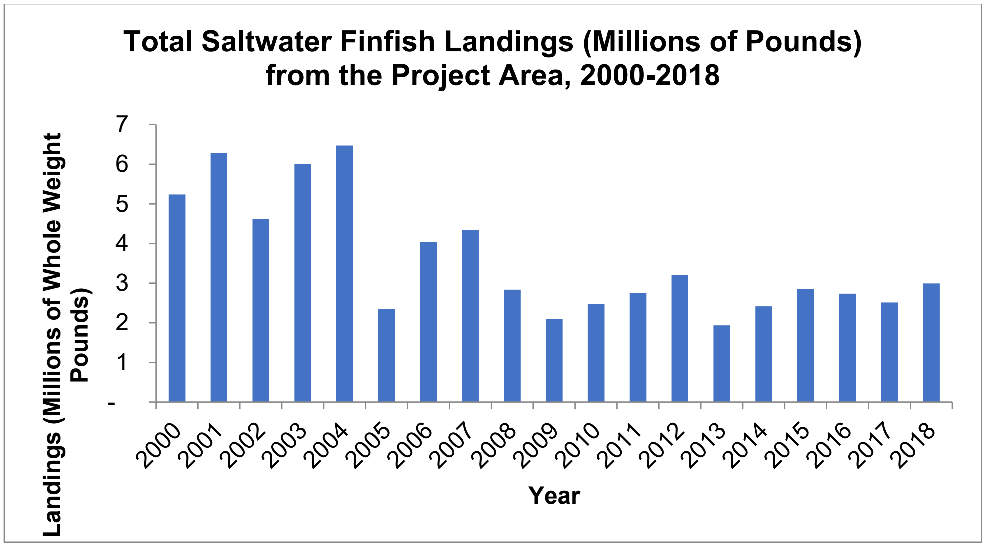
[c] Landings for saltwater finfish are reported in whole weight pounds.

[d] Values reported in 2018 dollars.

[e] Mississippi River Basin excludes sub-basins outside of the Project area (701, 702, and 705).

[f] Sub-basin 703, the Mississippi River, is partially located outside of the Project area, so these counts slightly overestimate the landings in the Project area for that sub-basin.

[g] Statewide data not available for 2018, so percent of statewide total relies on 2014 to 2017 averages.



Sources: LDWF 2019b and Barnes et al. 2017

Figure 3.14-10. Total Saltwater Finfish Landings from Project Area (landings by area fished). Saltwater finfish are measured in whole weight pounds and exclude menhaden.

The most common freshwater finfish harvested commercially in the Project area are blue catfish, channel catfish, flathead catfish and alligator gar (Isaacs 2018). Landings of freshwater finfish are slightly lower in volume and value than landings of saltwater finfish species in the Project area. Average total freshwater finfish landings in the Project area from 2014 to 2018 were approximately 1.4 million pounds, valued at $838,000 (see Table 3.14-7).

Table 3.14-7
Average Annual Freshwater Finfish Activity by Area Fished, 2014 to 2018[a]

Area Fished[b]	Landings by Weight[c] (lbs)	Landings Value[d] (2018 dollars)
Barataria Basin	**1,234,825**	**$758,812**
201	15,160	$6,453
202	613,884	$387,347
203	79,525	$40,308
204	10,083	$8,453
205	2,920	$2,071
206	34,778	$17,003
207	148,920	$109,696
208	9,056	$5,718
209	20,961	$10,898
210	264,480	$134,070
211	35,097	$26,794
Mississippi River Basin[e]	**157,546**	**$79,237**
703[f]	59,601	$29,969
704	89,937	$45,835
706	7,918	$3,433
Total Average Annual Activity	**1,392,281**	**$838,048**
Percent of State Total[g]	**14%**	**19%**

Source: LDWF 2019b.

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. Averages were calculated over the years 2014 to 2018.

b See Figure 3.14-1.

c Landings for freshwater finfish are reported in whole weight pounds.

d Values reported in 2018 dollars.

e Mississippi River Basin excludes sub-basins outside of the Project area (0701, 0702, and 0705).

f Sub-basin 703, the Mississippi River, is partially located outside of the Project area, so these counts slightly overestimate the landings in the Project area for that sub-basin.

g Statewide data not available for 2018, so percent of statewide total relies on 2014 to 2017 averages.

3.14.6 Aquaculture

Louisiana supports an important aquaculture industry, although the specific number of aquaculture projects within the Project area is not known. Commercial aquaculture industries exist in Louisiana for finfish, including channel catfish, baitfish, tilapia, and recreational sport fish; crustaceans, including crawfish, prawns, shrimp, and softshell crabs; mollusks, including clams, mussels, oysters, and snails; and reptiles, including the American alligator and red-eared turtle (Romaire et al. 2012, LSU Ag Center 2018a). Finfish aquaculture farms have not reported revenues in parishes within the Project area.

In 2012, there were 667 aquaculture farms with a market value of nearly $123 million in Louisiana; 496 of these were crustacean farms (including crawfish, prawns, shrimp, and softshell crabs) with a value of approximately $34 million. Crustacean sales in Louisiana represent nearly 42 percent of all crustacean aquaculture sales in the United States. Project area parishes contributed 23 percent of these statewide aquaculture sales in 2012 (USDA 2012). The Louisiana Oyster Task Force has indicated that the Mike Voisin Oyster Hatchery in Grand Isle is the only commercially available source of oyster larvae and seed for the burgeoning commercial aquaculture industry in the state (Louisiana Oyster Task Force 2017). Alligator farming and hunting also make up a substantial portion of Louisiana Aquaculture. During the 2018 wild season, a total of 20,165 alligators were harvested statewide by 2,773 licensed alligator hunters (LDWF 2019j). During the 2018 tag year (January 2018 through December 2018) an estimated 444,765 farm-raised alligators were harvested across all Louisiana. The total estimated value of these alligators was $104 million (LDWF 2019j). Out of 32 licensed alligator farms located in Louisiana in 2018, one was located in Plaquemines Parish and four in Lafourche Parish (LDWF 2018b).

Table 3.14-8 provides information on aquaculture farming in the Project area. In 2012, within parishes that overlap the Project area, there are 64 crustacean and mollusk farms, which had sales of $14.9 million, not including farms where information was withheld for confidentiality purposes. Plaquemines Parish reported the greatest number of crustacean and mollusk aquaculture farms as well as aquaculture revenues (USDA 2012). Finfish aquaculture (including catfish, baitfish, ornamental fish, and sport or game fish aquaculture) was not reported in the parishes that overlap the Project area as of 2012. Seventeen farms for “other aquaculture products” occur in Project area parishes (nine of these are in Assumption Parish). Other aquaculture products include alligators, frogs, and turtles, among others. Two farms in Plaquemines Parish were reported to have produced “other food fish” (including, for example, bass, perch, or tilapia).

Table 3.14-8 2012 Aquaculture in the Project Area by Parish[a]			
Parish	**Number of Crustacean and Mollusks Farms**	**Number of Other Aquaculture Products and Other Food Fish Farms**	**Value of Sales (thousands of 2017 dollars)**
Ascension	2	0	(D)[b]
Assumption	2	9	$630
Jefferson	7	4	$873
Lafourche	10	3	$357
Orleans	3	0	$323
Plaquemines	22	2	$7,329
St. Bernard	16	1	$5,428
St. Charles	1	0	(D)[b]
St. James	1	0	(D)[b]
St. John the Baptist	0	0	$0
Totals	**64**	**19**	**$14,939**
Percent of State Total	**12%**	**23%**	**23%**

Source: USDA 2012.

[a] Aquaculture farming for crustaceans and mollusks are included. Farming for crustaceans may include crawfish, prawns, or shrimp, or softshell crab. Mollusks include clams, mussels, oysters, and snails. Other aquaculture products include farming for alligators, frogs, and turtles, among others. Other food fish include for example, bass, perch, or tilapia. Other finfish aquaculture does not occur in Project area parishes.

[b] Indicates “withheld to avoid disclosing data for individual farms.”

3.14.7 Seafood Industry Regional Economic Contribution

The commercial fishing industry represents a major source of jobs and income in Louisiana. Table 3.14-9 presents an economic summary of the seafood industry across Louisiana, including NMFS estimates of industry impacts on jobs, sales, income, and total value added (NMFS 2022b). In 2019, the seafood industry in Louisiana generated total revenues of approximately $1.5 billion (NMFS 2022b). This included approximately $570 million in sales in the Commercial Harvesters sector and approximately $580 million in the Retail sectors. As indicated, the seafood industry supports nearly 27,000 jobs in Louisiana. In addition, the total “value added” of the seafood industry represented approximately 0.30 percent of Gross Domestic Product (GDP) in Louisiana (NMFS 2022b).

Table 3.14-9
Economic Impacts of the Louisiana Seafood Industry, 2019 (Without Imports)[a]
(Millions of 2017 Dollars)

Impacts	Jobs	Sales (million$)	Income (million$)	Value Added (million $)
Commercial Harvesters	10,168	570	192	282
Seafood Processors & Dealers	2,205	211	82	104
Seafood Wholesalers & Distributors	765	95	32	42
Retail Sectors	13,680	584	260	331
Total Impacts	**26,818**	**1,460**	**566**	**759**

Source: NMFS 2022b.

[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.

Another indicator of economic impact of the industry is the level of dependence of local communities on commercial fishing. NMFS has developed a suite of Fishing Engagement and Reliance Indices at the community level that capture the importance of commercial fishing to coastal communities (Jepson and Colburn 2013). Table 3.14-10 includes information on the two indices for the coastal communities that fall within the Project area and are included in the dataset. The indices include (Jepson and Colburn 2013):

- Commercial Fishing Engagement: absolute measure of the presence of commercial fishing through fishing activity as shown through permits and vessel landings. High rank indicates more engagement.

- Commercial Fishing Reliance: a relative measure of fishing activity consisting of value of landings per capita; number of commercial permits per capita; number of dealers per capita and percentage employed in agriculture, forestry and fishing. High rank indicates community is more reliant on commercial fishing.

Table 3.14-10
Commercial Fishing Engagement and Reliance Indices by Coastal Community, 2017[a]

Coastal Community	Parish	Commercial Fishing Engagement	Commercial Fishing Reliance
Avondale	Jefferson	Low	Low
Barataria	Jefferson	Medium	High
Bridge City	Jefferson	Low	Low
Grand Isle	Jefferson	High	High
Gretna	Jefferson	Medium	Low
Lafitte	Jefferson	High	High
Terrytown	Jefferson	Low	Low
Westwego	Jefferson	Medium	Low
Cut Off	Lafourche	High	Medium High
Galliano	Lafourche	High	Medium
Lockport	Lafourche	Medium High	Medium
Raceland	Lafourche	Medium	Low
Thibodaux	Lafourche	Medium	Low
Golden Meadow	Lafourche	High	High
Larose	Lafourche	High	Medium
New Orleans	Orleans	High	Low
Belle Chasse	Plaquemines	High	Medium
Boothville	Plaquemines	Medium	High
Venice	Plaquemines	High	High
Buras	Plaquemines	High	High
Empire	Plaquemines	High	High
Port Sulphur	Plaquemines	High	High
Chalmette	St. Bernard	Low	Low
Meraux	St. Bernard	Medium	Low
Violet	St. Bernard	Medium	Low
Des Allemands	St. Charles	Medium High	Medium High
Luling	St. Charles	Low	Low
Triumph	Plaquemines	Low	Low
Metairie	Jefferson	Medium	Low
Harvey	Jefferson	Medium	Low
Kenner	Jefferson	Low	Low
River Ridge	Jefferson	Low	Low
Jefferson	Jefferson	Low	Low
Crown Point	Jefferson	Low	Medium
Estelle	Jefferson	Low	Low
Harahan	Jefferson	Low	Low
Jean Lafitte	Jefferson	Low	Low
Woodmere	Jefferson	Low	Low

Source: NOAA 2019a. Commercial Fishing Engagement and Reliance Indices data for Louisiana Shoreline Communities for 2017.

[a] High index indicates higher vulnerability.

3.15 ENVIRONMENTAL JUSTICE

EO No. 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, and the Department of Defense's Strategy on Environmental Justice of 1995 direct federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of federal projects on minority and low-income populations, and Tribal Nations (see Chapter 1, Section 1.6 Scope of the EIS, Chapter 1, Section 1.7 Public Involvement Summary, and Chapter 1, Section 1.8 Agency Roles and Responsibilities, which describe the NEPA process and steps taken by USACE to involve the public and coordinate with Tribal Nations). The USEPA defines environmental justice (EJ) as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EJ efforts focus on improving the environment in communities, specifically minority and low-income communities, and addressing disproportionate adverse environmental impacts that may exist in those communities.

EO No. 14008, Tackling the Climate Crisis at Home and Abroad, issued in 2021, expands the federal government's commitment to EJ, directing agencies to "make achieving environmental justice part of their missions by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts." EO No. 14008 established the White House Environmental Justice Interagency Council (Interagency Council) and charged it with recommending updates to EO No. 12898. The Interagency Council's final recommendations, issued on May 21, 2021, emphasize the obligation of federal agencies to analyze "the environmental effects… of federal actions on communities of color, Tribal and indigenous communities, low-income communities, and people with disabilities; and ensure to the maximum extent practicable that mitigation measures outlined or analyzed in an… environmental impact statement, or record of decision address significant and adverse environmental effects of proposed Federal actions on communities of color, Tribal and indigenous communities, low-income communities, and people with disabilities." The Interagency Council further indicated the need for the federal government to take "decisive action… to dismantle the institutions and practices that inequitably place disproportionately human health, environmental, climate-related and other cumulative burdens on already disadvantaged communities." These recommendations are currently being considered by the White House CEQ in developing an approach for updating EO No. 12898.

Consistent with these directives concerning EJ, this section identifies low-income and minority populations within the Project area based on recent socioeconomic statistics, principally from the U.S. Census Bureau's American Community Survey

(ACS) 5-year estimates from 2014 to 2018.[28] These data are considered along with "the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action," in accordance with CEQ guidance on conducting EJ analysis under NEPA (CEQ 1997).

Tables 3.15-1 through 3.15-5 present data on key demographic and economic indicators in the 10 parishes within the Project area. To characterize low-income and minority populations within the Project area, data were obtained at the census block group-level and aggregated at the parish level for census block groups intersecting the Project area, unless otherwise noted. This illustrates the broader context for understanding potential impacts of the proposed Project on minority and low-income populations.

As shown in Table 3.15-1, minority populations are present throughout much of the Project area. Minority populations constitute 52 percent of the population of the census block groups in the 10 parishes that make up the Project area, compared to 41 percent for the state population. In the parishes closest to the location proposed for the Project (Plaquemines Parish and Jefferson Parish), the percentages of minority populations are 36 percent and 60 percent, respectively. These statistics do not distinguish smaller, yet important ethnic communities such as the Native American, Vietnamese, and Cambodian populations that also exist within the Project area; these groups are discussed later in this section.

Table 3.15-2 provides information for a number of economic indicators for the Project area block groups, including unemployment, median household income, and population living below poverty level, households receiving food stamp/supplemental nutrition assistance program (SNAP) benefits, and education level.

The 2018 poverty thresholds for the United States vary from $12,060 for an individual to $24,600 for a household of four. The U.S. Census Bureau defines a "poverty area" as a census tract or block numbering area with 20 percent or more of its residents below the poverty threshold level and an "extreme poverty area" as one with 40 percent or more below the poverty threshold level (U.S. Census Bureau 1995).

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[28] For incorporated place, Census Designated Place (CDP), and block group levels data, the source is ACS 5-Year Estimates, 2014-2018 (U.S. Census Bureau 2020). While 2020 ACS data was recently released, some data quality concerns exist regarding these data, which continue to be released as of this Final EIS (for example, see U.S. Census Bureau 2021a). For block-level data, which is used to report demographics of very small communities, the source is U.S. Census Bureau Decennial Census 2020. The Draft EIS reported 2010 Decennial Census data for block-level data, which has been updated in the Final EIS to 2020 Decennial Census data. Poverty data is unavailable at block level. Because Census and ACS data collection methods differ, data issues related to COVID-19 have a more limited impact on the Decennial Census (U.S. Census Bureau 2021b). However, the adoption of differential privacy measures in data reporting for the 2020 Census introduces new uncertainties related to data reported at smaller geographic scales than existed in the 2010 Decennial Census (U.S. Census Bureau 2021c). Because these communities are important to the EIS evaluation and received public comment, and because the updated data represent much more recent data, the block-level Decennial Census data have been updated in the Final EIS.

While all of the parishes have higher poverty levels (19 percent across the Project area) than the United States as a whole (14 percent), the Project area statistics are consistent with the state as a whole (19 percent). The two parishes closest to the location for the proposed Project (Plaquemines and Jefferson) have 20 and 19 percent, respectively, of their population in the Project area living below the poverty level. None of the parish-level statistics for the Project area exceed the “extreme poverty area” definition.

Table 3.15-1
Minority Populations for Census Block Groups within or Intersecting the Project Area (average, 2014 to 2018)

Project Area Parishes[a]	Total Parish Population	Population in Project Area	White Population (Not Hispanic or Latino) in Project Area	Total Minority Population in Project Area[b]	Percent Minority in Project Area
Ascension	121,176	10,410	2.947	7,463	72%
Assumption	22,714	13,855	7,177	6,678	48%
Jefferson	435,300	187,076	74,414	112,662	60%
Lafourche	98,214	79, 215	62,301	16,914	21%
Orleans	389,648	67,990	19,741	48,249	71%
Plaquemines	23,373	23,373	15,072	8,301	36%
St. Bernard	45,694	9,677	5,444	4,233	44%
St. Charles	52,724	27,573	18,080	9,493	34%
St. James	21,357	8,523	2,927	5,596	66%
St. John the Baptist	43,446	2,994	373	2,621	88%
Total Project Area	**1,253,646**	**430,686**	**208,476**	**222,210**	**52%**
Comparison Areas					
Louisiana	4,663,616	N/A	2,744,265	1,919,351	41%
U.S.	322,903,030	N/A	197,181,177	125,721,853	39%

Source: U.S. Census Bureau 2020. 2014-2018 ACS 5-year estimates. Represents the average across the 5-year survey period.

[a] Data presented include all census block groups that intersect or are within the Project area, aggregated to the parish level for all columns except Total Parish Population, which includes the entirety of the parish.

[b] The “Minority” column reflects all populations not identified as “Not Hispanic or Latino: White alone” in the ACS. For each of the parishes, the largest ethnic minority is Black or African American.

Table 3.15-2
Economic Indicators for Census Block Groups Intersecting the Project Area (average, 2014 to 2018)

Parish[a]	Unemploy-ment Rate	Median Household Income	Percent of Population Living Below Poverty Level	Percent of Household with Food Stamp/SNAP Benefits in past 12 months	Percent of Population with less than High School Education
Ascension	13%	$76,589	35%	29%	24%
Assumption	10%	$44,744	18%	18%	24%
Jefferson	8%	$52,558	19%	17%	20%
Lafourche	7%	$53,089	15%	13%	22%
Orleans	9%	$39,576	21%	16%	12%
Plaquemines	3%	$52,386	20%	12%	17%
St. Bernard	10%	$46,011	15%	15%	20%
St. Charles	6%	$66,620	14%	14%	13%
St. James	11%	$50,661	20%	18%	17%
St. John the Baptist	14%	$54,821	27%	26%	13%
Total Project Area	**8%**	**-**	**19%**	**16%**	**19%**
Comparison Areas					
Louisiana	7%	$47,942	19%	16%	15%
United States	6%	$60,293	14%	13%	12%

Source: U.S. Census Bureau 2020. 2014-2018 ACS 5-year estimates. Represents the average across the 5-year survey period.

[a] Data presented include all census block groups that intersect the Project area, aggregated to the parish level, with the exception of median household income, which represents the entirety of the parish.

Table 3.15-2 also shows that portions of the Project area have higher unemployment rates than the state and national averages. These parishes generally have higher percentages of households seeking such benefits as food stamps/SNAP, as well as having higher percentages of the population who have lower educational attainment levels. While only three of the 10 parishes (Assumption, Orleans, and St. Bernard Parishes) have median household incomes lower than the state, eight parishes fall below the national income level (Assumption, Jefferson, Lafourche, Plaquemines, Orleans, St. Bernard, St. James, and St. John the Baptist).

The percentage of the population that is elderly is also considered an indicator for EJ concerns (USEPA 1998). A higher proportion of elderly (defined as over 65 years old) in the population may indicate a higher vulnerability to environmental hazards. Based on the information presented in Table 3.15-3, the Project area has a largely similar proportion of elderly population (14 percent) when compared to state and national level statistics (both 15 percent).

Table 3.15-3
Percent of Population 65 Years and Over for Census Block Groups Intersecting the Project Area (2014 to 2018)

Parish[a]	Total Population in Project Area	Population 65 Years and Over	Percent of Population 65 and Over
Ascension	10,410	1,800	17%
Assumption	13,855	2,275	16%
Jefferson	187,076	25,719	14%
Lafourche	79,215	11,779	15%
Orleans	67,990	10,354	15%
Plaquemines	23,373	2,879	12%
St. Bernard	9,677	1,330	14%
St. Charles	27,573	3,233	12%
St. James	8,523	1,440	17%
St. John the Baptist	2,994	402	13%
Total Project Area	**430,686**	**61,211**	**14%**
Comparison Areas			
Louisiana	4,663,616	676,707	15%
U.S.	322,903,030	49,238,581	15%

Source: U.S. Census Bureau 2018. 2014-2018 ACS 5-year estimates

[a] Data presented include all census block groups that intersect the Project area, aggregated to the parish level.

A higher proportion of children living in poverty can also indicate a higher vulnerability; Section 3.13.7 Protection of Children in Socioeconomics provides information on the percentage of the population living in poverty that is under 18 years old.

The NEPA Committee and Federal Interagency Working Group on Environmental Justice states that agencies should identify and describe any unique conditions of the potentially affected minority and low-income populations that may be affected by the proposed action, including human health vulnerabilities, socioeconomic vulnerabilities (for example, reliance on a particular resource that may be affected by the proposed action), and cultural vulnerabilities (EJ IWG 2016). Commercial, recreational, and subsistence fishing is socioeconomically and culturally important to many communities in the Project area and may be affected by the proposed Project. For this EIS, coastal fishing communities were identified through a review of a screening study of fishing communities prepared by NOAA (Impact Assessment 2005). In the MSFCMA, a "fishing community" is defined as "a community which is substantially dependent or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew, and United States fish processors that are based in such communities" (50 CFR 600.345). The NOAA studies included communities based on evidence that some residents in each community were in some manner involved in the marine fisheries industry in the region. This list of fishing communities has been supplemented with additional communities identified through review of public scoping comments and relevant studies.

Guidance from the CEQ for analysis of EJ impacts recommends that analysts consider how impacts in minority or low-income populations may be different from impacts on the general population due to distinct cultural practices, such as subsistence fishing, hunting, or gathering (CEQ 1997). Subsistence fishing describes fishing activities pursued for non-market purposes, including meeting dietary needs, obtaining fresh and valued foods, and strengthening social ties through sharing foods with family, neighbors, and coworkers (Regis and Walton 2015). Subsistence activities go largely unrecorded and demographic data are not readily available to describe those who may rely on subsistence fishing. However, 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 that includes traditional types of employment with firms operating in a market economy while also engaging in various self-provisioning activities. About 70 percent of fishing households in southern Louisiana reported fishing in order to obtain fish for family consumption. Almost 89 percent of Louisiana's freshwater anglers and 91 percent of its saltwater anglers stated that they eat at least some of the fish that they catch (Industrial Economics, Incorporated 2014).

While subsistence fishing is important to populations throughout coastal Louisiana, it may be uniquely important for particular cultural and Indigenous groups. Historically, many Native Americans relied on traditional subsistence fishing. In addition to shrimping commercially, many of the Houma Indians in Lafourche Parish continue to rely on subsistence fishing, hunting and gathering other resources (Hemmerling and Colten 2004). While there are no Indian reservation lands within the Project area, there are tribal populations living within the Project area, including but not limited to the Houma, Atakapa-Ishak/Chawasha, and federally recognized Chitimacha Tribe of Louisiana. Cajun culture and identity increasingly signify a subsistence fishing and trapping lifestyle that incorporates long-standing, intimate connections with the south Louisiana wetland landscape (Wiley 2002, Austin et al. 2014a). Subsistence fishing is also crucial in Vietnamese communities (Austin et al. 2014a). For example, the Natural Resources Defense Council (Austin et al. 2014b) found in a 2010 survey taken after the DWH oil spill that some Gulf Coast communities, especially Vietnamese-American and Native American fishing communities in Mississippi and Louisiana, consumed between 3.6 and 12.1 times more shrimp and twice as many oysters and crabs than assumed in the federal risk assessment, which was based on the 90th percentile of seafood consumers nationally.

Table 3.15-4 summarizes potential communities in which commercial, recreational, or subsistence fishing activities take place within the Project area. This list provides a starting point for additional screening to identify minority and low-income populations that may be subject to disproportionately high and adverse human health or environmental impacts. Criteria for additional screening are discussed in Chapter 4, Environmental Consequences.

Table 3.15-4
Coastal Communities in the Project Area with Potential Minority and Low-Income Fishing and Hunting Participation

Communities	Description and Data Source
Jefferson Parish	
Avondale, Barataria, Bridge City, Crown Point, Estelle, Grand Isle, Gretna, Harvey, Jean Lafitte, Lafitte, Marerro, Terrytown, Timberlane, Westwego, Woodmere	Minority and low-income resident fishers[a, b]
Lafourche Parish	
Cut Off, Des Allemands, Galliano, Gheens, Leeville, Lockport, Mathews, Port Fourchon, Raceland, Thibodaux	Minority and low-income resident fishers[a, b, d]
Golden Meadow	Houma Indians who reside, and hunt and trap in wetlands to the west of Golden Meadow in Lafourche Parish [a, d]
Larose	Populations of Houma Indians, African-Americans, Asians, and Hispanics [a, d]
Plaquemines Parish	
Belle Chasse, Bohemia, Boothville, Braithwaite, Buras, Davant, Hermitage, Happy Jack, Empire, Live Oak, Myrtle Grove, Phoenix, West Pointe A La Hache, Port Sulphur, Scarsdale, Triumph, Venice, Wills Point, Woodlawn	Minority and low-income resident fishers[a, b]
Grand Bayou	Atakapa-Ishak/Chawasha Native American population [e]
Ironton	Population of African-American resident fishers located in direct proximity to MBSD site [b, c]

a Impact Assessment, Inc. 2005. Identifying Communities Associated with the Fishing Industry in Louisiana. Volumes I to III. Prepared for NMFS, Southeast Regional Office. December 2005.
b MBSD Final Scoping Report (Appendix A).
c Hemmerling, S.A. and C.E. Colten 2004.
d Rich 2014.
e Marshal 2016.

In addition to the fishing community profiles, NOAA's National Marine Fisheries Service has developed a suite of Community Social Vulnerability Indicators (CSVIs) that include measures of social vulnerability in coastal communities, including (Jepson and Colburn 2013):

- Labor force structure: characterizes the strength and stability of the labor force and employment opportunities that may exist;
- Housing characteristics: measures infrastructure vulnerability and includes factors that indicate housing that may be vulnerable to coastal hazards;
- Poverty: based on different poverty variables that cover all facets of the concept of poverty including the elderly, young, and families in poverty, along with the general percent of population receiving assistance;

- Population composition: indicates presence of populations traditionally considered more vulnerable due to circumstances often associated with low incomes and fewer resources; and

- Personal disruption: factors that disrupt a community member's ability to respond to change because of personal circumstances affecting family life, educational levels, or propensity to be affected by poverty.

Table 3.15-5 includes information on these five CSVIs indices for a subset of coastal communities within the Project area included in the dataset, as well as an index indicating vulnerability to sea-level rise. A higher index indicates a more vulnerable population. Not all communities within the Project area are included in the dataset. However, this evaluation provides another screen that estimates potential vulnerability of populations in the Project area.

Table 3.15-5
Community Social Vulnerability Indices by Coastal Community, 2016

Coastal Community	Social Vulnerability Indices[a]					Sea-Level Rise Risk Index
	Labor Force	Housing Characteristics	Poverty	Population Composition	Personal Disruption	
Jefferson Parish						
Avondale	Medium	Medium	High	High	High	Low
Barataria*	Low	N/A	Medium	Low	High	High
Bridge City	Low	High	High	High	High	Low
Grand Isle*	Medium High	Medium High	Medium	Low	Low	High
Gretna	Medium	Medium High	Medium	Medium High	Medium High	Low
Lafitte*	High	N/A	High	Low	Medium	High
Jean Lafitte*	Low	Medium High	Medium	Low	Medium	High
Terrytown	Low	Medium	Medium High	High	Medium High	Low
Westwego	Medium	Medium High	High	Medium	High	Low
Lafourche Parish						
Cut Off	Medium	Medium High	Low	Low	Medium	Low
Galliano*	Medium High	High	Low	Medium	Medium	Low
Lockport	Medium	High	Medium	Low	Medium High	High
Raceland	Low	High	Medium	Medium	High	High
Thibodaux	Medium	Medium High	Medium	Medium	High	Medium
Golden Meadow*	Medium High	High	Medium High	Low	Medium High	Low
Larose	Medium	High	Medium	Medium	Medium	High
Orleans Parish						
New Orleans	Low	Medium	High	Medium High	Medium High	Medium
Plaquemines Parish						
Belle Chasse*	Low	Medium	Low	Medium	Low	Low
Boothville	Medium High	N/A	High	Medium	High	Low
Venice*	Low	N/A	High	Low	Medium High	Low

Table 3.15-5
Community Social Vulnerability Indices by Coastal Community, 2016

Coastal Community	Social Vulnerability Indices[a]					Sea-Level Rise Risk Index
	Labor Force	Housing Characteristics	Poverty	Population Composition	Personal Disruption	
Buras*	Low	High	Low	Low	Low	Medium
Empire*	Medium High	High	High	Medium	Medium High	Medium
Port Sulphur*	High	N/A	High	High	High	Medium
St. Bernard Parish						
Chalmette	Low	Medium High	Medium High	Medium High	Medium High	Low
Meraux	Low	Medium	Low	Low	Low	Low
Violet	Medium	Medium	High	Medium High	High	Low
St. Charles Parish						
Des Allemands *(Partially in Lafourche Parish)*	Medium	High	Low	Low	Medium	High
Luling	Low	Medium	Low	Low	Low	High
Paradis	Medium	High	Low	Medium	Medium	High

Source: NOAA Fisheries Office of Science and Technology 2019a. NOAA Fisheries CSVIs. Version 3. https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-fishing-communities.

[a] High index indicates higher vulnerability. Indicators are classified as high, medium high, medium, and low. N/A reflects insufficient data.

* Evaluated in Chapter 4. The source for this table did not evaluate every community that is analyzed in Chapter 4, which also includes the small communities of Crown Point, Leeville, Ironton, Myrtle Grove, Grand Bayou, Hermitage, Happy Jack, and West Pointe A La Hache, as described in Table 3.15-6.

Table 3.15-6 provides demographic and socioeconomic data for all communities identified in this section as having minority and/or low-income populations and potential amplifying factors for impacts of the proposed Project on those populations. A subset of these communities was selected for analysis of EJ impacts based on criteria indicated in the table and is discussed in Chapter 4, Environmental Consequences.

For subsistence fishing, there is a lack of data connecting specific minority and low-income populations to subsistence activities or fisheries. Given this lack of data, communities identified as having minority and low-income populations that may participate in subsistence fishing were not analyzed for EJ impacts at the individual community level. Instead, these impacts are evaluated in the aggregate in Chapter 4.

Table 3.15-6
Communities with Minority and/or Low-Income Populations Considered and Selected for Environmental Justice Impact Analysis

Community	Demographics and Socioeconomics[a]			Selection Criteria			Selected for EJ Impact Analysis
	Total Population	% Minority	% Low-Income	Construction Activities (<0.5 mile from Project)	Near Proposed Project Outfall (<10 miles N or <20 miles S) & Outside Federal Flood Protection on West Bank	Reliance on Impacted Fisheries Commercial: ● Subsistence: ○	
Jefferson Parish							
Avondale	4,989	51%	19%			○	
Barataria	979	18%	5%		●	●	◆
Bridge City	6,894	63%	29%			○	
Crown Point[b]	781	32%	10%		●	●	◆
Estelle	17,099	44%	12%			○	
Grand Isle	757	1%	22%			●	◆
Gretna	17,797	47%	18%			○	
Harvey	20,712	57%	17%			○	
Jean Lafitte	1,971	11%	16%		●[e]	●	◆
Lafitte	990	4%	34%		●[e]	●	◆
Marerro	32,088	58%	21%			○	
Terrytown	24,244	60%	23%			○	
Timberlane	10,192	54%	8%			○	
Westwego	8,499	37%	28%			○	
Woodmere	10,458	85%	22%			○	
Lafourche Parish							
Cut Off	5,897	22%	11%			○	
Des Allemands *(partially in St. Charles Parish)*	1,597	6%	15%			○	
Galliano	7,131	26%	17%			●	◆
Gheens[b]	877	5%	19%[f]			○	
Golden Meadow	2,023	16%	21%			●	◆
Larose	7,529	15%	15%			○	

Table 3.15-6
Communities with Minority and/or Low-Income Populations Considered and Selected for Environmental Justice Impact Analysis

Community	Demographics and Socioeconomics[a]			Selection Criteria			Selected for EJ Impact Analysis
	Total Population	% Minority	% Low-Income	Construction Activities (<0.5 mile from Project)	Near Proposed Project Outfall (<10 miles N or <20 miles S) & Outside Federal Flood Protection on West Bank	Reliance on Impacted Fisheries Commercial: ● Subsistence: ○	
Leeville[b]	58	22%	18%[f]			●	◆
Lockport	2,489	7%	15%			○	
Mathews	2,649	4%	6%			○	
Port Fourchon[b]	42	33%	28%[f]			●	◆
Raceland	10,686	36%	17%			○	
Thibodaux	14,515	36%	19%			○	
Orleans Parish							
New Orleans	389,648	66%	25%				
Plaquemines Parish							
Belle Chasse	13,490	19%	11%			●	◆
Bohemia[b]	22	100%	51%[f]			○	
Boothville	626	53%	34%			○	
Braithwaite[b]	191	50%	51% [f]			○	
Buras	907	24%	23%			●	◆
Davant[b]	777	82%	51%[f]			○	
Empire	1,060	61%	40%			●	◆
Grand Bayou[b,c]	25	72%	18%[f]		●	●	◆
Hermitage[b,c]	62	63%	18%[f]		●	○	◆
Happy Jack[b,c]	16	25%	18%[f]		●	○	◆
Ironton[b]	125-153[e]	89-90%[e]	18%[f]	●		●	◆
Live Oak[b]	2,575	26%	17%			●	◆
Myrtle Grove[b,c,d]	108-136[e]	11-29%[e]	18%[f]		●	○	◆
Phoenix[b]	253	99%	51% [f]			○	
Port Sulphur	2,175	83%	53%			●	◆

Table 3.15-6
Communities with Minority and/or Low-Income Populations Considered and Selected for Environmental Justice Impact Analysis

Community	Demographics and Socioeconomics[a]			Selection Criteria			Selected for EJ Impact Analysis
	Total Population	% Minority	% Low-Income	Construction Activities (<0.5 mile from Project)	Near Proposed Project Outfall (<10 miles N or <20 miles S) & Outside Federal Flood Protection on West Bank	Reliance on Impacted Fisheries Commercial: ● Subsistence: ○	
Scarsdale[b]	41	12%	51%[f]			○	
Suzie Bayou[b,c]	40-157	22-35%	18%[f]		●	●	◆
Triumph	493	26%	17%			○	
Venice	245	4%	11%			●	◆
West Pointe A La Hache[b]	32	75%	18%[f]			●	◆
Wills Point[b]	23	26%	51%[f]			○	
Woodlawn[b]	107	42%	51%[f]			○	
St. Bernard Parish							
Chalmette	23,602	31%	21%				
Meraux	7,296	19%	10%				
Violet	5,424	70%	20%				
St. Charles Parish							
Luling	13,614	23%	11%				
Paradis	1,759	6%	4%				

a For incorporated place, Census Designated Place (CDP), and block group levels data, the source is ACS 5-Year Estimates, 2014-2018 (U.S. Census Bureau 2020). While 2020 ACS data was recently released, some data quality concerns exist regarding these data, which continue to be released as of this Final EIS (for example, see U.S. Census Bureau 2021a).

b For block-level data, which is used here to report demographics of very small communities, the source is U.S. Census Bureau Decennial Census 2020. The Draft EIS reported 2010 Decennial Census data for block-level data, which has been updated in the Final EIS to 2020 Decennial Census data. Poverty data is unavailable at block level. Because Census and ACS data collection methods differ, data issues related to COVID-19 have a more limited impact on the Decennial Census (U.S. Census Bureau 2021b). However, the adoption of differential privacy measures in data reporting for the 2020 Census introduces new uncertainties related to data reported at smaller geographic scales than existed in the 2010 Decennial Census (U.S. Census Bureau 2021c). Because these communities are important to the EIS evaluation and received public comment, and because the updated data represent much more recent data, the block-level Decennial Census data have been updated in the Final EIS.

c For the 2020 Census, portions of both Ironton and Myrtle Grove fall within Census Block 1031 (Block Group 1, Census Tract 504, Plaquemines Parish). Consequently, exact population totals, including minority populations, for Ironton and Myrtle Grove cannot be determined. To account for uncertainty, the

Table 3.15-6
Communities with Minority and/or Low-Income Populations Considered and Selected for Environmental Justice Impact Analysis

Community	Demographics and Socioeconomics[a]			Selection Criteria			Selected for EJ Impact Analysis
	Total Population	% Minority	% Low-Income	Construction Activities (<0.5 mile from Project)	Near Proposed Project Outfall (<10 miles N or <20 miles S) & Outside Federal Flood Protection on West Bank	Reliance on Impacted Fisheries Commercial: ● Subsistence: ○	

lower bound estimate for Ironton excludes all populations counted in Block 1031, while the upper bound estimate includes all populations counted in Block 1031. Similarly, the lower bound estimate for Myrtle Grove excludes all populations counted in Block 1031, while the upper bound estimate includes all populations counted in Block 1031. In addition, portions of Suzie Bayou and Myrtle Grove fall within Census Block 1076 and portions of Suzie Bayou and Hermitage fall within Census Block 1099 (Block Group 1, Census Tract 504, Plaquemines Parish). The lower bound estimate for Suzie Bayou excludes all of the populations in the two blocks, while the upper bound includes all populations in the two blocks.

d The community of Woodpark is included in a census block that overlaps Myrtle Grove and as such is combined with Myrtle Grove in this table, Census Block 1076 (Block Group 1, Census Tract 504, Plaquemines Parish).

e Local/non-federal levee system only.

f Unlike racial demographic data, poverty data are not available at the block level from the ACS. Poverty data for communities in non-incorporated, non-CDP areas are taken from the corresponding census tract. For Ironton, Myrtle Grove, Suzie Bayou, Grand Bayou, Hermitage, Happy Jack, and West Pointe A La Hache, poverty data are presented for Census Tract 504, Plaquemines Parish; for Crown Point: Tract 280, Jefferson Parish; for Leeville: Tract 212, Lafourche Parish; and for Port Fourchon: Tract 211.01, Lafourche Parish.

Figure 3.15-1 depicts selected communities, their populations, and major levee systems within the Project area, indicating whether these communities are located inside or outside of federal levee systems and illustrating their proximity to 10 miles inland and 20 miles gulfward of the proposed diversion outfall.

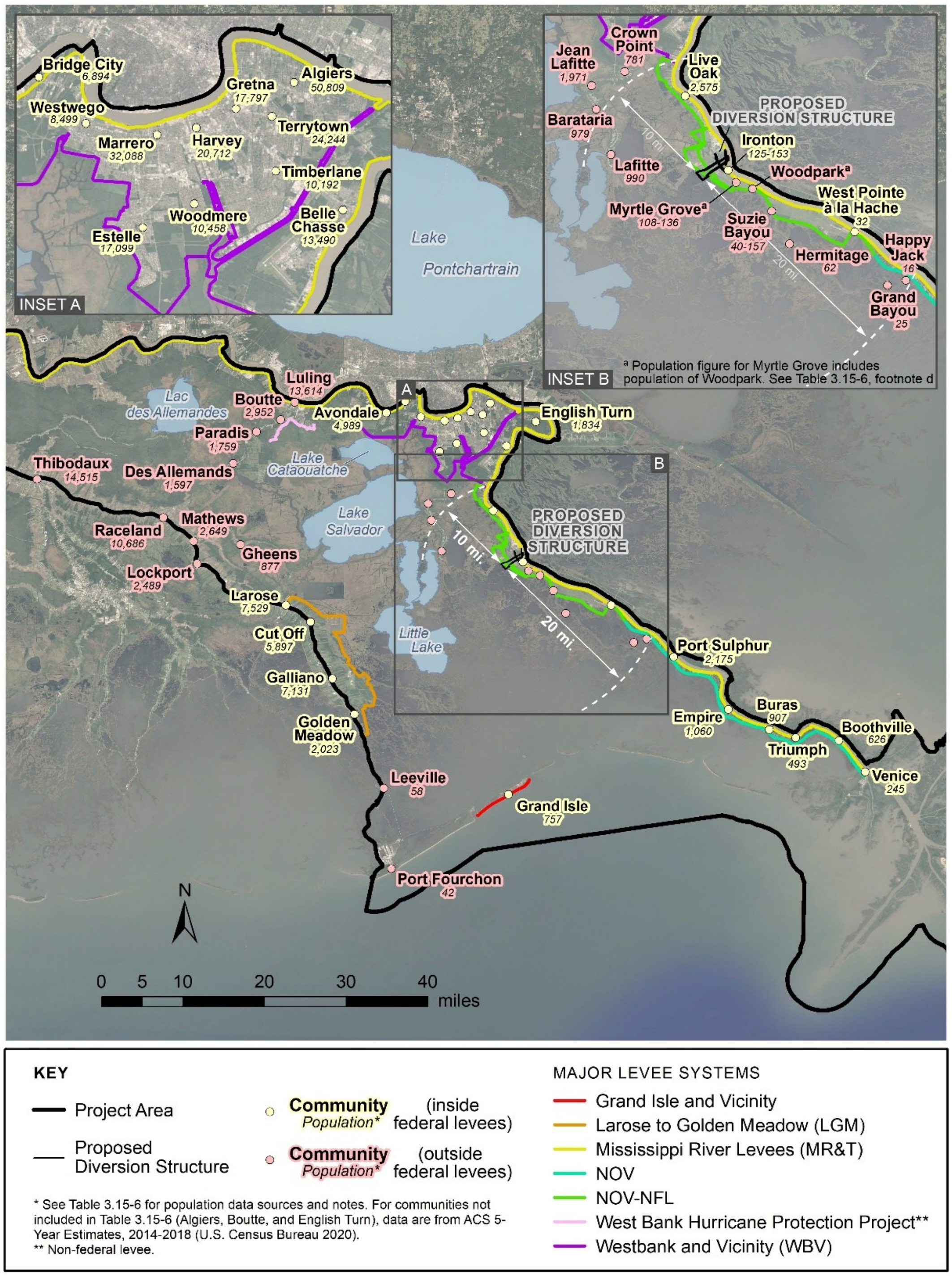


Figure 3.15-1. Selected Communities, Populations, and Major Levee Systems within the Project Area.

Figures 3.15-2 and 3.15-3 show the communities selected for EJ impact analysis in Chapter 4, as indicated in Table 3.15-6, in relation to the proposed Project. Data on minority populations and low-income populations, respectively, reflect census block groups within or intersecting the Project area.

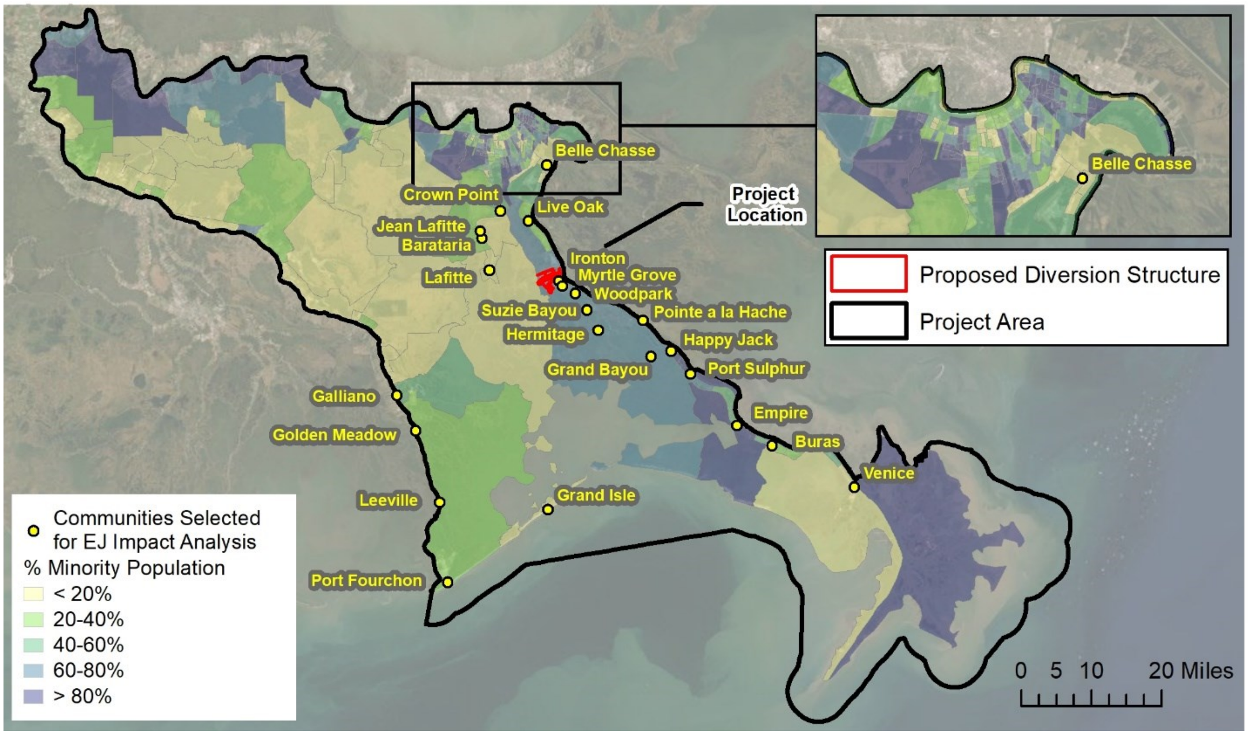


Figure 3.15-2. Selected Communities for Environmental Justice Impact Analysis, with Data on Minority Populations by Census Block Groups within or intersecting the Project Area.

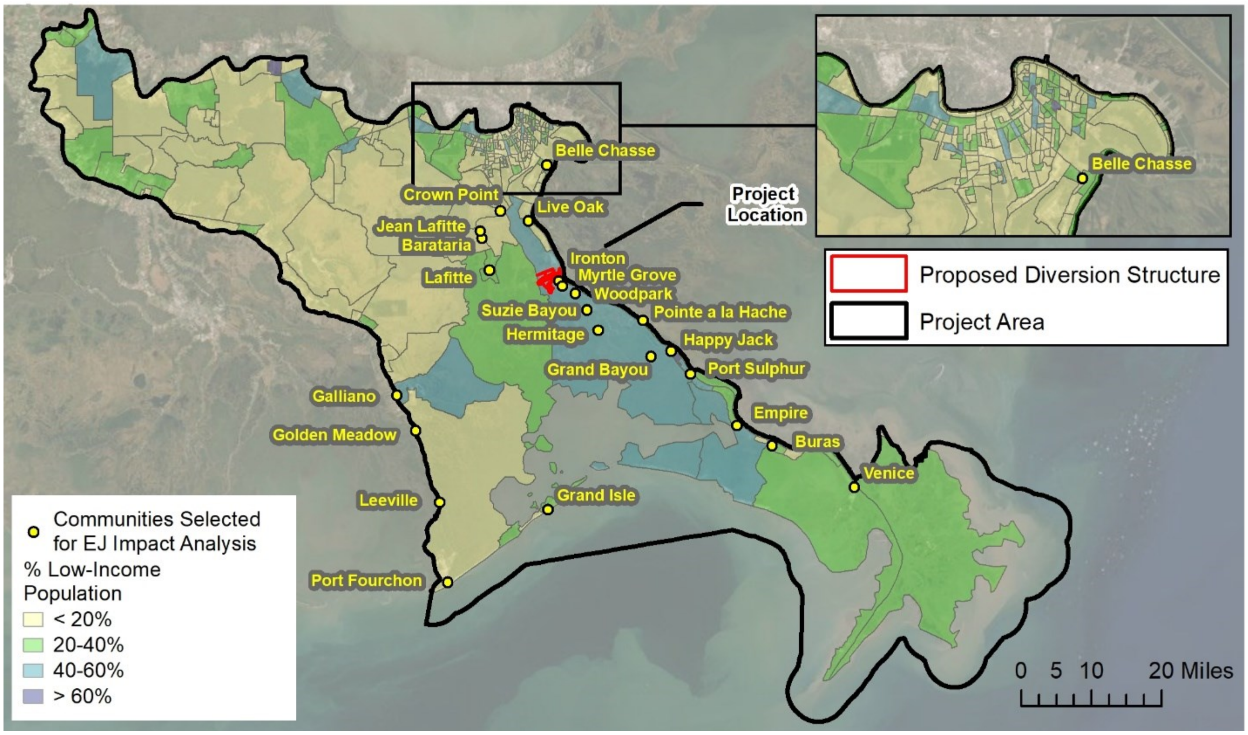


Figure 3.15-3. Selected Communities for Environmental Justice Impact Analysis, with Data on Low-income Populations by Census Block Groups within or intersecting the Project Area.

Figure 3.15-4 shows the proportion of minority populations by U.S. Census Block located near the location of the proposed Project. The boundaries of several of the communities shown – Myrtle Grove, Hermitage, Grand Bayou, and Happy Jack – do not coincide with census block boundaries. As a result, it is not possible to determine the exact overall population or minority population within these communities. However, each of these communities contains census blocks that include minority populations (entirely within their boundaries and which do not overlap with adjacent communities), as indicated in Table 3.15-6. The inset in Figure 3.15-4 shows that census blocks with minority populations fall entirely within the boundaries of Myrtle Grove. Data for a comparable map of low-income populations within these census blocks are not available.

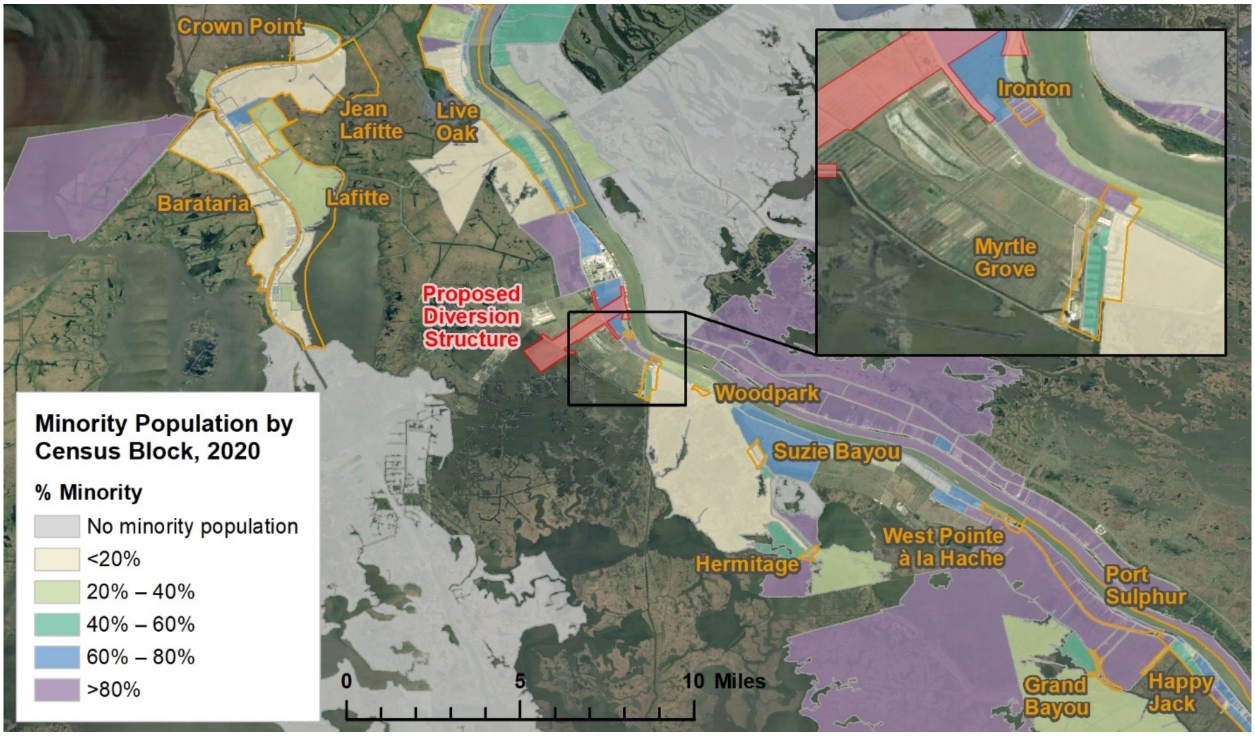


Figure 3.15-4. Proportion of Minority Populations by U.S. Census Block near the Proposed Project.

3.16 RECREATION AND TOURISM

3.16.1 Introduction

The varied landscape and waterways in the Project area support a wide range of activities for outdoor recreationalists and tourists (defined as in-state or out-of-state travelers for recreational purposes), including fishing, hunting, wildlife watching, and boating. This section describes the recreational resources within the Project area, including an overview of the regulatory environment and trends in recent activity levels. Where available, recreation data presented in this section is derived from site-specific data within the Project area; parish-level data are used when site-specific data are not available.

3.16.1.1 Recreation Sites

The Project area includes a wide variety of recreation sites, including a variety of protected or designated lands (referred to as recreation areas), public fishing access points, boat launches, marinas, and hunting areas (see Figure 3.16-1 for a map of recreation sites in the Project area). Table 3.16-1 and Table 3.16-2 provide descriptions of the recreation lands and facilities in the Project area, which includes a total of 14 public recreation areas and 37 recreation sites that offer fishing access, boat ramps, or marinas. While recreation may occur on private and other lands outside of the area identified on the map and in the tables, these exhibits highlight those areas designed to provide outdoor recreational opportunities for the public. See Section 3.14 Commercial

Fisheries for information regarding commercial fishing areas, including oyster grounds, in the Project area.

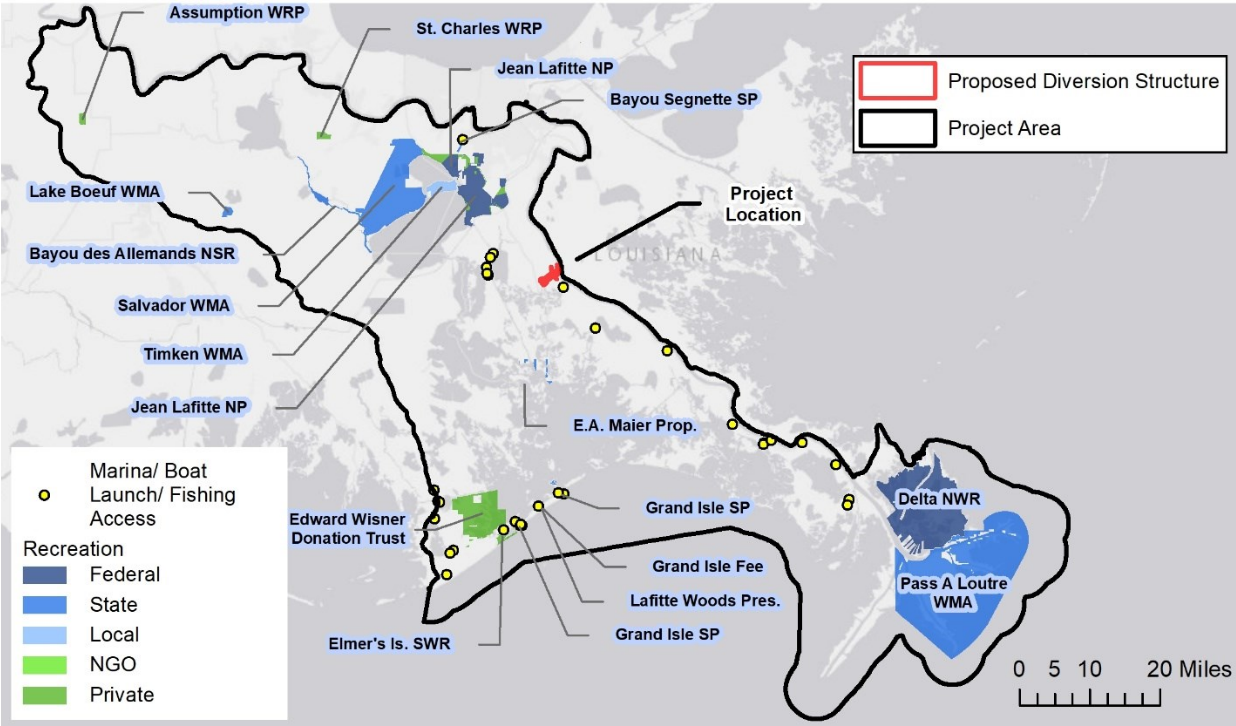


Figure 3.16-1. Map of Recreation Resources in the Project Area.

Table 3.16-1
Recreation Areas[a] in the Project 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	N/A	50,000
National Park Service	Jean Lafitte National Historical Park and Preserve-Barataria Preserve	Jefferson	Restricted fishing, restricted hunting, trails, wildlife watching	457,000 (409,000 in Barataria Unit)	23,000
State					
LDWF	Pass A Loutre Wildlife Management Area	Plaquemines	Restricted fishing, boat ramps, restricted hunting	N/A	115,000
	Salvador Wildlife Management Area	St. Charles	Restricted fishing, boat ramps, restricted hunting, trails, wildlife watching	N/A	32,000
	Timken Wildlife Management Area	St. Charles	Restricted fishing, boat ramps, restricted hunting, trails, wildlife watching	N/A	2,900
	Bayou des Allemands Natural and Scenic River	Lafourche and St. Charles	Protected area	N/A	2,600
	Elmer's Island Wildlife Refuge	Jefferson	Fishing access, wildlife watching	N/A	1,100
	Lake Boeuf Wildlife Management Area	Lafourche	Fishing access, boat ramps, hunting, trails, wildlife watching	N/A	800
Louisiana State Park and Recreation	Bayou Segnette State Park	Jefferson	Fishing access, 6 boat ramps, trails, wildlife watching	201,805 (2011)	580
	Grand Isle State Park	Jefferson	Fishing access, boat ramp, trails	105,737 (2011)	210
LDNR	E.A. Maier Family Donation	Jefferson	Unspecified	N/A	800
Private					
Private	Wisner Wildlife Management Area	Lafourche	Unspecified	N/A	17,000
Non-Governmental Organization (NGO)	Grand Isle Fee	Jefferson	Fishing access	N/A	2
NGO (The Nature Conservancy)	Lafitte Woods Preserve	Jefferson	Wildlife watching	N/A	7

Sources: USGS 2016, LDWF 2018e, NPS 2018, Office of Parks 2012.

[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.

Table 3.16-2 Recreational Fishing and Boating Access Facilities in the Project Area			
Site Name	**Waterbody**	**Closest Town**	**Facilities / Activities Description**
Jefferson Parish			
Buras Boat Harbor	Bay Pomme D'or	Grand Isle	Marina
Sand Dollar Marina	Bayou Fifi	Grand Isle	Marina, fishing access, boat ramp
Bank Along Hwy 1 Roadside	Bayou Lafourche	Fourchon	Fishing access
Jean Lafitte Harbor	Bayou Rigolettes	Lafitte	Fishing access, 2 boat ramps
Jean Lafitte Public Boat Launch	Bayou Barataria	Crown Point	Fishing access, 2 boat ramps
Lafitte Public Fishing Pier	Bayou Rigolettes	Lafitte	Fishing access
Seaway Marina	Bayou Rigolettes	Lafitte	Marina, fishing access, 2 boat ramps
Bayou Segnette State Park	Bayou Segnette	Westwego	Fishing access, boat ramp
Abandoned Hwy 1 Bridge (East)	Caminada Bay	Grand Isle	Fishing access
Abandoned Hwy 1 Bridge (West)	Caminada Bay	Grand Isle	Fishing access
Elmer's Island Camping And Fishing	Caminada Bay	Grand Isle	Fishing access
Bridge Side Marina	Caminada Bay	Grand Isle	Marina, fishing access, boat ramp
Grand Isle Kayak Launch	Caminada Bay	Grand Isle	Kayak launch
Wakeside Marina	Caminada Bay	Grand Isle	Fishing access, 2 boat ramps
Grand Isle Beach Area (also, Grand Isle, Mid-Island)	Gulf of Mexico	Grand Isle	Fishing access, wildlife watching
Grand Isle State Park Fishing Pier	Gulf of Mexico	Grand Isle	Fishing access
Joe's Landing	The Pen	Barataria	Marina, fishing access, 2 boat ramps
Cochiara Shipyard and Marina	The Pen	Lafitte	Marina, fishing access, 2 boat ramps
Lafourche Parish			
Bobby Lynn's Marina	Bayou Lafourche	Leeville	Marina, fishing access, boat ramp
Moran's Marina	Bayou Lafourche	Golden Meadow	Marina, fishing access
Port Fourchon Marina	Bayou Lafourche	Golden Meadow	Marina, fishing access, boat ramp
Oak Ridge Launch	Catfish Lake	Golden Meadow	Fishing access, 3 boat ramps
Leeville Public Launch	Bayou Lafourche	Leeville	Fishing access, 2 boat ramps
Top Water Marina	Bayou Lafourche	Leeville	Fishing access, 2 boat ramps
Irvin P. Melancon Parish Public Boat Launch	Bayou Lafourche	Port Fourchon	Fishing access, 2 boat ramps
Roadside Along Shoulder Of Hwy 1	Bayou Lafourche	Port Fourchon	Fishing access

Table 3.16-2
Recreational Fishing and Boating Access Facilities in the Project Area

Site Name	Waterbody	Closest Town	Facilities / Activities Description
Plaquemines Parish			
Delta Marina	Adam’s Bay	Empire	Marina, fishing access, boat ramp
Joshua’s Marina	Bay Pomme D’or	Buras	Marina, fishing access, boat ramp
Bayou Log Cabins	Lake Judge Perez	Lake Hermitage	Fishing access, boat ramp
Riverside Marina	Mississippi River	Buras	Fishing access, boat ramp
Myrtle Grove Marina	Mississippi River	Myrtle Grove	Marina, fishing access, 2 boat ramps
Happy Jack’s Marina	Mississippi River	Port Sulphur	Fishing access, boat ramp
Fort Jackson	Mississippi River	Venice	Fishing access, boat ramp
Port Sulphur Launch	Bay Lanaux	Port Sulphur	Fishing access, 2 boat ramps
Cypress Cove Marina	West Bay	Venice	Marina, fishing access, 2 boat ramps
Venice Marina	West Bay	Venice	Marina, fishing access, 3 boat ramps
Yellow Cotton Marina	Yellow Cotton Bay	Yellow Cotton	Fishing access, 2 boat ramps
Sources: NMFS 2018a, NOAA 2013, USDOI 2020b.			

3.16.1.2 Regional Economic Contribution of Outdoor Recreation and Tourism

Natural resource dependent recreational activities, including fishing, hunting, wildlife viewing, and boating, can provide a source of economic stability to rural communities where other commercial and industrial activity is relatively limited. Regional economic models are tools that allow analysts to determine how a single stimulus, such as spending related to a birding trip, trigger additional spending between interrelated sectors in the regional economy. This is known as the “ripple effect” or “multiplier effect.” For example, Southwick Associates quantified how expenditures on recreation in Louisiana stimulate activity in related economic sectors. This study determined that fishing (inclusive of both commercial and recreational fishing and shellfishing), wildlife, and boating-related activities account for six percent of Louisiana’s total employment and six percent of the state’s Gross State Product. Overall, at the state level, these activities generated $8 billion in economic activity, $532 million in state and local tax revenues, $503 million in federal tax revenues, and accounted for 76,700 jobs in 2006 (Southwick 2008). All dollar values in this section are presented in 2017 dollars applying the GDP deflator.

3.16.2 Recreational Fishing

Recreational fishing in the Project area includes fishing for oysters, shrimp, crab, crawfish, and various finfish species. The most popular freshwater finfish species for recreational fishing in Louisiana in 2011 were crappie, panfish, bass, and catfish. Popular finfish species include red drum (red fish) and seatrout (weakfish, speck) (USDOI 2013). The Project area contains 42 public access fishing sites (30 with boat ramps), 18 marinas, four Wildlife Management Areas (WMAs) and one Wildlife Refuge with restricted fishing, two state parks with boat and fishing access, and one National Historical Park and Preserve with restricted fishing.

3.16.2.1 Regulatory Environment

LDWF regulates both freshwater and saltwater fishing in Louisiana state waters, which include inland waterbodies to waters three miles offshore. LDWF, in coordination with the LWFC, manages fishing licensing, gear, bait, bag limits, species, seasons, and closures (LDWF 2018f). In addition to LDWF, the Louisiana Department of Health and Hospitals (DHH) regulates oyster areas and seasons in state waters through the Molluscan Shellfish Program. In the event of public health concerns related to oystering, DHH has the authority to close oyster harvesting areas (LDWF 2018a). Individuals over the age of 16 are required to obtain the appropriate fishing license for recreational fishing pursuits.

To ensure sustainable fishery management and healthy fish populations, LDWF regulates fishing seasons and bag limits on a per-species and often per-season basis. In general, LDWF regulations prohibit recreational anglers from harvesting species listed under the federal Endangered Species Act (LDWF 2018f).

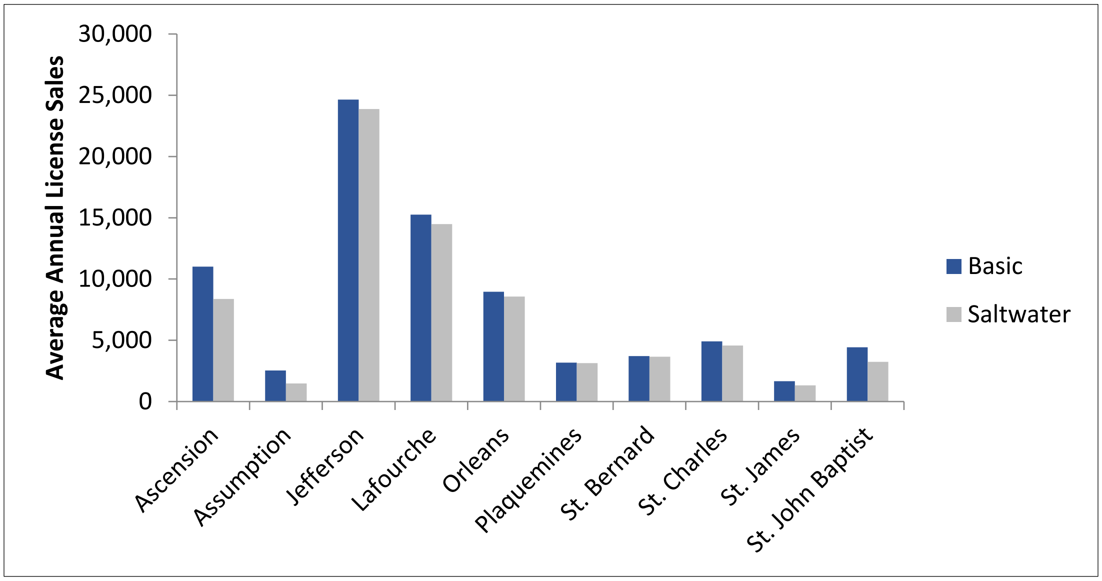
3.16.2.2 Special Fishing Regulations on Wildlife Management Areas, Refuges, and Federal Lands

Fishing on LDWF-administered lands, such as WMAs, wildlife refuges, and habitat conservation areas, requires a license. Regulations are specific to each area. The Project area completely or partially includes the following five LDWF-administered lands: Elmer’s Island Wildlife Refuge, Lake Boeuf WMA, Pass A Loutre WMA, Salvador WMA, and Timken WMA. Federally managed lands such as Jean Lafitte National Historical Park and Preserve and the Delta NWR maintain additional fishing regulations: both areas require compliance with LDWF fishing regulations in addition to area-specific location, season, and time restrictions (NPS 2014, USFWS 2018b).

3.16.2.3 Participation in Recreational Fishing

LDWF license sales data from 2010 to 2017 depicts activity levels and trends for various recreational fishing activities in the Project area and across the state (LDWF 2018h). Most fishing licenses purchased in the Project area are for saltwater fishing (approximately 71,000 saltwater licenses were purchased annually between 2010 and 2017 in the Project area) (see Figure 3.16-2). Saltwater 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. Approximately 79,000 basic licenses were sold annually between 2010 and 2017, suggesting that over 90 percent of licensed anglers engaged in saltwater fishing activities. Saltwater license sales were highest in Jefferson and Lafourche Parishes. Jefferson is the most populated parish in the Project area according to the 2016 census population estimate, likely contributing to the high number of license sales in that parish (U.S. Census Bureau 2017c). Lafourche Parish is the fourth most populated parish in the Project area behind Jefferson, Orleans, and Ascension, but is close to Jefferson in number of license sales. As shown, while saltwater license sales are more prevalent than basic license-only sales throughout the Project area, more freshwater fishing licenses are sold in the four inland parishes in the

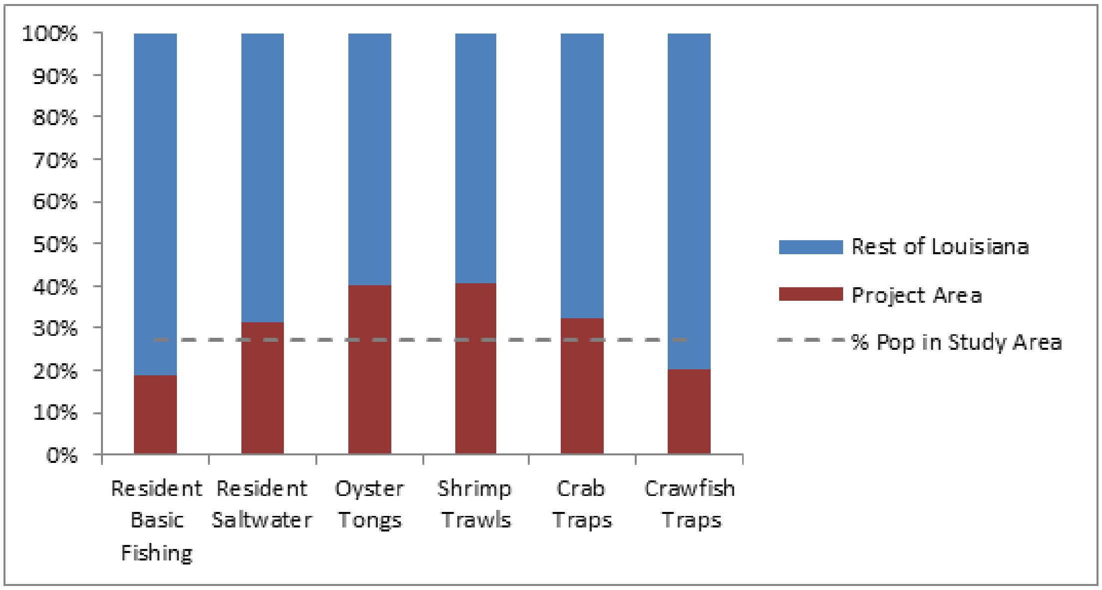
Project area (Ascension, Assumption, St. John the Baptist, and St. James) than in coastal parishes. A decline in the number of fishing licenses issued has occurred in recent years.



Source: LDWF 2018d

Figure 3.16-2. Annual Saltwater and Basic Fishing License Sales for Residents and Non-residents in the Project Area, Average 2010 to 2017.

Saltwater fishing activities including oystering, shrimping, and crabbing occur at higher rates in the Project area than in the state as a whole (see Figure 3.16-3). According to the 2016 Oyster Fisheries Management Plan, recreational oyster harvest likely accounts for less than 0.1 percent of the overall oyster harvest in Louisiana (Banks et al. 2016). Despite an overall small recreational oyster harvest compared to the commercial harvest, Figure 3.16-3 demonstrates that recreational oystering in the Project area, as approximated by oyster tong license sales, accounts for 40 percent of the state's total recreational oyster harvest. Recreational shrimping and crabbing gear license sales in the Project area account for 41 and 32 percent, respectively, of the state's total. Recreational crawfish gear license sales in the Project area only account for 20 percent of the state's total. Because finfish fishing does not require specific gear licenses, the LDWF license sales data cannot be used to discern between finfish species licenses in the Project area.



Sources: LDWF 2018h, U.S. Census Bureau 2017c

Figure 3.16-3. Percent of License Sales in the Project Area Parishes as Percent of All Sales in State. Project area population line indicates the percentage of Louisiana population living in Project area parishes (below the dotted line) and the percent of the population living in the rest of Louisiana (above the line).

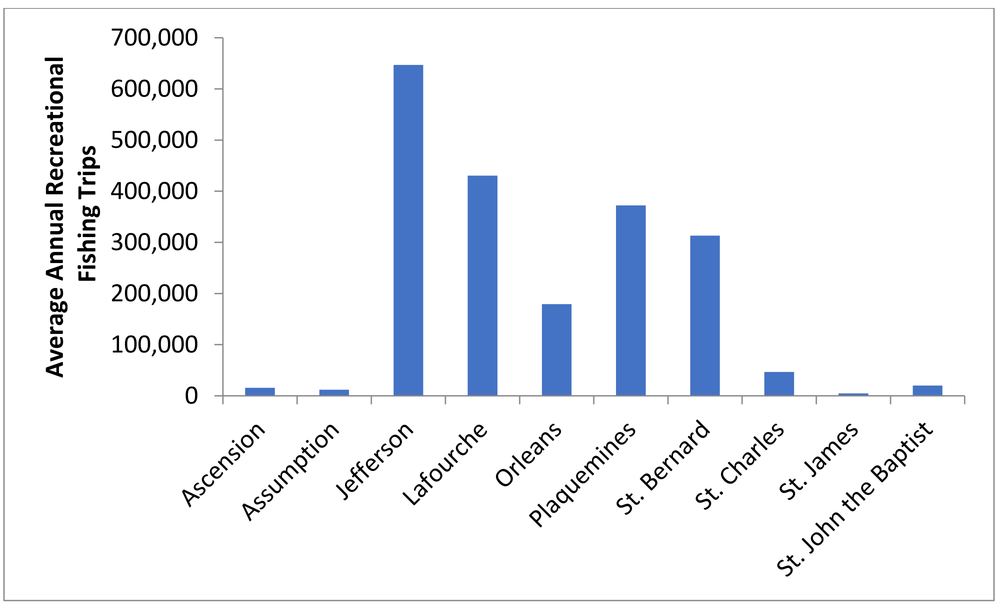
NOAA's Marine Recreational Information Program (MRIP) also provides information on recreational fishing in the Project area. Table 3.16-3 depicts an estimated number of recreational fishing trips in Project area parishes between 2010 and 2016. As evidenced by these data, recreational fishing was low in 2010, likely due to area closures precluding recreational fishing following the DWH oil spill. MRIP trip estimates indicate that Jefferson and Lafourche Parishes host the greatest average number of recreational fishing trips per year in the Project area (see Figure 3.16-4).

Table 3.16-3
MRIP-estimated Recreational Fishing Trips by Parish, 2010 to 2016[a]

Parish	2010	2011	2012	2013	2014	2015	2016	Annual Average
Ascension	30,284	30,103	1,088	519	36,591	7,823	2,652	15,580
Assumption	5,196	14,623	3,541	25,161	5,976	5,494	24,163	12,022
Jefferson	583,667	776,135	539,383	730,802	724,886	533,000	641,214	647,012
Lafourche	289,193	510,832	510,259	336,544	440,696	389,669	534,875	430,295
Orleans	214,519	157,759	133,846	210,102	142,693	223,384	172,353	179,237
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
St. Charles	23,255	161,900	35,250	21,866	33,173	37,871	13,165	46,640
St. James	7,377	5,616	3,327	1,366	9,476	3,480	2,653	4,756
St. John the Baptist	29,227	4,764	31,396	20,823	9,504	20,653	23,177	19,935
Project Area Total	**1,804,474**	**2,598,127**	**2,013,026**	**2,093,742**	**1,980,432**	**1,763,650**	**2,033,907**	**2,041,051**

Source: NOAA NMFS 2018a.

[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 to 2016 estimates.



Source: NOAA NMFS 2018a.

Figure 3.16-4. Average Annual MRIP-estimated Recreational Fishing Trips in Project Area Parishes, 2010 to 2016.

In addition to license sales and fishing trip estimates, indicators of the importance of recreational fishing within the Project 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 3.16-4 presents information on the two indices for the coastal communities that fall within the Project area and are included in the dataset. 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 relative to the population of a community. High rank indicates increased reliance.

Table 3.16-4
Recreational Fishing Engagement and Reliance Indices by Coastal Community, 2014[a]

Coastal Community	Recreational Fishing Engagement	Recreational Fishing Reliance
Avondale	Low	Low
Barataria	Low	Medium
Bridge City	Low	Low
Grand Isle	High	High
Gretna	Low	Low
Lafitte	Medium High	Medium
Terrytown	Low	Low
Westwego	Low	Low
Cut Off	Low	Low
Galliano	Low	Low
Lockport	Low	Medium
Raceland	Low	Low
Thibodaux	Low	Low
Golden Meadow	Medium High	Medium
Larose	Low	Low
New Orleans	High	Low
Belle Chasse	Low	Low
Boothville	Low	Low
Venice	High	High
Buras	Medium	Medium High
Empire	Medium	Medium High
Port Sulphur	Medium	Low
Chalmette	Medium	Low
Meraux	Low	Low
Violet	Low	Low
Des Allemands	Low	Low
Luling	Low	Low
Paradis	Low	Low

Source: NOAA 2018b. 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.

Another source that can be used to estimate recreational fishing participation in the Project area is the *Deepwater Horizon* (DWH) Boating Valuation Survey (U.S. Department of the Interior 2020a). This survey was conducted in support of the NRDA for the DWH oil spill. The survey was administered from April 2012 through June 2013 to residents of Louisiana, Mississippi, Alabama, and Florida, plus portions of Georgia. This sample was supplemented with addresses of registered boaters. Interviews were completed with 2,585 individuals. The respondents identified locations where they launched their boats to participate in boat-based coastal recreation along the Gulf of Mexico. The survey captured all types of boating trips where the main purpose was fishing, hunting, wildlife viewing, or general recreation, though it did not ask respondents to report which boating activities they engaged in during their trips. Much of the boating use captured by the survey is believed to be associated with recreational fishing. Weighted up to the population, the survey implies an estimated 377,974 boating trips took place at sites in the Barataria Basin annually (see Table 3.16-5). See Appendix H for more details about this survey.

Table 3.16-5
Estimated Annual Boating Trips by Site in the Barataria Basin

Site Name	Parish	Total Trips
Jean Lafitte Launch	Jefferson	47,670
Jean Lafitte Harbor	Jefferson	11,283
Myrtle Grove Marina	Plaquemines	20,733
Port Sulphur Launch	Plaquemines	29,563
Oak Ridge Launch	Lafourche	90,067
Top Water Marina	Lafourche	25,418
Leeville Boat Launch	Lafourche	13,870
Buras Boat Harbor	Plaquemines	25,521
Sand Dollar Marina	Jefferson	19,766
Grand Isle, Mid-Island	Jefferson	37,165
Grand Isle, Bridge Side	Jefferson	56,919
Total		**377,974**

Source: DWH Boating Valuation Survey, USDOI 2020b. Supporting analysis in Appendix H.

[a] As described in Appendix H a site aggregation approach was applied to sites in and near the Barataria Basin in which trips to low-visitation sites were assigned to their nearest neighbor sites. Thus, the trip estimates presented in this table include trips to the sites listed in the Site Name column and to some low-visitation sites located nearby.

Finally, the LDWF LA Creel Survey is a survey designed to estimate the number of anglers that fish in Louisiana, the number of trips taken by those anglers, and the species targeted and caught on those trips. The survey involves a weekly telephone call to both in-state and out-of-state holders of Louisiana fishing licenses asking whether they fished in the previous week and, if so, where. Fishing destinations are characterized at a broad scale with one destination being the Barataria Basin. Surveys with anglers at recreation access points are used separately to record information on species targeted and caught. The program was started in 2014 and replaced the MRIP, which was administered by NOAA. From 2014 through 2018, an average of 566,343 fishing trips were taken to the Barataria Basin annually (see Table 3.16-6). The fishing estimates from LA Creel overlap with the estimates from the DWH surveys because both of those surveys included recreational fishing. See Appendix H for more details about this survey.

Table 3.16-6
Estimated Fishing Trips by Year in the Barataria Basin, 2014 to 2018

Year	Total Trips
2014	423,061
2015	570,217
2016	583,301
2017	674,880
2018	580,254
Average	**566,343**

Source: LA Creel data provided by LDWF (2019).

3.16.2.4 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 $884 million on trip-related expenditures and equipment within the state. This equates to approximately $1,050 per angler including spending on fishing equipment, as well as approximately $33 per fishing day for trip-related expenses, such as boating costs, bait, food, and lodging (USDOI 2013).

Accounting for the multiplier effects of recreational fishing and shellfishing, one study estimated a total regional economic contribution of $903 million in 2006, as well as more than 18,000 jobs and $136 million in state and local tax revenues. Approximately 56 percent of the economic activity generated was associated with freshwater recreational fishing in that year (Southwick 2008).

3.16.3 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 percent hunted big game (for example, deer, turkey), 34 percent hunted small game (for example, squirrel, rabbits), and 40 percent hunted migratory birds (for example, ducks, geese). Resident hunters accounted for 91 percent of all hunters in Louisiana in 2011 (USDOI 2013).

3.16.3.1 Regulatory Environment

The minimum license requirement to hunt quadrupeds 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 2018i).

3.16.3.2 Special Hunting Regulations on Wildlife Management Areas, Refuges, and Conservation Areas

Land managed by the LDWF includes WMAs, wildlife refuges, and habitat conservation areas (LDWF 2018j). Hunting on any land managed by LDWF requires a WMA Hunting Permit. In 2011, 36 percent of hunters in Louisiana (both residents and non-residents above the age of 16) hunted on public land and 75 percent hunted on private land (USDOI et al. 2013).

3.16.3.3 Hunting Participation

Table 3.16-7 presents the most popular types of hunting licenses purchased in the Project area and a comparison to Louisiana as a whole. The most popular types of licenses obtained or purchased in the Project area were the Migratory Bird Harvest Information Program (HIP) Certification (required to hunt migratory birds), combination hunting and fishing licenses, and the basic hunting license. There were also significant numbers of big game and duck licenses purchased, while turkey and special equipment licenses were not as popular. Nearly one-fifth of all combination hunting/fishing licenses and trapping licenses purchased in Louisiana were purchased in the Project area, although they were not necessarily used in the same area in which they were purchased.

Table 3.16-7
Average Annual Number of Hunting Licenses by Type, 2010 to 2017[a]

Type of License	Number of Licenses Sold in Project Area Parishes[b]	Percent of State Total
HIP Certification[c]	21,817	11%
Combo Hunt and Fish[d]	19,403	17%
Basic Hunt	19,328	10%
Big Game	11,679	8%
Duck	9,243	13%
WMA Hunting Permit	5,091	13%
Primitive Firearms	2,788	8%
Bow	2,528	8%
Turkey	480	4%
Trapping	396	18%
Combo Hunt[d]	296	2%

Source: LDWF 2018h.

[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 2010 to 2017.

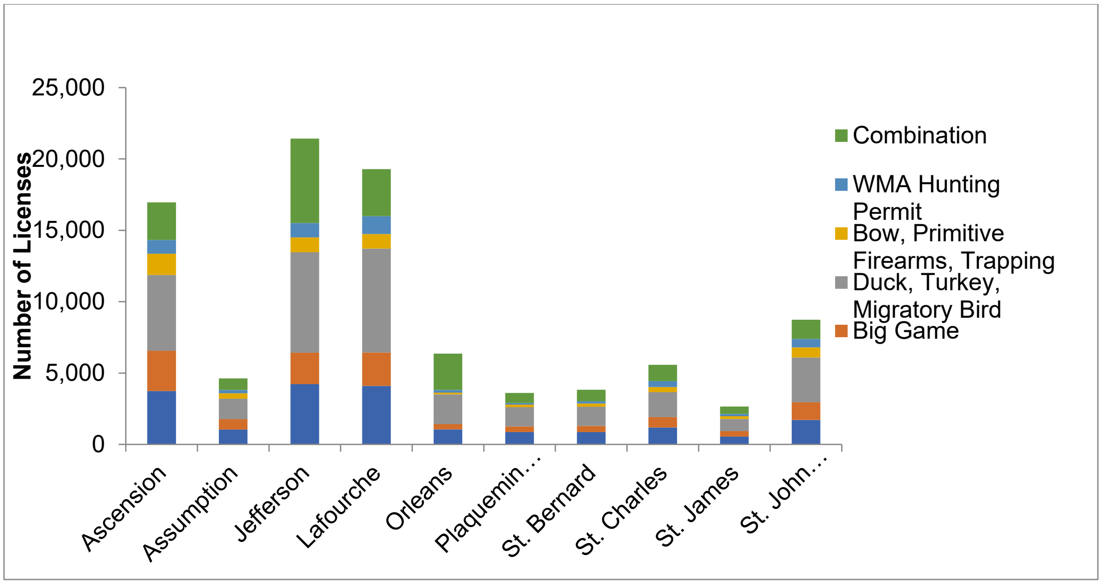
[b] These totals are for the entirety of the listed parishes (not just the portions of the parishes found within the Project area).

[c] The HIP Certification is required for all migratory bird hunters.

[d] 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.

Figure 3.16-5 illustrates the average annual hunting license counts by parish where the license was sold over the period 2010 to 2017. Ascension, Jefferson, and Lafourche Parishes had the highest total numbers of licenses purchased. Duck, turkey, and migratory bird hunting licenses were the most popular types of licenses obtained.

As noted, 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 2018j). After a successful hunt, the hunter must tag the animal, record the date and parish of the kill, and validate the tag.



Source: LDWF 2018h

Figure 3.16-5. Average Annual Number of License Sales by Parish, 2010 to 2017.

According to the Louisiana Deer Report 2016 to 2017, none of the 10 parishes in the Project area were in the top 20 total harvest parishes or in the top 20 harvest per acre parishes in Louisiana (LDWF 2017m). The top deer hunting parishes in Louisiana in 2016 to 2017 were outside of the Barataria and Mississippi River Basins (LDWF 2017m). The only parish in the Project area that is in a turkey hunting zone is Ascension. In 2009, there were six reported wild turkeys harvested in Ascension compared to the state total of 2,586, and in 2010, there was one reported wild turkey harvested in Ascension compared to the state total of 2,221 (LDWF 2010a). Overall, deer or turkey hunting activity within the Project area is very limited.

LDWF has established regulations governing the harvest of wild populations of alligators and alligator eggs, and raising and propagation of farmed alligators. Approximately 81 percent 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 (for example, in Lafourche Parish, there is one alligator tag issued per 140 acres of brackish marsh). Tag allotment for a particular area is determined by area-specific factors such as prior harvest statistics and habitat and biological assessments. In 2015, 63 percent of the non-marsh alligator tags for the cypress-tupelo swamp region in the northern portion of the Project area were allotted to parishes in the Project area (Ascension, Assumption, Lafourche, St. Charles, St. James, and St. John the Baptist) (LDWF 2016a).

Hunters may also harvest alligators on public lands through a lottery process (LDWF 2018b). An alligator hunting license is required for hunting on private or public land (LDWF 2017n). Alligator hunting is managed by LDWF in some WMAs in the Project area. In 2015, six alligator tags were issued to hunters for the Lake Boeuf

WMA, and four of the tags were filled. In Pass A Loutre WMA, 350 commercial tags and 27 recreational lottery tags were issued to alligator hunters in the 2015 season. All but two of the tags were filled. LDWF issued 456 commercial tags and 30 recreational lottery tags for alligator harvest in the Salvador/Timken WMAs, and 483 tags were filled. Overall in the 2015 lottery alligator harvest program, 349 hunters harvested a total of 897 alligators in 45 public areas throughout the state (LDWF 2016a). 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 Project area. As of January 2016, there were 55 licensed farmers in Louisiana with farm inventories totaling 807,986 alligators; two parishes within the Project area are home to alligator farms as of December 2015 (Plaquemines and Lafourche) (LDWF 2016a).

Another source that can be used to estimate recreational hunting participation in the Project area, as well as other shoreline activities like wildlife watching, is the Deepwater Horizon (DWH) Shoreline Use Valuation Survey (USDOI 2020a). This survey was conducted in support of the NRDA that followed the DWH oil spill. It collected information about non-boat based recreational activities, including shore-based fishing, wildlife viewing, hunting, and other types of general shoreline use, though the survey did not ask respondents to report which shoreline activities they engaged in during their trips. During 2012 and 2013, 41,716 telephone interviews were conducted with a sample of households in the contiguous 48 United States. Weighted up to the population, the survey implies that approximately 645,000 annual shoreline trips were taken to areas in the Barataria Basin excluding the birdfoot delta (see Table 3.16-8). See Appendix H for more details about this survey.

Table 3.16-8
Estimated Annual Shoreline Trips by Area in the Barataria Basin

Area[a]	Total Trips
Northern Barataria Basin	431,015
Southern Barataria Basin	213,581
Total	**644,596**

Source: DWH Shoreline Valuation Survey, USDOI 2020a.

[a] The DWH shoreline valuation dataset provides estimates for the northern and southern portions of the basin (excluding the birdfoot delta) but not specific sites within those areas.

3.16.3.4 Regional Economic Impacts of Hunting

Approximately 277,000 hunters spent $618 million in Louisiana in 2011. These direct expenditures amounted to $2,080 per hunter for equipment and include around $51 per hunting day on trip-related expenses (USDOI et al. 2013). A separate study additionally considered the multiplier effects of hunting (excluding alligator hunting) in 2006, finding a total economic contribution of $1.16 billion and over 13,000 jobs, as well as $74 million in state and local tax revenues. The same study estimated the regional economic contribution of alligator harvests of $124 million, 714 jobs, and $6.4 million in state and local tax revenues (Southwick 2008).

3.16.4 Wildlife Watching, Including Birding

Wildlife watching is a very common activity in the Project 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 watching activity supported 6,200 jobs and provided $32 million in state and local tax revenue in 2006 (Southwick 2008).

A number of birding sites exist throughout the Barataria Basin. Within the Project area, Grand Isle State Park and the NPS's Barataria Preserve are recognized as birding hotspots by the National Audubon Society (Audubon 2018). These locations are also home to birding events. For example, the annual Grand Isle Migratory Bird Celebration is an event supported by BTNEP, which attracts birdwatchers from across Louisiana as well as non-residents to Grand Isle (LDWF 2005b). Other birding festivals are held annually throughout the state. 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).

3.16.5 Recreational Boating Activities

The Project area provides recreational boaters ample opportunity to access Barataria Basin waters, as presented in Table 3.16-2. Recreational boating may include touring, fishing, watersports, and swimming, and includes for-hire charter boat fishing activities.

LDWF requires any person operating a motorboat with an engine of more than 10 horsepower to obtain a Boater Education Certification. Starting at age 10, individuals are eligible for the Boater Education Certification by passing an online or in-person course. Although LDWF encourages all boaters to enroll in boater education, people born before January 1, 1984 are not required to complete the Boater Education Certification course. In addition to licensing, all motorboats operating in state waters must be registered with LDWF. Registration lasts for three years. Any motorboat engaging in watersports such as waterskiing, wakeboarding, wake surfing, or similar activities in which a person is towed behind the boat must be occupied by at least two competent individuals (LDWF 2018k).

According to LDWF motorboat registrations by parish from 1988 to 2011, Project area parishes account for 21 percent of state average annual motorboat registrations. From 1988 to 2011, about 67,500 annual applications for motorboat registrations were submitted to LDWF in the Project area (LDWF 2018g). As shown in Table 3.16-9, Jefferson Parish accounts for the largest number of boat registrations from 1988 to 2011, followed by Lafourche Parish. As previously noted, Jefferson is the most populated parish in the Project area (U.S. Census Bureau 2017c). Plaquemines and

Jefferson Parishes maintain the greatest number of boat ramps and marinas. Fewer registrations were in the parishes of St. Bernard, St. John the Baptist, and St. James, each of which provided just over 10 percent of the total registrations. In 2011, Jefferson Parish with 18,627 registrations ranked second in the state in numbers of motorboat registrations behind St. Tammany Parish (18,716).

Table 3.16-9
Motorboat Registrations by Parish, 1988 to 2011[a]

Parish	Average Annual	1988 to 2011 Total	Percent of Registrations in Project Area Parishes Total[b]	Percent of Registrations in State
Jefferson	21,992	527,804	33%	7%
Lafourche	11,245	269,870	17%	4%
Orleans	7,116	170,791	11%	2%
Ascension	6,784	162,822	10%	2%
St. Bernard	4,772	114,532	7%	2%
St. Charles	4,241	101,786	6%	1%
Plaquemines	3,800	91,197	6%	1%
Assumption	3,190	76,552	5%	1%
St. John the Baptist	2,415	57,970	4%	1%
St. James	1,973	47,362	3%	1%
Project Area Total	**67,528**	**1,620,686**	**100%**	**21%**
State Total	**314,255**	**7,542,119**	**N/A**	**100%**

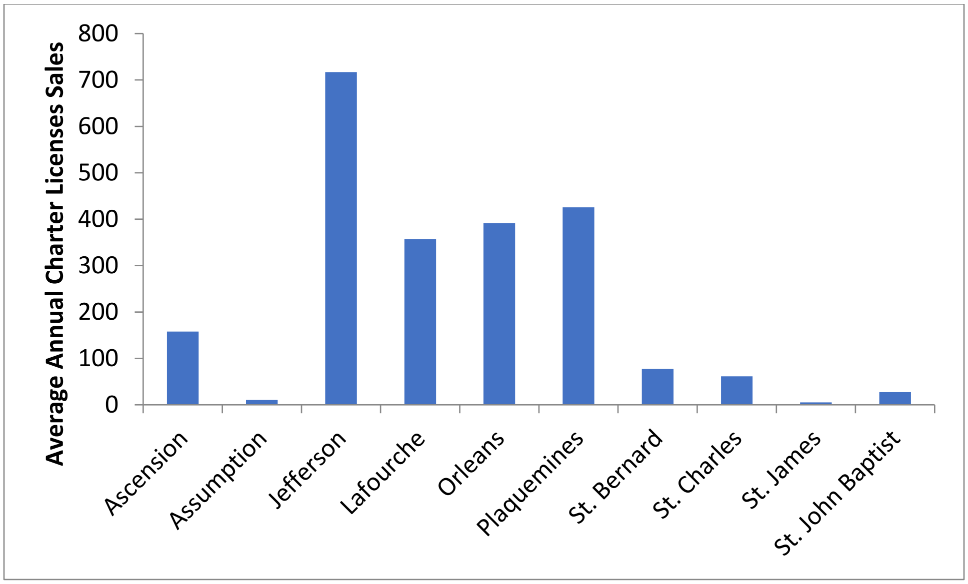
Source: LDWF 2018g.

[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 to 2011.

[b] These totals are for the entirety of the listed parishes (not just the portions of the parishes found within the Project area).

The annual total motorboat registrations in the 10 parishes of the Project area declined by nearly 10,000 between 2000 (330,293) and 2011 (320,819).

Another form of recreation in the Project area is for-hire charter fishing. LDWF license statistics data provide estimates of charter fishing activity in the Project area. Charter fishing licenses include a 3-day charter passenger license, which permits license holders to saltwater fish with a licensed guide in a charter vessel in state waters, and the 3-day charter skiff license, which permits license holders to saltwater fish in a licensed charter skiff under the direction of a charter operation, but not with a guide, in state waters (LDWF 2018f). According to the LDWF license statistics data, average annual charter fishing license sales from 2010 to 2017 are greater in Jefferson Parish than any other parish in the Project area (see Figure 3.16-6). On average, St. James and St. John the Baptist Parishes contribute less than 50 charter licenses per year, while Jefferson Parish produces more than 700 charter licenses per year.



Source: LDWF 2018h

Figure 3.16-6. Average Annual Charter Fishing License Sales by Parish, 2010 to 2017. Charter fishing licenses include the 3-day charter passenger license and the 3-day charter skiff license. Annual averages were calculated over the years 2010 to 2017.

3.16.6 Visitation to Non-governmental Protected Areas

Three areas owned by non-governmental or private organizations that are used for public recreation are located in the Project area. These include:

- a 15,000-acre privately owned parcel in Lafourche Parish known as the Edward Wisner Donation Trust. Between 1980 and 2009, the Edward Wisner Donation leased the land to the State of Louisiana, during which time it was called the Wisner Wildlife Management Area. The site is now open to private access only via a number of waterways, bayous, and canals;
- a 7-acre parcel owned by The Nature Conservancy in Jefferson Parish known as the Lafitte Woods Preserve. This parcel is located on Grand Isle and is used for wildlife watching. Hunting is not allowed (The Nature Conservancy 2018); and
- a 2-acre parcel owned by a non-governmental organization in Jefferson Parish on Grand Isle, known as the Grand Isle Fee parcel, which is primarily used for fishing access.

3.17 PUBLIC LANDS

Public lands and recreation areas within the Project area include state and national parks, WMAs, wildlife refuges, and wild and scenic rivers (see Table 3.16-1 and Figure 3.16-1 in Section 3.16 Recreation and Tourism). These are areas designated by state and federal agencies for conservation purposes, such as preserving wetlands habitat and providing sanctuary for threatened and endangered species. These public lands also provide outdoor recreational opportunities for visitors, such as fishing, hunting, hiking, and wildlife viewing. This section describes these public lands and provides a brief description of each.

3.17.1 Barataria Basin

The Barataria Basin includes one national park, the Barataria Preserve, which is one of six units in the Jean Lafitte National Historical Park and Preserve. The Barataria Preserve is administered by the NPS and protects 20,000 acres of wetlands in the basin. The NPS established the preserve for the purpose of preserving the natural and historical resources of the MRD region (NPS 1995) (see Section 3.16 Recreation and Tourism, Figure 3.16-1). Located in Jefferson Parish, the Barataria Preserve includes bayous, swamps, marshes, and forests. Hunting and trapping are allowed at the Barataria Preserve by permit only, but permits are free with a valid Louisiana Trapping License. In 2017, the Jean Lafitte National Historical Park and Preserve reported 457,000 visitors, 409,000 of which visited the Barataria Preserve (NPS 2018).

The Louisiana State Park and Recreation Commission and Office of State Parks manages two state parks in the basin – Bayou Segnette State Park and Grand Isle State Park. Bayou Segnette State Park is a popular 580-acre park located in Jefferson Parish and includes fishing access, six boat ramps, and trails. The Louisiana Office of State Parks reported that this park received 201,805 visitors in 2011 (Louisiana Department of Culture, Recreation and Tourism [LADCRT] 2012). Grand Isle State Park is a 210-acre park that provides fishing access, boat ramps, and trails. This park is a noted birding destination and hosts an annual birding festival. The Louisiana Office of State Parks reported that this park received 105,737 visitors in 2011 (LADCRT 2012)

In addition to these parks, LDNR manages the 800-acre E.A. Maier Family donation in Jefferson Parish. Visitation to this parcel is not reported.

The Barataria Basin also includes five areas managed by LDWF (LDWF 2018e), including three WMAs, one wildlife refuge, and one state-designated natural and scenic river. LDWF manages these areas not only to conserve the state's wildlife and fisheries resources and their habitat but also to provide the public with an array of outdoor recreational opportunities including hunting (including lottery hunts), fishing, canoeing, hiking, ATV riding, and birding (LDWF 2020d). These five areas are described as follows:

- Salvador WMA: 32,000-acre WMA located in St. Charles Parish. This WMA allows fishing and hunting on a restricted basis and includes boat ramps;
- Timken WMA: 2,900-acre WMA located in St. Charles Parish. This WMA allows fishing and hunting on a restricted basis and includes boat ramps;
- Lake Boeuf WMA: 800-acre WMA located in Lafourche Parish. This WMA allows fishing and hunting on a restricted basis and includes boat ramps;

- Elmer's Island Wildlife Refuge: 1,100-acre state wildlife refuge located in Jefferson Parish on the Caminada Headland. Fishing and wildlife observation are allowed; and

- Bayou des Allemands Natural and Scenic River: inland 2,600-acre protected area located in Lafourche and St. Charles Parishes from Lac des Allemands to Lake Salvador. Certain activities that alter the natural and scenic qualities of rivers in the system are prohibited in the Louisiana Natural and Scenic Rivers System, including channelization and the use of vehicles in river areas (LDWF 2018l).

3.17.2 Birdfoot Delta

Public lands in the birdfoot delta include the Delta NWR and Pass A Loutre WMA. The Delta NWR is managed by the USFWS and 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, other management objectives for the refuge include protecting threatened and endangered coastal fish and wildlife species, providing quality outdoor recreation opportunities for visitors, and managing, restoring, and conserving marshland and coastal wetland habitat (USFWS 2008b). The Delta NWR comprises close to 48,800 acres of marsh and open water in Plaquemines Parish. Access to the Delta 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 2018c).

LDWF manages the 115,000-acre Pass A Loutre WMA, which is characterized by river channels and their associated banks, natural bayous, and man-made canals interspersed with intermediate and freshwater marshes. Hurricane damage and subsidence have contributed to the conversion of vegetated marsh areas to large ponds. LDWF is developing habitat on the WMA primarily by creating delta crevasses, which involves diverting sediment-laden Mississippi River water into open bay systems to promote delta growth. This WMA allows fishing and hunting on a restricted basis and includes boat ramps (LDWF 2020d).

3.18 LAND USE AND LAND COVER

3.18.1 Historical Land Cover

As discussed in Section 3.1 Introduction, lands in the Project area have degraded due to a combination of saltwater intrusion, decreased freshwater supply, alterations to the natural hydrology of the area, and a lack of sediment input. Landscape changes from the oil and gas industry, navigation, and flood protection have resulted in extensive wetland loss and barrier island erosion in the Barataria Basin and the larger delta. In addition, meteorological events and anthropogenic impacts (see Section 3.1.3 in Introduction) have also contributed to land loss, with over 29 percent of land lost in the Barataria Basin from 1932 to 2016 (Couvillion et al. 2017). Section 3.2

Geology and Soils provides additional detail on the geological history of the Project area.

The location proposed for the Project diversion complex and outfall area are in Plaquemines and Jefferson Parishes. Plaquemines and Jefferson Parishes were established in 1807 and 1825, respectively (Carmon 2017, University of Washington Department of Urban Planning and Design 2006). Plaquemines Parish is the largest parish in the state, in terms of area, and is defined most notably by the Mississippi River, supporting trade and travel. Storm events in the first 30 years of the 20th century and more recently (2005 and 2011) have destroyed infrastructure and inundated uplands.

The current boundary of Jefferson Parish was established in 1874 and the parish was characterized as rural with vast tracts of undeveloped land and dairy farms. Between 1950 and 1970 the first migration of families to the northern part of the parish began the establishment of bedroom communities around New Orleans (Jefferson Parish 2017).

3.18.2 Existing Land Use/Land Cover

As discussed in Section 3.1 Introduction, the Project area includes all or portions of the following parishes: Ascension, Assumption, Lafourche, Jefferson, Orleans, Plaquemines, St. Charles, St. John the Baptist, St. James, and St. Bernard. While these parishes are characterized by a variety of land types, 45.1 percent of the Project area is open water, 25.7 percent is emergent herbaceous wetlands, 12.0 percent is woody wetlands, 6.5 percent is a mix of agricultural (cultivated crops) or open land (including pasture, hay, and shrub/scrub), 5.1 percent is developed (high, low, medium intensity and open space, as well as barren land), and 0.2 percent is upland forest land (deciduous, evergreen, and mixed forest). Table 3.18-1 summarizes the percentage of each land use type within the Project area based on the 2019 National Land Cover Dataset (NLCD) (Multi-Resolution Land Characteristics Consortium 2019). The definitions of each land use type are as follows:

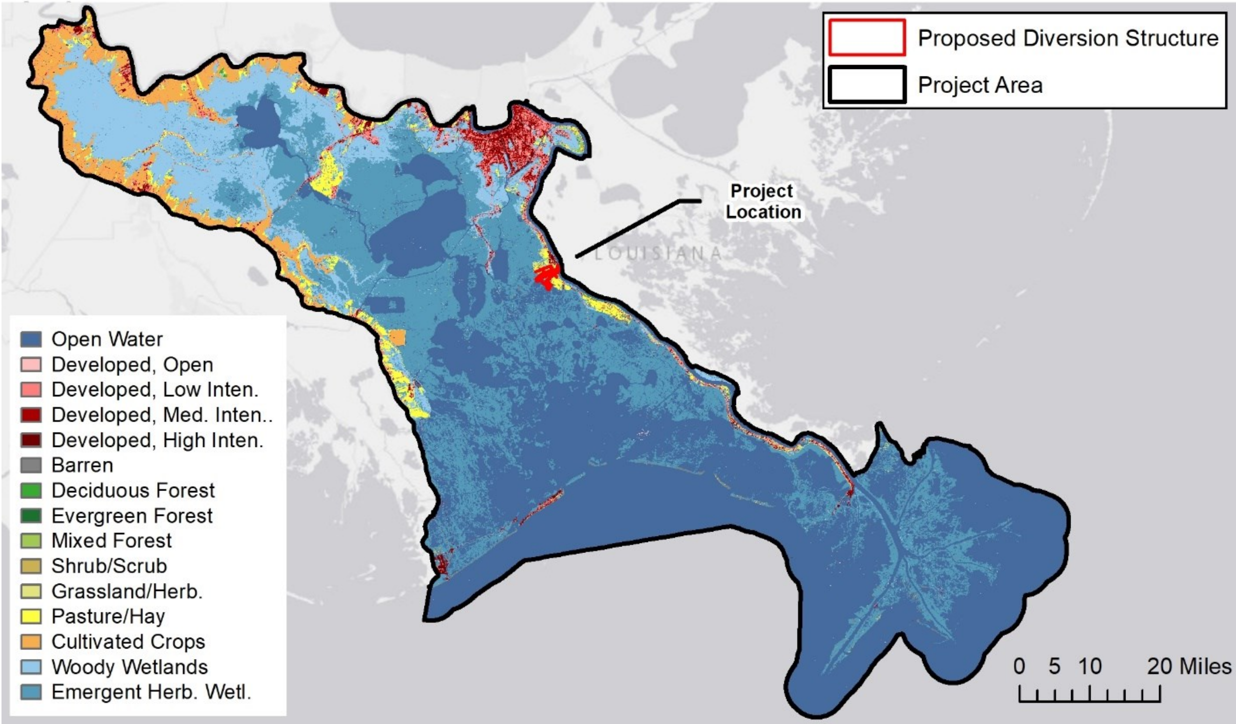
- Open Water – waterbodies, such as streams, lakes, and ponds, which are generally void of vegetation and soil;
- Wetlands – areas that are saturated with or covered by water, and include emergent herbaceous and woody wetlands;
- Agricultural – cultivated crop land that may be actively tilled or fallow 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;

- Open Land – shrubland and herbaceous lands; and
- Forest Land – deciduous, evergreen, and mixed forest.

Table 3.18-1
Project Area Land Use Types[a]

Land Use Type	Percentage of Project Area
Open Water	45.1%
Barren Land (Rock/Sand/Clay)	0.8%
Developed, High Intensity	0.5%
Developed, Low Intensity	2.4%
Developed, Medium Intensity	0.7%
Developed, Open Space	0.8%
Emergent Herbaceous Wetlands	25.7%
Woody Wetlands	12.0%
Grassland/herbaceous	0.3%
Deciduous Forest	0.1%
Mixed Forest	0.1%
Evergreen Forest	0.0%
Cultivated Crops	4.4%
Pasture/Hay	2.1%
Shrub/Scrub	0.0%
Unclassified	5.2%
Total Project Area	**100%**

The NLCD does not include a residential land use category; however, residences potentially affected by the Project have been identified within the Project area and are discussed below and in Section 3.8 Noise. The location proposed for the Project diversion complex would be in Plaquemines Parish in an area that is mostly rural in nature with residential and industrial/commercial development concentrated along LA 23 and the Mississippi River (see Figure 3.18-1).



Source: MRLC 2019

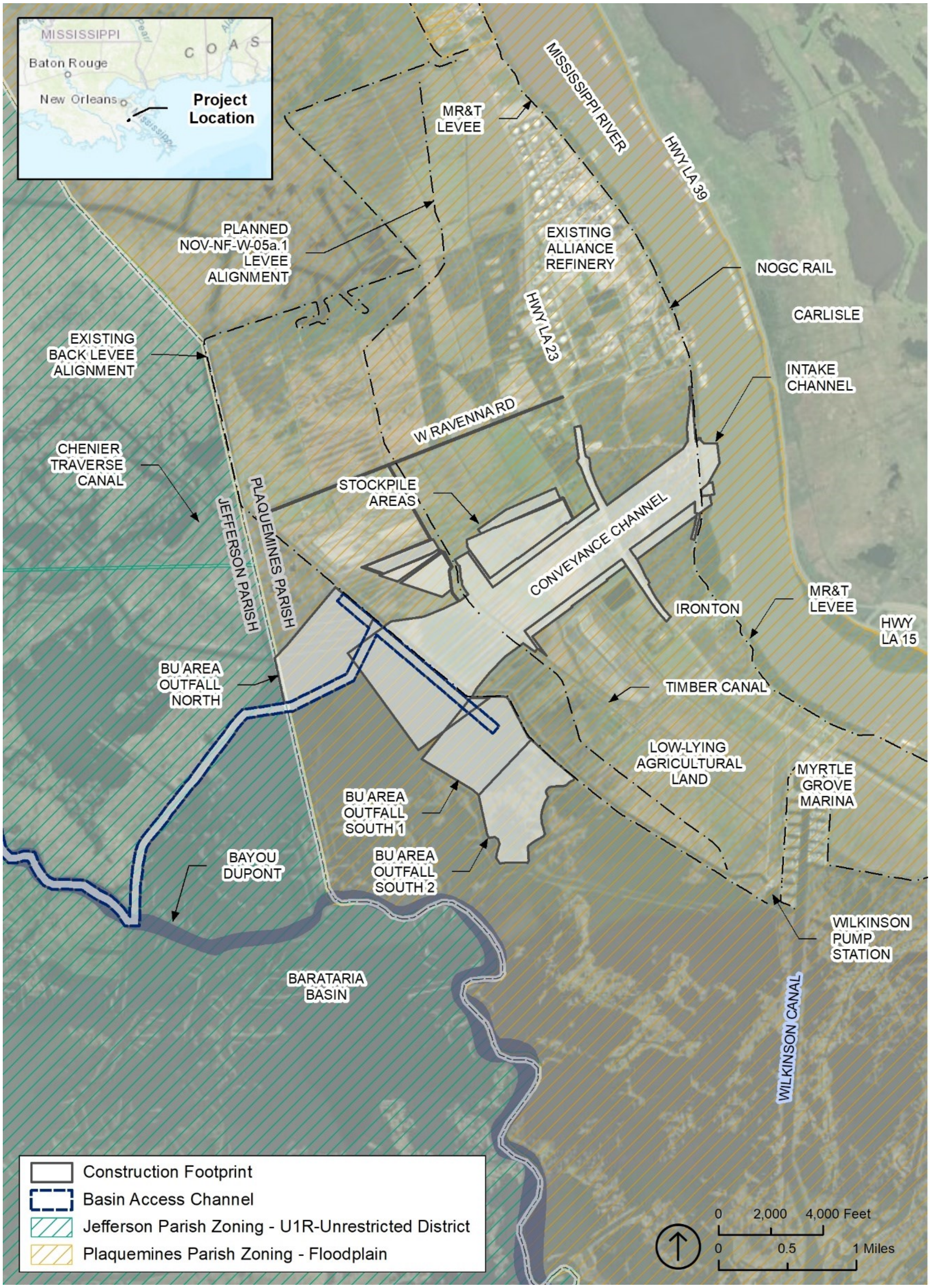
Figure 3.18-1. Land Cover and Land Use Types in the Project Area, 2019.

3.18.3 Zoning

Louisiana established provisions for land use regulation and zoning in 1921, 5 years prior to the U.S. government's passing of the Standard State Zoning Enabling Act (SZEA) (Land 2013). The regulations were focused on land use zoning for municipalities, versus parishes, and specifically to keep residential development separate from industrial/commercial development and to prevent overcrowding (Land 2013). While Louisiana adopted the federal government's Standard State Zoning Act of 1926, parishes were not granted authority to manage lands through zoning until 1944.

All of the parishes in the Project area manage land use and development through zoning ordinances and established comprehensive management plans. However, since the proposed Project features would be located entirely in Plaquemines and Jefferson Parishes, the discussion that follows focuses on the current and future land use in these two parishes.

Plaquemines and Jefferson Parishes utilize 20 and 33 zoning districts, respectively, to regulate development and land use. Plaquemines Parish has 10 residential districts (including single, two, and multiple family, and mobile home park), seven commercial/industrial districts, two rural or agricultural districts, and one floodplain district. Jefferson Parish has 15 residential districts, 17 commercial/industrial districts, and one Pedestrian-Core. Figure 3.18-2 depicts the zoning districts within the Project area in Jefferson and Plaquemines Parishes.



Source: Brousse 2018, Spears 2018

Figure 3.18-2. Zoning Districts in the Project Area.

The proposed Project features that would be located in Plaquemines Parish include the proposed Project diversion complex, auxiliary features including LA 23 and NOGC railroad modifications, the outfall transition feature, the Outfall South beneficial use areas, a portion of the Outfall North beneficial use area, and a portion of the barge access channels in the basin (see Figure 2.8-1 Construction Footprint in Chapter 2). These facilities would be located in the floodplain district, which comprises areas that are prone to periodic or occasional inundation and that are not within publicly owned hurricane protection levees or pump drainage systems. Certain residential, commercial, and industrial uses that meet building and sanitary codes are allowed in the district; other uses are allowed subject to approval.

The proposed Project features that would be located in Jefferson Parish include a portion of the Outfall North beneficial use area and a portion of the barge access channels in the basin. These areas are currently zoned as unrestricted rural.

3.18.4 Future Land Use

In response to the critical need to guide appropriate development in coastal Louisiana, state and local governments have developed comprehensive management plans, as described in the following section.

3.18.4.1 Comprehensive Master Plans

According to Louisiana's Comprehensive Master Plan for a Sustainable Coast (2017 Coastal Master Plan), over 1.1 million acres of coastal land were lost between 1932 and 2010, with 16.7 percent of this loss occurring over a 4-year period (2004 to 2008) due to hurricanes (CPRA 2017a). Other factors contributing to land loss identified in the 2017 Coastal Master Plan 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 coastal areas that exist and restoring lost resources in order to protect communities and infrastructure, and maintain current land use and natural resources. The 2017 Coastal Master Plan 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 Coastal Master Plan 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 plan, adopted in 2003, is focused on recovery and prosperity though the year 2030, with a core goal of improving the quality of life for residents. The plan identified planning elements such as population, coastal restoration, drainage and stormwater management, transportation, water and wastewater systems, and land use. Like the Coastal Master Plan, 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.

Jefferson Parish's comprehensive plan is part of the parish's Code of Ordinances (Ordinance No. 219390) (Jefferson Parish 2017). The plan outlines five key elements of the parish's planning and development strategy, which are land use, transportation, housing, open space and recreation, and implementation and administration. The plan also adopts subarea plans focused on development for key locations concentrated in the northern part of the parish in the area surrounding New Orleans.

3.19 AESTHETIC AND VISUAL RESOURCES

Visual resources refers to the composite of basic terrain features, geologic features, hydrologic features, vegetation patterns, and anthropogenic features that influence the visual appeal of an area for residents or visitors. As discussed in Section 3.1.2 in Introduction, the location proposed for the Project would be within the southern portion of the Mississippi Alluvial Plain (USEPA 2017c). This ecoregion spans seven states from southern Louisiana to southern Illinois, with its most notable feature being the Mississippi River. Elevation changes and differences in soil saturation characteristics allow for various ecosystems, ranging from inundated areas supporting bald cypress/tupelo swamp communities to areas of temporary flooding with cherrybark oak/pecan communities, as well as overcup oak/water hickory, elm/ash/hackberry, and sweetgum/red oak communities (NatureServe 2018).

3.19.1 Existing Environment

The Project area's existing viewshed includes predominately open lands with scrub vegetation, agricultural crops, sporadic homes, and industry. The viewshed also includes the Mississippi River and Mississippi River and Tributaries (MR&T) Levee east of the location proposed for the Project diversion structure, open land to the north and south, and wetlands to the west associated with the NOV-NFL Levee and the Barataria Basin. LA 23 and the NOGC Railroad run generally parallel to the Mississippi River and through the Project site.

As described further in Section 3.21 Navigation, the Mississippi River supports the movement of domestic and foreign products, with more than 360 vessels transiting the overall reach every day in 2016, and hundreds of deep and shallow-draft vessels expected to pass the location proposed for the Project diversion structure each day. As such, the movement of these vessels contributes to the characterization of the existing viewshed.

There are no institutional or publicly significant visual features in or around the location proposed for the Project diversion structure such as federal or state lands, or national or state-designated wild or scenic rivers, although these features exist within the broader Project area (USGS 2017e) (see Section 3.4 Surface Water and Coastal Processes and Section 3.17 Public Lands for addition details). The closest public use area is the Myrtle Grove Marina, which is about 0.6 mile northeast of the existing Wilkinson Canal Pump Station.

3.19.2 Potential Visual Receptors

Due to the proposed Project's proximity to the Mississippi River, Barataria Basin, and the general lack of vegetation to act as a visual buffer, the location proposed for the Project would be visible from a variety of vantage points, during both day- and night-time. However, the Project area experiences long periods of humidity, with year-round precipitation, which can reduce the distance from which features are visible (see Section 3.1.3 in Introduction).

As discussed in Section 3.18 Land Use and Land Cover, the Project area is a mix of open water, agricultural and open lands intermingled with developed areas. As such, the existing viewshed ranges from rural to industrialized settings. The existing night-time viewshed includes illuminated land- and water-based features associated with traffic on nearby waterways, motorists, and the Alliance Refinery, with areas of indistinguishable features in the more distant viewshed.

As discussed in Section 3.16 Recreation and Tourism, the Project area includes a wide variety of recreation sites, including public fishing access points, boat launches, marinas, hunting areas, and a variety of protected or designated lands (see Tables 3.16-1 and 3.16-2). Potential visual receptors in the broader Project area would include visitors to these recreation sites engaging in recreational and tourism activities.

Visual receptors in the vicinity of the location proposed for the Project diversion structure would include water-based users of the Mississippi River, motorists on LA 23, and visitors to Myrtle Grove Marina and other nearby recreation areas discussed in Section 3.16 Recreation and Tourism. The closest residential community, Ironton, is about 0.5-mile south-southeast.

3.20 PUBLIC HEALTH AND SAFETY, INCLUDING FLOOD AND STORM HAZARD RISK REDUCTION

3.20.1 Overview

3.20.1.1 Risks to Public Health and Safety

The health and safety of residents living within the Project area is threatened by severe weather events, which may result in loss of life, injury, and flood-related health hazards. As described in Section 3.1.3, Climate in Affected Environment, the Project area is subject to storm events and hurricanes. The Project area has relatively low topographic relief and most is within the 100-year flood plain (see Section 3.20.2.1). Sea-level rise is expected to further increase risks from flooding and storm surge. Potential risks include:

- Storm surge, tidal, and riverine flooding from extreme weather events;
- Failure of existing risk reduction infrastructure (including levees and pump stations); and

- Damage to potable water quality and infrastructure due to flooding.

Coastal communities such as those throughout the Project area, where the risks of storm impacts are most severe, may sustain social, cultural, and economic impacts, and storm events may result in the temporary or permanent displacement of coastal residents. Residents less likely to be able to evacuate without assistance, such as the poor, disabled, and elderly, are more likely to be impacted by weather-related hazards (USACE 2009b). In addition, when emergency service providers such as hospitals are impacted by flooding and storm damage, impacts on residents' health and safety may be greater. FEMA data indicate that flood claims paid in the Project area parishes between 1978 and November 2017 totaled more than $11 billion (FEMA 2018).

In 2005, Hurricane Katrina caused widespread flooding in the New Orleans metropolitan area where the storm surge overtopped and breached levees. Storm surge flooding along the southeastern Louisiana coast was 10 to 20 feet above-normal tidal levels (NOAA 2018a). Hurricane Katrina resulted in an estimated 1,200 fatalities, long-term impacts on social infrastructure due to school and hospital closures, and property loss and damage (USACE 2009b). In 2012, Hurricane Isaac made landfall in Plaquemines Parish, bringing a storm surge between 10 and 17 feet above ground level and greater than 10 inches of rain, which resulted in flooding (Berg 2013). Areas that are not protected by the federal levee system were significantly damaged, and an estimated 59,000 homes were damaged in southeast Louisiana (Berg 2013).

In addition to direct flood-related impacts on property and human health, large weather events can disrupt industrial operations and compromise wastewater and petrochemical facilities, resulting in releases of hazardous materials into the environment. For example, Hurricane Katrina resulted in greater than 200 releases of hazardous chemicals, natural gas, and petroleum (Santella et al. 2010). Section 3.23, Hazardous, Toxic, and Radioactive Waste Assessment documents known releases of hazardous materials in the immediate vicinity (within 0.5-mile) of proposed Project construction workspaces, and Section 3.2.3, Mineral Resources in Geology and Soils identifies oil and gas infrastructure in the Project area.

3.20.2 Storm Surge and Flooding

3.20.2.1 Floodplains

FEMA generates FIRMs for coastal areas nationwide. The maps depict zones with various probabilities of experiencing a flood event based upon the elevation of that zone and the BFE. The 100-year flood zone represents a zone estimated to have a 1 percent chance of being flooded up to the BFE in any individual year. The lowest mapped probability of flooding in any individual year is 0.2 percent, equivalent to an average estimated flooding recurrence interval of 500 years.

FEMA Digital Flood Insurance Rate Maps (DFIRM) data are distributed for viewing and query as part of FEMA's National Flood Hazard Layer, or NFHL (FEMA 2022c), but DFIRM data have not been completed for Lafourche Parish. As such, the

DFIRM data available via the NFHL were supplemented with older FEMA Digital Q3 flood data (FEMA 1999), as well as the associated scanned paper FIRMs (FEMA 2017) to evaluate flood risk across the Project area. Nearly the entire Project area is mapped as Zone A, VE, or AE, meaning within the 100-year floodplain, (FEMA 2017b) reflecting the generally low-relief topography at or near sea level. Areas along the rim of the Barataria Basin have somewhat reduced flood risks. The strip of uplands along the northern margin of the Barataria Basin, including communities adjacent to the Mississippi River Levees in Plaquemines, Orleans, St. Charles, St. John the Baptist, St. James, and Ascension parishes, as well as areas along the western margin of the Barataria Basin encompassing the uplands and levees along Bayou Lafourche, are classified as Zone X500, meaning they are in the 500-year floodplain. Some areas in Jefferson Parish and the far northwest of the Project area are classified as Zone X with a reduced flood risk due to levee protection (see Figure 3.20-1).

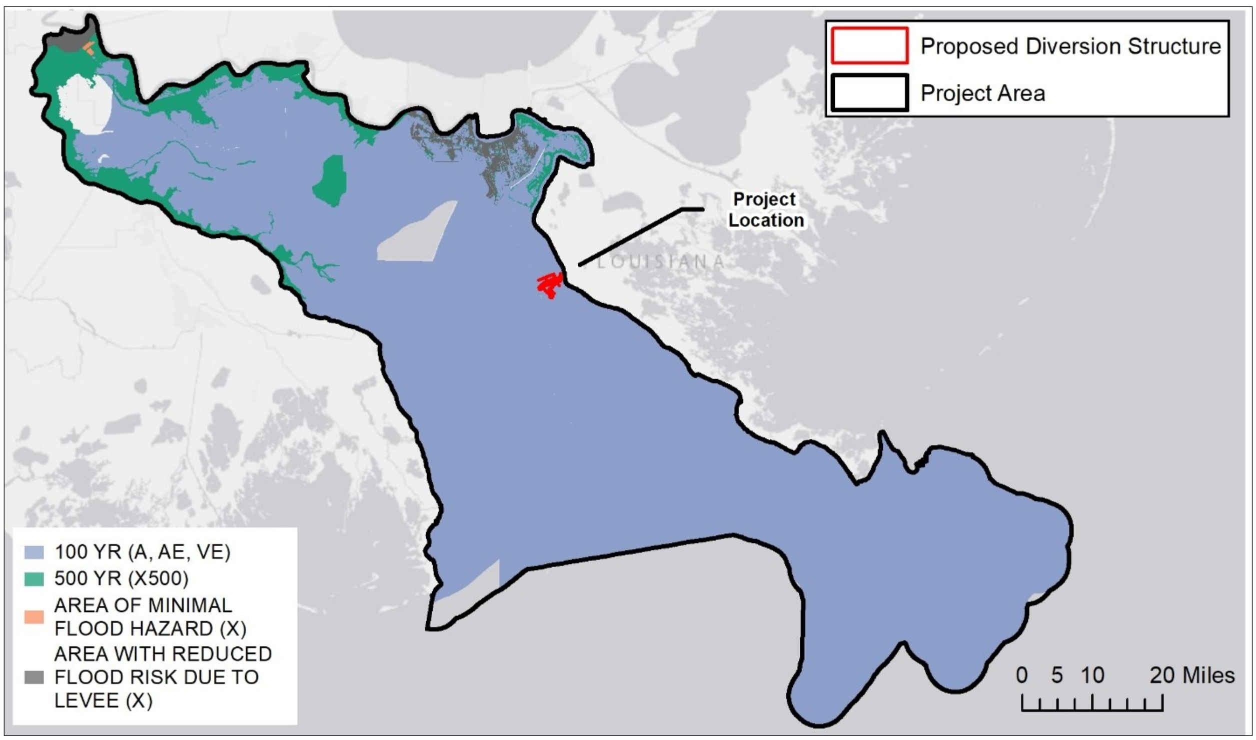


Figure 3.20-1. Map of the Project area Depicting Integrated FEMA DFIRM and Digital Q3 Flood Data.

Figure 3.20-2 depicts the communities within the Barataria Basin and outside of federal levee systems within approximately 10 miles north and 20 miles south of the proposed diversion complex, including Myrtle Grove, Woodpark, Suzie Bayou, Hermitage, Grand Bayou, and Happy Jack. In addition to being located within the FEMA floodplain, these communities are also largely designated as Coastal High Hazard Areas (see Figure 3.20-3).

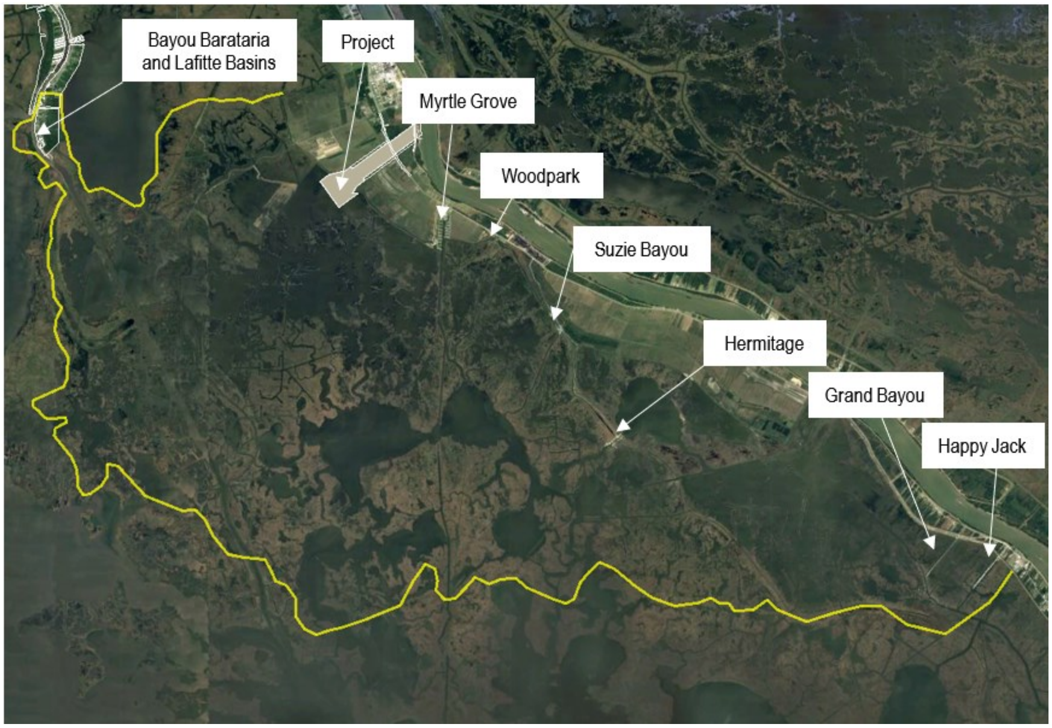


Figure 3.20-2. Communities and Subdivisions within the Barataria Basin and Outside Federal Levee Systems that could be Subject to Increased Water Levels during Operation of the Proposed Project.

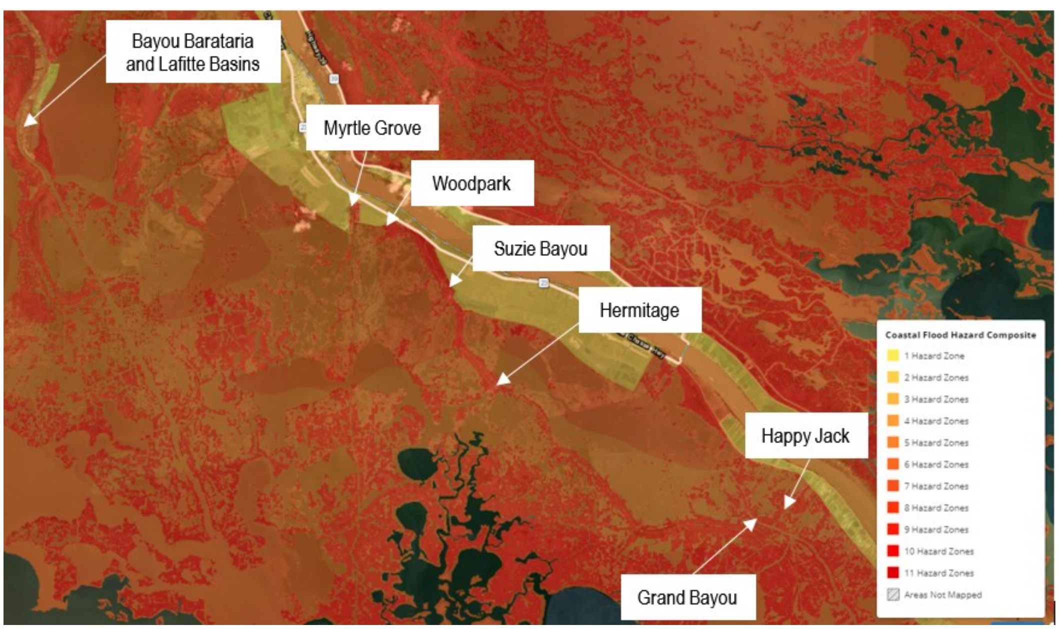


Figure 3.20-3. The Communities and Subdivisions Subject to Increased Water Levels during Operation of the Proposed Project are Largely Designated as Coastal High Hazard Areas. Image and data from the NOAA Coastal Flood Exposure Mapper (NOAA OCM 2020).

Communities, or portions of communities, outside of federal levee systems such as those shown in Figure 3.20-3, currently experience a low-to-moderate frequency of short duration and shallow tidal (non-storm) flooding. Within the next 20 to 50 years, these communities are projected to experience tidal flooding with increasing frequency and duration due to the effects of subsidence and sea-level rise (See Section 3.4.1.1 Sea-Level Rise and Subsidence for additional information regarding rates of relative sea-level rise in the Project area). They are also at increased risk of storm-related flooding as compared to communities inside federal levee systems.

NOAA's Coastal Flood Hazard Composite tool (NOAA OCM 2020) depicts areas that are most prone to coastal flooding hazards, as measured by the number of mapped flood hazard zones an area falls within. The 10 mapped flood hazard zones considered in this composite score are the following:

- FEMA Flood Zone V (Coastal areas with a 1 percent or greater chance of flooding and an additional hazard associated with storm waves);
- FEMA Flood Zone A (Areas with a 1 percent annual chance of flooding);
- FEMA Flood Zone X (Areas with a 0.2 percent annual chance of flooding);
- NOAA-identified areas subject to high tide flooding;
- NOAA-identified three zones within potential sea-level rise inundation extents for 1 foot, 2 feet, and 3 feet above current Mean Higher High Water (each inundation extent is a separate zone); and
- NOAA/National Weather Service-identified three zones subject to storm surge by Category 1, 2 or 3 hurricanes (each hurricane category is a different zone).

In general, the existing subdivisions within these Barataria Basin communities have parcels that are subject to at least eight out of the 10 flood hazards listed above. These subdivisions are occupied by residences and non-residential campsites, and other properties with storage structures. These properties are subject to parish floodplain management regulations or other state or local regulations that prescribe standards for the purpose of flood damage prevention and reduction as further discussed in Section 3.20.3.2 Other Risk Reduction Measures; however, improvements on some properties may pre-date those regulations.

3.20.2.2 Storm Hazards

Hurricane intensity is measured on the Saffir-Simpson Scale and ranges from a Category 1 storm with winds above 74 MPH to a Category 5 storm with winds greater than 157 MPH (NOAA, NWS, and NHC 2017). In the Gulf of Mexico, tropical storms have wind speeds between 39 MPH and 73 MPH. From 1970 to 2010, an average of 6 hurricanes and 11 tropical storms per season impacted the Atlantic Ocean, Caribbean, and Gulf of Mexico (Blake et al. 2011). From 1855 to 2012, the center tracks of 66 tropical storms and hurricanes have intersected the Project area (Knapp et al. 2010). National Hurricane Center analyses indicate an estimated return period for hurricanes making landfall in the vicinity of the Project area of between 7 and 8 years (NOAA, NWS, and NHC 2017) – among the highest rates in the Gulf of Mexico coastline except for South Florida.

Because of the extremely low elevation of the Project area and its proximity to coastal lakes and bays and the open water of the Gulf of Mexico, the area is particularly vulnerable to storm surge and flooding caused by the landfall of tropical storms and hurricanes. Hazards associated with hurricanes include storm surges, heavy rainfall, inland flooding, high winds, tornadoes, and rip currents. Hurricanes also impact the marsh by killing mature trees (through canopy wind impacts and salty storm surge), eroding shorelines and canal banks, pushing salty water and wrack (organic debris) into interior marsh, tearing and compacting flotant marsh (floating marsh), and pushing saline water into fresh groundwater lenses. Salty storm surge driven through canals and across wetland surfaces can impact plants and animals in freshwater coastal wetland habitat by causing habitat change or loss. The heavy precipitation during hurricanes can also introduce fresh water and nutrients via runoff, reducing salinity and enhancing coastal productivity, sometimes causing algal blooms (Conner et al. 1989). They also re-suspend and deposit sediment on wetland surfaces, which helps to offset relative sea-level rise and increase marsh elevation (Baumann et al. 1984, Cahoon et al. 1995).

The wind, rain, and storm surge damage generated by tropical storms and hurricanes is costly. An analysis of NOAA NCDC Storm Events database (NOAA 2017e) of all severe weather events occurring in Plaquemines Parish between 1997 and 2017 indicated that property damage from tropical storms and hurricanes (primarily wind) totaled 3.1 billion dollars, whereas property damage from storm surge flooding associated with storm events totaled 4.1 billion dollars. The majority of this damage was from Hurricane Katrina in 2005. In the US, costs generated by tropical storms and hurricanes appear to be increasing. NOAA estimates that 9 of the last 10 most costly storms have occurred since 2004. Notable storm events in vicinity of the Project area in the past 20 years that caused significant storm surge flooding in the Project area and vicinity include Hermine in 1998, Allison in 2001, Bertha in 2002, Hanna in 2002, Isidore in 2002, Bill in 2003, Matthew in 2004, Cindy in 2005, Katrina and Rita in 2005, Gustav and Ike in 2008, Bonnie in 2010, Isaac in 2012, and Nate in 2017. Hurricane Katrina dwarfs all other hurricanes in previous decades in terms of magnitude of storm surge and overall property damage in the Project area. Additional hurricanes that have not made landfall in the Project area have resulted in storm surge or rainfall flooding impacts in the Project area.

3.20.3 Risk Reduction Measures

Coastal risk reduction is achieved through a variety of measures, including natural features such as barrier islands and wetlands that help attenuate storm energy (see Section 3.6, Wetland Resources and Waters of the U.S.); built infrastructure (for example, levees, storm surge barrier gates, floodwalls, and pump stations);

infrastructure adaptations (for example, elevated foundations, pilings, and setbacks from the shoreline); and non-structural measures such as emergency response and evacuation plans (USACE 2013).

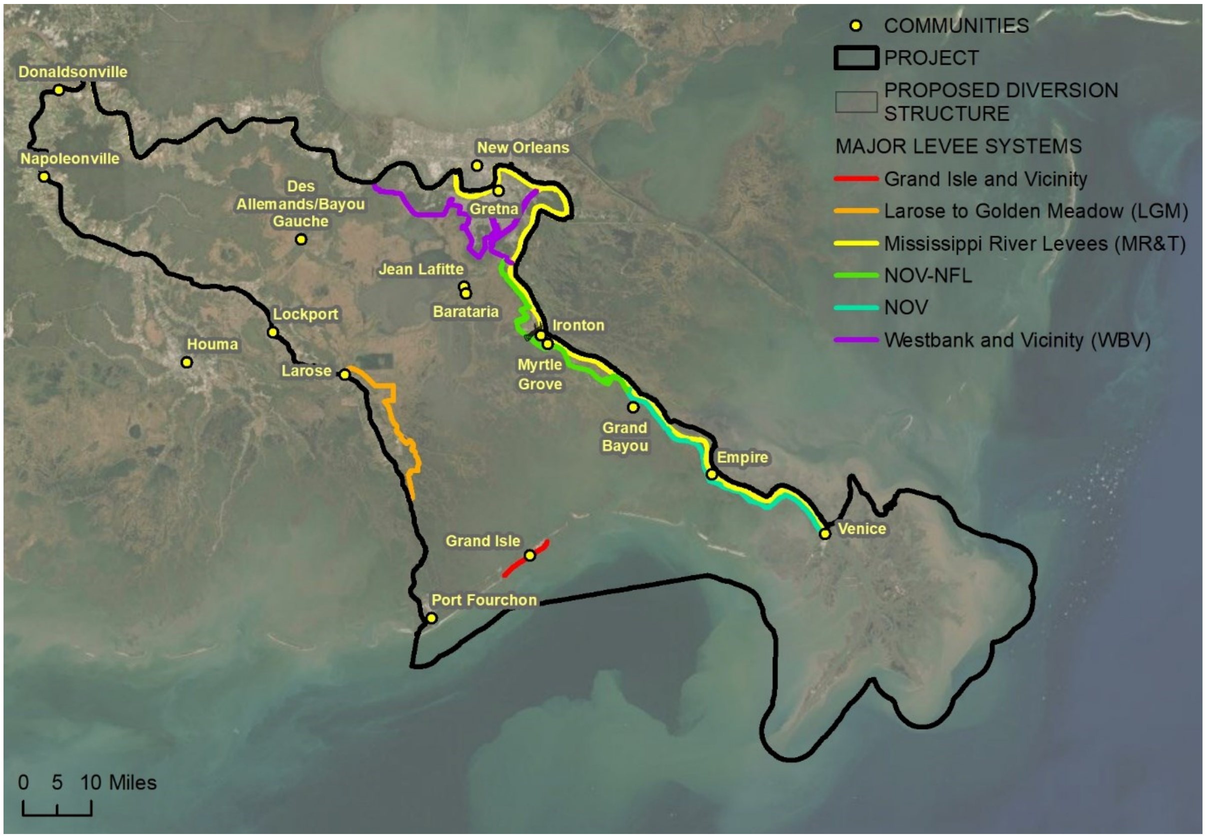
3.20.3.1 Federal Risk Reduction Levees

Multiple risk reduction levees are located within the Project area. Some are federal structures, which means they were built by the USACE and are maintained by the USACE and/or by the project's non-federal sponsor; while others were built and are maintained by non-federal entities. In some instances, ongoing construction is modifying and repairing the levees, which will increase the level of risk reduction for developed land and infrastructure behind the levees. Risk reduction levees within the Project area include (see Figure 3.20-4):

- Mississippi River and Tributaries (MR&T) Mississippi River Levee;
- New Orleans to Venice (NOV) federal levees;
- Plaquemines Parish Non-Federal Levees, which are being incorporated into the NOV system (NOV-NFL);
- West Bank & Vicinity (WBV) Levees;
- Grand Isle and Vicinity; and
- Larose to Golden Meadow Levees (LGM).

The MR&T Project, authorized by the Flood Control Act of 1928, as amended, is designed to reduce flood risk in the Mississippi River alluvial valley from the "project design flood," which is defined as the largest flood with a reasonable probability of occurrence. The MR&T Mississippi River Levee feature extends for nearly 1,610 miles along the Mississippi River beginning near Cape Girardeau, Missouri to approximately 10 miles AHP near the Gulf of Mexico and is the backbone of the MR&T flood risk management system. In the Project area, the Mississippi River Levee is located along the west bank of the Mississippi River and traverses the Project area in a generally north to south direction. The MR&T Mississippi River Levee is the nearest levee to the Project and the construction footprint of the proposed diversion complex crosses that levee.

At and below New Orleans, the Mississippi River Levee is designed to pass Mississippi River flows of up to 1.25 million cfs. The MR&T Mississippi River Levee typical section consists of a batture (the alluvial land between the low-tide of the river and the levee) to separate the levee from the river and permanent erosion protection measures along the river bank, batture, and levee waterside slope. The measures include articulated block mats placed along the riverbank from the batture downslope to the bottom of the river channel, rock riprap along the top of the river bank slope and batture surface, and slope pavement along the levee waterside slope. The MR&T Mississippi River Levee is operated and maintained by the USACE and local sponsors.



Source: USACE EGIS Gateway Tool 2018

Figure 3.20-4. Major Risk Reduction Systems within the Project Area.

The NOV federal levees are a system of back levees and a river levee authorized by the Flood Control Act of 1962 to provide risk reduction to portions of Plaquemines Parish from storm surge and river flooding. The NOV federal levees are located on the east bank of the Mississippi River and, within the Project area, along the basin side of developed land on the west bank of the Mississippi River south of Myrtle Grove to Venice. After Hurricane Katrina, the USACE has engaged in completing the authorized project, including constructing, restoring, and armoring levees, installing flood walls, and raising and stabilizing existing pump station walls and gates to meet federal design criteria. The NOV levees are maintained by the non-federal sponsors, CPRA, and Plaquemines Parish Government.

Approximately 51 miles of NOV-NFL Levees are located in Plaquemines Parish along the basin side of the developed land located along the Mississippi River. On the west bank, approximately 34 miles of non-federal back levees extend from Oakville to St. Jude within the Project area. These non-federal levees were intended to reduce the risk of storm surge flooding in developed areas; they currently provide different levels of protection and have varied crown elevations. Built in phases between the 1950s and 1990s, they were constructed with local public and private funding, built to local rather than USACE standards, and maintained locally by Plaquemines Parish. Under Emergency Supplemental Appropriations Acts (Public Laws [PL]109-234 (2006) and 110-252 (2008)) for Flood Control and Coastal Emergencies, improvements to these 34 miles of levees and incorporation of these reaches into the NOV federal levee system were authorized. These levees within the Project area are at various stages of improvement; once completed, the levees will provide up to a 2 percent AEP (50-year) level of risk reduction.

The WBV Levees are located along the west bank of the Mississippi River within St. Charles, Jefferson, Orleans, and Plaquemines Parishes. The WBV extends from Ama in St. Charles Parish to Oakville in Plaquemines Parish. In 1986, as a result of flooding from Hurricane Juan, authorization was secured to build the West Bank Hurricane Protection Levee, which would provide hurricane protection from the City of Westwego to the west bank of the Harvey Canal. In 1996, the project was expanded to include the Lake Cataouatche Levee that would provide protection to Avondale, Bridge City, and Waggaman and also expand the "East of Harvey Canal" project to provide protection for Gretna, Harvey, Algiers, and Belle Chasse. In 2005, as part of the overall HSDRRS for southeast Louisiana that was funded after Hurricane Katrina, improvements were authorized to raise the level of risk reduction of the WBV. Improvements included more than 75 miles of levees that were raised, constructed, or repaired to reduce the risk of a 1 percent AEP (100-year) storm surge event. A 100-year storm is defined as a storm with a size and intensity that has a 1 percent chance of occurring in a given year, or 1 percent AEP. The WBV is maintained by the Southeast Louisiana Flood Protection Authority-West.

The LGM system, originally authorized in 1965, consists of approximately 43 miles of levees and floodwalls surrounding developed areas along the east and west banks of Bayou Lafourche. Approximately 22 miles of levee on the east side of Bayou Lafourche fall within the Project area, with elevations ranging from 16 feet at Golden Meadow to 8.5 feet at Larose. The LGM system is maintained by the South Lafourche Levee District.

The Grand Isle and Vicinity system consists of a 7.5-mile vegetated sand dune on the gulf side of the island, a jetty to stabilize the western end of the island at Caminada Pass, and an offshore breakwater system.

3.20.3.2 Other Risk Reduction Measures

Aside from the federal levee projects discussed in Section 3.20.3.1, communities such as Lafitte and Jean Lafitte in the Barataria Basin are located outside the federal levee system; however, a local system of disconnected levees provides some protection to these communities. For example, a 3-mile flood protection project was completed in 2020 that provides additional protection for the town of Jean Lafitte, and other floodwall protection and back levee improvements are proposed (CPRA 2020a). Additionally, Jefferson and Plaquemines Parishes have floodplain management ordinances that include requirements for new construction and substantial improvements that decrease the risk of flooding such as minimum elevation requirements for structures

(Plaquemines Parish Ord. No. 08-211; Jefferson Parish Ord. No. 25457). Similarly, local land use decisions, such as zoning, can affect flood risk faced by homeowners and businesses.

Major projects aside from levee and floodwall system undertaken by USACE include repair and storm-proofing of pump stations. Of the 78 pump stations in the HSDRRS area, 33 have been repaired since Hurricane Katrina (USACE 2018f). While pump stations are not part of the storm surge barrier system, they are important for protection of the interior of the levee and floodwall system from rainfall and in the event that storm surge or waves overtops the levee system (USACE 2009b).

In addition to storm risk reduction infrastructure, state and local governments provide emergency response services and facilitate evacuation of coastal residents as appropriate in flood and storm hazard events. The communities in the immediate vicinity (within 0.5-mile) of proposed diversion complex are situated between the Mississippi River and the Barataria Basin; therefore, limited land-based evacuation routes are available in the event of an oncoming storm. Hurricane evacuation routes in the Project area are addressed in Section 3.22 Land-Based Transportation and include Louisiana Highway 1 (LA 1), LA 308, and LA 23.

Finally, the USEPA implements hazardous spill prevention and preparedness rules to minimize the potential for impacts on water quality and human health from leaks and spills of hazardous materials, including oil. The Spill Prevention, Control, and Countermeasures rule requires facilities to implement measures to prevent oil from reaching navigable waters, and to contain discharges of oil (40 CFR 112.3). The USEPA'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). By implementing the measures required by the USEPA, compliant facilities are prepared to minimize the environmental and human health damage that could result from oil spills caused by severe weather events.

3.21 NAVIGATION

The Lower Mississippi River is the nation's busiest waterway, providing waterborne commerce a pathway via the Upper Mississippi, Illinois, Ohio/Tennessee, Missouri, and Red/Arkansas Rivers, and other systems connecting through to the Gulf of Mexico (USACE 2018k). Thousands of ports and terminals receive and send goods via inland shallow-draft, navigable waterways referred to as the Mississippi River System, of which navigation channels in the Barataria Basin are a part. This section describes the commercial navigation trends in the Lower Mississippi River and the federal channels in the Barataria Basin. Project-area commercial navigation industries include portions of the Mississippi River System outside of the Project area because the cargoes would ultimately transit the waterways within the Barataria Basin. See Section 3.16 Recreation and Tourism for information about recreational boating in the Project area.

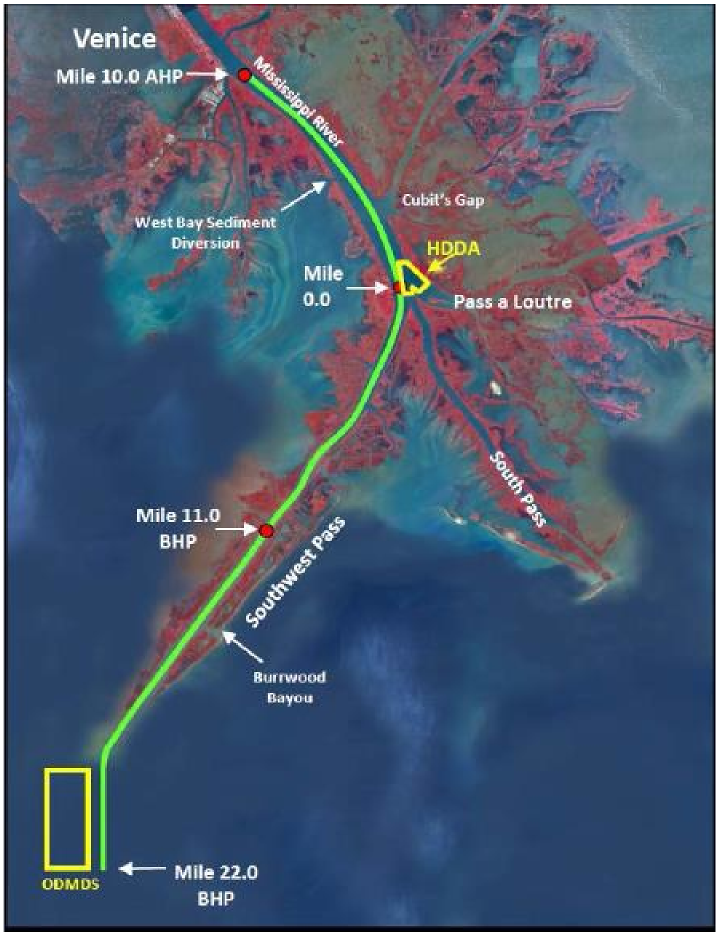
Commercial navigation in the Project area is characterized using the cargoes and vessels transiting the Mississippi River System and Barataria Basin. The most current comprehensive cargo and vessel statistics available for the Mississippi River and channels and waterways within the Barataria Basin are Waterborne Commerce Statistics from 2016 (Waterborne Commerce of the U.S. [WCUS] 2018). Historical cargo and vessel trends are also presented to provide a timeline of commercial activity in an historical context.

3.21.1 Mississippi River

The Mississippi River navigation channel is commonly divided into upper and lower segments, with the Upper Mississippi River extending from Minneapolis, Minnesota to Cairo, Illinois, and the Lower Mississippi River extending from Cairo, Illinois to the Gulf. The main stem waterway below Cairo often has navigation depths greater than nine feet that allow deeper loading barges in the range of 12 to 15 feet in depth. North of Baton Rouge, the Mississippi River navigation channel is maintained to a depth of 9 feet.

South of Baton Rouge is the deep-draft navigation portion of the Lower Mississippi River. The navigation channel is maintained to a depth of 40 feet from RM 233.8 AHP to RM 232.4 AHP. Between RM 232.4 AHP to the Gulf, it is maintained to a depth of 45 feet although authorized to a depth of 55 feet by the Supplemental Appropriations Act of 1985 (PL 99-88) and the 1986 WRDA (PL 99-662). For the MRSC, Gulf to Baton Rouge, Louisiana Project, Phase III Deepening, the USACE prepared an integrated General Re-evaluation Report and SEIS to deepen the existing Mississippi River Ship Channel from the current depth of 45 feet to a depth of 50 feet (USACE 2018l). Construction of the MRSC Deepening Project began in 2020.

South of RM 0.0 (Head of Passes) in the birdfoot delta, the Southwest Pass extends into the Gulf to RM 22 BHP and is maintained to a depth of 45 feet. Within the next few years, Southwest Pass will be deepened to a depth of 50 feet as part of the MRSC Deepening Project. The South Pass is 14.2 miles in length and is maintained to a depth of 13 feet (see Figure 3.21-1).



Source: USACE 2016a

Figure 3.21-1. Reach of Active Dredging in the Lower Mississippi River from Venice to the Gulf of Mexico. The Hopper Dredged Disposal Area (HDDA) is the Head of Passes Hopper Dredged Disposal Area, and the ODMDS is the Ocean Dredged Material Disposal Site.

3.21.1.1 Maintenance Dredging

CEMVN has the largest annual navigation Operation and Maintenance (O&M) program in the nation. The CEMVN dredges an average of 77 mcy of material annually during maintenance dredging of federal navigation channels, most of which occurs in the Mississippi River, the Calcasieu River, and the Atchafalaya River (USACE 2016a).

South of Baton Rouge, the Mississippi River navigation channel includes two segments that are consistently dredged to maintain navigation depths:

- New Orleans Harbor (RM 101.1 AHP to RM 94.6 AHP): This channel segment lies within the jurisdictional limits of the Port of New Orleans and is dredged periodically to maintain depths of 15 to 35 feet. The average amount dredged annually from 1996 through 2019 was 1.0 mcy (USACE 2019a); and

- Venice to the Gulf (RM 13.0 AHP to RM 22.0 BHP): This reach includes the portion referred to as Southwest Pass, which extends from RM 0.0 (Head of Passes) to RM 22.0 BHP (see Figure 3.21-1). Maintenance dredging is performed by a combination of hopper dredges and cutterhead dredges (USACE 2016a). Material dredged by cutterhead dredges is placed in shallow, open water placement areas located on either side of the Mississippi River and Southwest Pass. Material dredged by hopper dredges is placed in the ODMDS, the Head of Passes Hopper Dredged Disposal Area (HDDA), or through agitation dredging. From 1996 through 2019, an average of approximately 17.4 mcy from RM 13.0 AHP to 22 BHP was dredged annually for maintenance of the channels (USACE 2019a).

The material placed at the HDDA is subsequently dredged through a separate cutterhead dredge contract and is used beneficially to create and restore coastal habitat in compliance with USACE engineering regulations. A total of 3,885 acres of wetlands have been created by placing dredged material from the HDDA into shallow open water areas of the Delta NWR (USACE 2019a), including 2,659 acres in the Delta NWR, 463 acres in the Pass A Loutre WMA, 87 acres in the LCA BUDMAT Spanish Pass Ridge Restoration Project, and 676 acres in West Bay.

From the New Orleans Harbor to RM 13.0 AHP (near Venice, Louisiana), depths historically exceed 55 feet and do not require maintenance dredging. It is in this segment that the proposed Project diversion intake structure is located on the west bank of the river at RM 60.7 AHP.

3.21.1.2 Traffic

Where the proposed Project diversion intake structure is located, the sailing line is located along the opposite bank. The sailing line is the approximate track a vessel would follow downstream during a low river stage. Actual channel boundaries are established and marked by the USCG. Deep-draft vessels must closely adhere to the marked channel; however, shallow-draft vessels may use any part of the river cross-section. There is no standard definition of shallow-draft versus deep-draft vessels, but a 14-foot draft is a common dividing line (USACE 2018m). Many shallow-draft vessels are “tows,” a combination of a push boat and one or many barges lashed together into one unit. Shallow-draft vessels are more likely to use near-bank, shallow waters (such as the area of the channel near the proposed Project intake structure) than are deep-draft vessels.

Vessel traffic passing the proposed Project intake structure can be estimated from waterborne commerce statistics compiled by the USACE. Table 3.21-1 shows the number of vessel transits on the river between New Orleans and the Mississippi River Head of Passes, divided into shallow-draft (less than 14 feet in depth) and deep-draft (greater than 14 feet in depth) vessels. Not all the transits shown in the table pass by the proposed Project because terminals are located both upstream and downstream of the site.

Table 3.21-1
Mississippi River Channel Vessel Transits, New Orleans to Head of Passes

Vessel Draft, feet	2012	2013	2014	2015	2016
Less than 14	229,970	208,505	185,440	207,932	121,021
Greater than 14	14,293	12,959	46,822	13,451	13,550
Total Vessel Transits	244,263	221,464	232,262	221,383	134,571
Total Cargo Tons	325,568,588	311,609,380	342,577,378	342,635,539	347,621,922

Source: USACE 2018n.
Notes: Transits include both upbound and downbound traffic.

Table 3.21-1 shows that while traffic in this section of the river declined in 2016, the tonnage increased somewhat, suggesting that larger vessels were employed more than in prior years and fewer empty vessels passed, a trend that is expected to continue. Nonetheless, an average of more than 360 deep- and shallow-draft vessels transited the segment every day in 2016.

3.21.1.3 Cargo

3.21.1.3.1 Lower Mississippi River Commodity Tons by River Segment

The Mississippi River System, including navigable tributaries, can be viewed as a funnel, with the top representing the cargo gathering areas at the geographical extremities of the navigable waterway network including, but not limited to, Minneapolis, Chicago, Pittsburgh, and Shreveport. The bottom of the funnel represents the Mississippi River Passes where vessels interface with the Southwest Pass and South Pass at Head of Passes.

Table 3.21-2 presents data for Mississippi River commercial cargo tons by river segment and foreign and domestic sources. The deep-draft Mississippi River Passes (or “Passes”) segment represents the bottom of the entire Mississippi River system and is a good proxy for cargo and vessels entering and exiting the river, particularly deep-draft vessels transiting past the proposed Project location (New Orleans to Head of Passes segment). Total cargo tonnage in the Passes segment was nearly 250 million in 2016. The “through” designation indicates the cargo tons that move across the segment as opposed to originating or terminating in the segment. The “through” for the Passes segment indicates that nearly all (about 219 million tons) of the total cargo traffic (about 254 million tons) moves through the segment. Most of the cargo tons crossing the Passes segment are for foreign trade (import and export). Foreign commerce transiting the Passes was about 219 million tons in 2016 compared to domestic commerce of about 35 million tons in 2016.

Table 3.21-2
Mississippi River Cargo Tons (000) by River Segment and Major Commodity Groups by Foreign and Domestic Sources, 2016

Mississippi River Segment	Foreign and Domestic: All Traffic[a]	Foreign and Domestic: Through Traffic[b]	Domestic: All Traffic[c]	Domestic: Through Traffic[d]	Foreign: All Traffic[e]
Mississippi River Passes[f]	254,042	253,361	35,408	34,727	218,634
New Orleans, LA to Head of Passes[g]	347,622	211,151	128,987	53,953	218,634
Baton Rouge, LA to Head of Passes[h]	484,648	26,702	266,014	26,665	218,634
Minneapolis, MN to Head of Passes[i]	526,265	27,548	307,630	27,512	218,634

Source: USACE Institute for Water Resources (USACE IWR) 2018

[a] Foreign and Domestic All Traffic = the total tons of all cargo on each segment.
[b] Foreign and Domestic Through = total cargo tons transiting over each river segment to another segment.
[c] Domestic All = total domestic cargo tons on each river segment.
[d] Domestic Through = total domestic cargo tons transiting over each river segment to another segment.
[e] Foreign All = the total tons of import export cargo.
[f] Mississippi River Passes = South Pass, 14.2 miles and Southwest Pass, 21.2 miles.
[g] New Orleans, LA to Passes = New Orleans to Head of Passes, Lower Mississippi from RM 106 to Mile 0.
[h] Baton Rouge, LA to Passes = Baton Rouge to Head of Passes, Lower Mississippi River from RM 236 to Mile 0.
[i] Minneapolis, MN to Passes = Minneapolis, MN to Head of Passes.

Waterborne transport, characterized by slow speed and relatively low cost, tends to attract heavy bulk cargoes. The largest commodity groups within the Mississippi River Passes with respect to total tons are petroleum and petroleum products (nearly 100 million tons) and farm products (nearly 90 million tons) (USACE Institute for Water Resources [USACE IWR] 2018). The remaining commodity groups are considerably smaller.

Petroleum and farm products accounted for over three-quarters of total commodity tons transiting the Mississippi River Passes in 2016. Chemicals were nearly 10 percent of total tons, and crude materials were just over 6 percent. Petroleum accounted for just over 80 percent of total domestic cargo on the Mississippi River Passes. Foreign trade cargo tons on the Mississippi River Passes segment consisted primarily of petroleum (33.6 percent) and farm products (42.3 percent). Although petroleum had a substantial domestic trade component, farm products were nearly all foreign trade in nature (USACE IWR 2018).

Total commodity cargo tons moving annually on the Mississippi River Passes segment during the period 2000 through 2016 have not changed significantly (USACE IWR 2018). Domestic cargo tonnage in the Mississippi River Passes segment has been stagnant to declining, while foreign cargo tonnage, although fluctuating, has experienced a slow overall growth. These trends are consistent with the slow growth of cargo transiting the domestic U.S. waterway system, of which the Mississippi River System predominates (Workboat 2017).

Table 3.21-2 also presents the cargo tons for two other deep-draft Mississippi River segments, New Orleans to Passes and Baton Rouge to Passes. The shallow-draft segment (Minneapolis to Baton Rouge) plus the deep-draft segments are reflected by the Minneapolis to Passes segment in the table. The volume of total waterborne cargo tons progressively increases upstream, such that nearly 350 million, 490 million, and 525 million tons of cargo are handled on the New Orleans to Passes, Baton Rouge to Passes, and Minneapolis to Passes segments, respectively. Similarly, the “domestic” cargo increases as the scope of the river is enlarged from the Passes to the full network (Minneapolis to Passes). Very little domestic cargo is handled on the Passes segment (about 35 million tons) compared to the New Orleans to Passes segment (nearly 130 million tons), Baton Rouge to Passes segment (nearly 270 million tons), and Minneapolis to Passes segment (nearly 310 million tons).

The relatively large volume of “all” domestic cargo on each river segment is contrasted with the smaller tons of domestic “through traffic” that move across the segments. For example, of the nearly 310 million tons of total domestic cargo on the Minneapolis to Passes segment, only about 27 million tons move through the entire waterway. The rest are originating or terminating on the Mississippi River, often to be reshipped as foreign cargo imports and exports on the deep-draft Baton Rouge to Passes and New Orleans to Passes segments.

3.21.1.3.2 Lower Mississippi River Deep-Draft Port Commodity Tons

Table 3.21-3 depicts the total 2016 annual cargo tons for the major commodity groups for the four deep-draft cargo ports on the Lower Mississippi River, extending from Baton Rouge to the Passes: the Port of Baton Rouge; Port of South Louisiana; Port of New Orleans; and Port of Plaquemines.

Table 3.21-3
Lower Mississippi River Deep-Draft Port Commodity Tons (000) by Domestic and Foreign Cargo, 2016

Commodity Type	All Traffic	Domestic	Foreign
Food and Farm Products	179,226	86,772	92,456
Petroleum and Products	177,552	104,096	73,454
Chemicals and Products	59,984	38,620	21,364
Crude Materials	26,468	11,662	14,806
Coal, Lignite and Products	18,887	12,887	6,000
Primary Manufactured Goods	17,421	9,210	8,211
Unknown or Not Classified	1,261	0	1,261
Manufactured Equipment	1,150	69	1,081
Total, All Commodities	**481,949**	**263,314**	**218,634**

Source: USACE IWR 2018

The four ports handled a combined total of nearly 482 million cargo tons in 2016, of which about 263 million tons were domestic and 218 million tons were foreign (see Table 3.21-3). Petroleum and farm products made up the primary tonnages at all four ports. The Port of New Orleans extending between RM 81.1 AHP to RM 114.9 AHP, had a container trade reflecting a larger volume of primary manufactured goods relative to total cargo tons; the Port of Baton Rouge, extending between RM 168.5 AHP and RM 253 AHP, had a larger volume of chemicals relative to total cargo tons; the Port of Plaquemines, extending between RM 0.0 AHP and 81.1 AHP handled a relatively greater volume of coal compared to its total cargo tons (USACE IWR 2018).

The Port of South Louisiana, extending between RM 114.9 AHP and 168.5 AHP, had slightly more than one-half (54.3 percent) of the total deep-draft sector of the Lower Mississippi River cargo tons in 2016. The Port of South Louisiana was particularly important in the farm products sector with a 63.3 percent share of total 2016 cargo tons for this group, split nearly evenly between domestic (63.9 percent) and foreign (62.8 percent). The niche markets of the other three ports are evident in their respectively higher shares of individual commodities. At the Port of New Orleans, the high share of primary manufactured goods reflects a concentration of containerized cargo trade. The Port of Baton Rouge had a large share of chemicals, reflecting the industrial base adjacent to the port. The Port of Plaquemines had a large share of domestic coal; while the Port of South Louisiana had a large share of foreign coal (exports) (USACE IWR 2018).

3.21.1.3.3 Industry Adjacent to the Project Site

The Alliance Refinery in Belle Chasse is 0.5 mile upriver from the location proposed for the Project intake structure. The refinery mainly processes light, low-sulfur crude oil received domestically from the Gulf of Mexico via pipeline and other U.S. oil via marine transport.[29]

3.21.2 Federal Channels in the Barataria Basin

The Barataria Basin includes multiple shallow-draft waterways that are used for commercial and recreational purposes. The length and depth[30] of primary, federally maintained channels in the Barataria Basin include:

- Barataria Bay Waterway: 41.3 miles from the GIWW to the Gulf of Mexico with a branch channel to Grand Isle. Depths of 17 feet in the Bar Channel and 10 feet elsewhere;
- GIWW: 47 miles from the Harvey and Algiers Locks on the Mississippi River at New Orleans to Larose on Bayou Lafourche, continuing beyond the basin to Texas. Depths of 10 to 12 feet; and

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[29] In November 2021, Phillips 66 announced its plan to convert its Alliance Refinery into a terminal facility. Whether this conversion may affect its docking and mooring facilities is not known.

[30] Channel depths in the Gulf coastal zone refer to water depth below Mean Low Gulf (MLG) datum or mean lower low water (MLLW) datum.

- Bayou Lafourche and Lafourche-Jump Waterway: 50 miles from Lockport, Louisiana to the Gulf of Mexico. Depths of 28 feet in Bar Channel, 27 feet in Jetty Channel, and 9 feet in channel to Lockport.

These primary channels and other open water passages, such as the Empire Waterway, are shown in Figure 3.1-1.

3.21.2.1 Maintenance Dredging

The three federal navigation channels in the Barataria Basin are dredged by the USACE to maintain navigation depths for shallow-draft vessels as follows:

- Barataria Bay Waterway: 1996 to 2018: Ten maintenance dredging events in the waterway averaged 254,742 cy per year accumulation from 1996 to 2018. Reaches of the Barataria Bay Waterway that were dredged include the Bar Channel, the Bay Channel, the “Y,” Bayou Rigaud, and Mile 31.0 to 25.5. (USACE 2019a).

- GIWW: 1996 to 2018: Twenty-three maintenance dredging events in the Barataria Basin segments of the GIWW averaged 96,097 cy annually from 1996 to 2018 (USACE 2019a). Reaches of the GIWW that were dredged include the Inner Harbor Navigational Canal (IHNC) Lock and Lock Forebay, the GIWW Lock Forebays, the Algiers Lock and Lock Forebay, and the Harvey Lock and Lock Forebay.

- Bayou Lafourche: 1996 to 2018: Maintenance dredging was conducted in Bayou Lafourche 10 times, solely in the vicinity of Port Fourchon, with an annual average of 427,786 cy over the 23-year time period (USACE 2019a). No maintenance dredging occurred in Bayou Lafourche upriver of the port during this time-frame. Reaches of the bayou that were dredged include the Jetties/Bar Channel and Mile 3.4 to 0.0 Inland.

3.21.2.2 Traffic

The primary centrally managed ports in the basin are Port Fourchon, Port of Grand Isle, and Port of Plaquemines Parish; however, numerous terminals, wharves, and publicly available docks lie along the major and minor channels of the basin. The USACE Navigation Data Center “Port Facility Spreadsheet” lists 177 independent docks and wharves on the Barataria Bay Waterway, Bayou Lafourche, and GIWW in Jefferson, Lafourche, and Plaquemines Parishes. Vessel transits and cargo tonnages for these facilities are included in the waterway summaries in Tables 3.21-4 and 3.21-5. See Section 3.14 Commercial Fisheries for information about commercial fishing landings for the Project area.

Commercial waterborne traffic in the Barataria Basin consists mainly of vessels engaged in petroleum, fishing, and related industries. Multiple federal and non-federal channels provide waterborne access to ports and terminals throughout the basin. In addition, commercial and recreational vessels occasionally travel through open waters that lack a recognized navigation channel.

Waterborne traffic statistics for primary channels inside the basin are shown in Table 3.21-4. Transits are shown for shallow- and deep-draft classes. Transits of vessels with greater than authorized depth are achieved by timing transits to high tides. Transits on the GIWW include those that extend beyond Bayou Lafourche. For that reason and other possible duplications, Barataria Basin overall totals would be somewhat lower than shown in the table, but the table is generally representative.

Table 3.21-4
Barataria Basin Vessel Transits

Vessel Draft, feet	2012	2013	2014	2015	2016
Barataria Bay Waterway					
Less than 14	10,423	8,656	9,240	5,214	3,885
Greater than 14	16	8	7	1	0
Total	10,439	8,664	9,247	5,215	3,885
Bayou Lafourche					
Less than 14	35,357	37,589	39,991	35,252	30,135
Greater than 14	2,653	3,275	3,830	3,928	3,022
Total	38,010	40,864	43,821	39,180	33,157
GIWW, New Orleans to Sabine River					
Less than 14	103,938	93,858	98,588	86,643	76,407
Greater than 14	13	78	6	42	6
Total	103,951	93,936	98,594	86,685	76,413

Source: USACE 2018n.
Notes: Transits include both upbound and downbound traffic.

3.21.2.3 Cargo

Cargo tonnages by federal waterway are shown in Table 3.21-5. Petroleum products dominate cargo weights on the GIWW, with over 60 percent of the total amount, whereas Barataria Bay Waterway and Bayou Lafourche cargoes are more heavily weighted (over 50 percent) to manufactured equipment. Much of the manufactured equipment is destined for petroleum exploration and production in the Gulf.

Table 3.21-5
Barataria Basin Commercial Waterborne Cargo (in tons)

Category	2012	2013	2014	2015	2016
Barataria Bay Waterway					
All Commodities	***288,431***	***205,232***	***329,264***	***224,175***	***281,972***
Coal, Lignite & Coal Coke	0	0	647	0	0
Petroleum and Petroleum Products	43,291	15,775	58,721	30,957	24,010
Chemicals and Related Products	0	0	1,157	0	0
Crude Materials, Inedible Except Fuels	51,662	33,068	48,479	111,530	97,591
Primary Manufactured Goods	429	19	26,333	1,034	23
Food and Farm Products	15,840	2,642	4,845	787	1,127
All Manufactured Equipment, Machinery and Products	177,209	153,726	186,959	79,867	159,221
Unknown or Not Elsewhere Classified	0	2	2,123	0	0
Bayou Lafourche					
All Commodities	***6,091,583***	***6,506,121***	***7,794,331***	***8,943,226***	***8,430,258***
Coal, Lignite & Coal Coke	0	0	648	579	0
Petroleum and Petroleum Products	1,408,699	1,746,933	2,000,041	2,079,020	1,591,315
Chemicals and Related Products	174,260	162,154	165,989	167,019	119,898
Crude Materials, Inedible Except Fuels	900,870	1,173,942	1,274,799	1,029,391	1,049,855
Primary Manufactured Goods	43,110	35,566	80,540	84,955	65,184
Food and Farm Products	263,190	198,253	232,653	190,276	263,983
All Manufactured Equipment, Machinery and Products	3,038,055	2,831,588	3,682,753	4,965,255	5,051,417
Waste Material; Garbage, Landfill, Sludge, Waste Water	263,399	357,685	356,908	426,731	288,606
GIWW, New Orleans to Sabine River					
All Commodities	***64,156,513***	***63,338,728***	***73,083,342***	***71,662,895***	***66,675,836***
Coal, Lignite & Coal Coke	131,748	121,130	262,338	136,984	132,034
Petroleum and Petroleum Products	35,549,244	36,420,920	42,087,311	43,531,142	41,149,856
Chemicals and Related Products	10,335,623	9,787,777	10,437,115	9,994,704	10,272,005
Crude Materials, Inedible Except Fuels	12,579,734	11,561,162	14,756,163	13,287,783	10,835,353
Primary Manufactured Goods	3,156,116	2,943,627	3,025,452	2,413,797	1,859,185
Food and Farm Products	1,249,905	1,233,102	1,491,946	1,586,760	1,792,929
All Manufactured Equipment, Machinery and Products	563,346	569,383	359,398	197,300	293,578

Table 3.21-5 Barataria Basin Commercial Waterborne Cargo (in tons)					
Category	**2012**	**2013**	**2014**	**2015**	**2016**
Waste Material; Garbage, Landfill, Sludge, Waste Water	590,797	701,627	663,619	514,425	340,896
Source: USACE IWR 2018.					

3.22 LAND-BASED TRANSPORTATION

3.22.1 Roads

LA 1 and LA 308, on the Project area's western boundary, parallel the west and east sides of Bayou Lafourche, respectively, from Donaldsonville to Grand Isle (see Figure 3.22-1). They provide the primary hurricane evacuation route for these communities, and they provide access to Mississippi River bridges in Donaldsonville and Luling via LA 70, US 90, and U.S. Interstate 310 (I-310). These highways traverse portions of two Louisiana DOTD Metropolitan Planning Areas (MPAs), including the Baton Rouge MPA in and around Donaldsonville and the Houma MPA in and around Thibodaux. DOTD classifies LA 1 as a Minor Urban Arterial from Donaldsonville to Leeville, and a Minor Rural Arterial from Leeville to Grand Isle. DOTD classifies LA 308 as a Major Urban Collector for most of its length, with portions between Raceland and Larose classified as a Minor Urban Arterial (DOTD 2017).

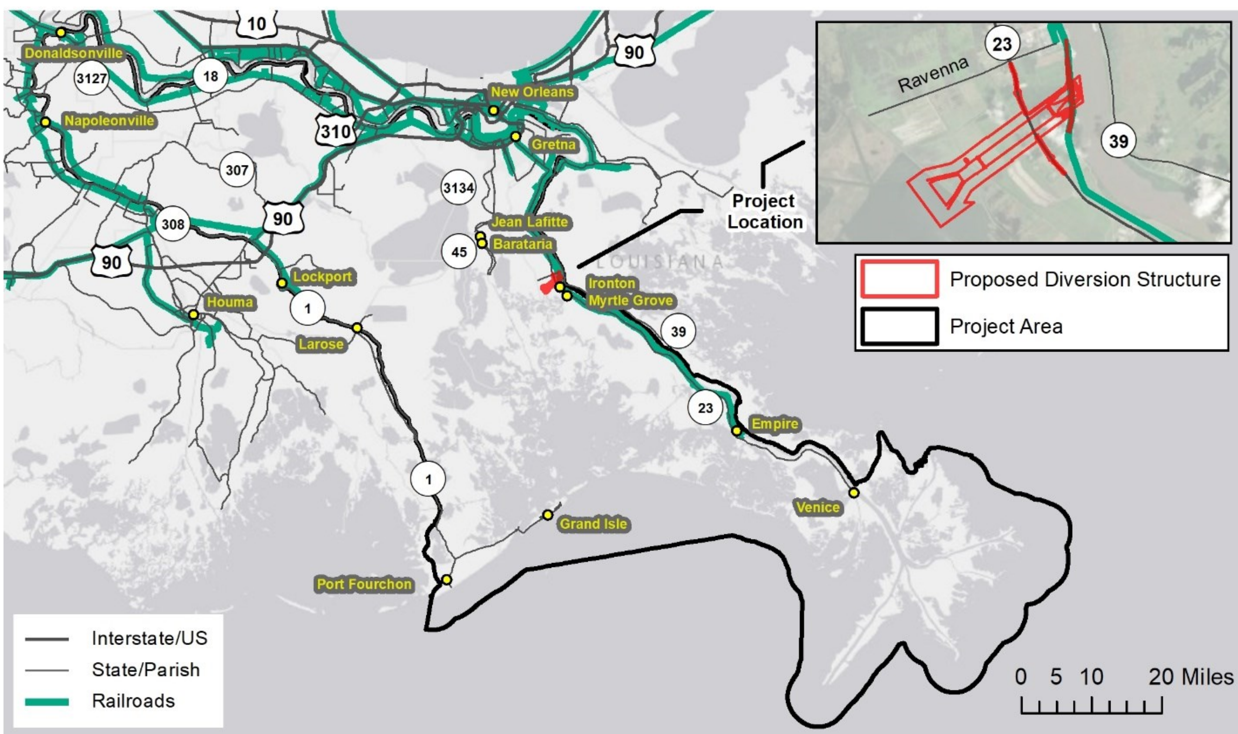

Figure 3.22-1. Major Roads and Railroads in the Project Area.

LA 18, adjacent to the Mississippi River's west bank on the Project area's northern boundary, and LA 3127, farther inland, parallel the Mississippi River from Donaldsonville to the New Orleans metropolitan area. These highways connect Donaldsonville, St. James, Vacherie, Wallace, Edgard, Hahnville, Luling (where LA 3127 ends but LA 18 continues), Avondale, and Bridge City. U.S. Highway 90 (US 90) crosses the Mississippi River into Metairie at this point, via the Huey P. Long Bridge, but also continues eastward through Westwego, Marrero, Harvey, and Gretna, where it intersects LA 23 before entering Orleans Parish and crossing the Mississippi River again, via the Crescent City Connection, into New Orleans. Together, these highways provide an important east-west corridor and provide access to Mississippi River bridges at five locations; Donaldsonville, Gramercy, Luling, Bridge City, and Gretna. DOTD classifies that portion of LA 18 located in the New Orleans MPA as a Minor Urban Arterial. The remaining portion, to Donaldsonville, is classified as a Major Collector with urban and rural reaches. DOTD classifies 3127 as a Minor Rural Collector throughout its entire length within the Project area (DOTD 2017).

US 90, the proposed future I-49 route, provides an important east-west route through central portions of the Project area, connecting the roadways that traverse the western, northern, and eastern Project area boundaries. Via its intersection with LA 45 in Marrero, US 90 also provides access to LA 45 and LA 3134, which are the north-south Minor Urban Arterial/Collector routes traversing Jefferson Parish to Crown Point and the Local Urban routes that parallel Bayou Jean Lafitte through the communities of Jean Lafitte, Barataria, and Lafitte. US 90 connects New Orleans, in the Project area's northeast, to Raceland, on the Project area's western boundary. DOTD classifies that reach of US 90 from New Orleans to the boundary of the Houma MPA as a Principal Arterial, mostly urban but with a rural reach west of Des Allemands. As it enters the Houma MPA near Raceland, DOTD classifies the highway as a Principal Rural Arterial Freeway/Expressway (DOTD 2017).

LA 23, the state highway that crosses the location of the proposed diversion structure, traverses Jefferson and Plaquemines Parishes along the west bank of the Mississippi River on the Project area's eastern boundary, connecting Venice near the mouth of the river to Gretna near New Orleans. Approximately 75 miles in length, LA 23 connects the west bank communities of Belle Chasse, Jesuit Bend, Ironton, Myrtle Grove, West Pointe A La Hache, Port Sulphur, Nairn, Empire, Buras, Triumph, Boothville, and Venice and provides the only hurricane evacuation route for these communities. At two locations, in Belle Chasse and at West Pointe A La Hache, it provides access to the river's east bank and LA 39 via ferries operated by DOTD. At its northern extent, it offers access, via US 90, to the Huey P. Long Bridge and the Crescent City Connection.

DOTD classifies the northern 13 miles of LA 23, from its intersection with US 90 in Gretna to a point just south of the main entrance to Naval Air Station-Joint Reserve Base New Orleans (NAS-JRB) at Russell Drive, as a Principal Urban Arterial. DOTD classifies the remaining 62 miles as a Minor Arterial; urban for the approximately 11-mile reach from NAS-JRB to the location proposed for the Project diversion structure, and rural for the 51 miles from the location proposed for the Project diversion structure to Venice (DOTD 2017). With the exception of an approximately 3-mile reach through and south of Port Sulphur, LA 23 south of Belle Chasse has four-lanes.

The 2015 Average Annual Daily Traffic (AADT) data indicate greater volumes on LA 23's northern, more urban reaches and declining volumes as count locations move south (see Table 3.22-1).

Table 3.22-1
LA 23 AADT in the Project Area (2015)

Mile Point	Location	2015 AADT
68.69	Gretna, near LA 23 – Engineers Rd. intersection, at Jefferson-Plaquemines border, approximately 16.8 miles north of the location proposed for the Project diversion structure.	30,534
62.68	Belle Chasse, near LA 23 – Mullins Rd. intersection, south side of NAS-JRB, approximately 10.8 miles north of the location proposed for the Project diversion structure.	22,520
49.97	Ironton, near LA 23 – Ironton Rd. intersection, approximately 0.4-mile south of the location proposed for the Project diversion structure.	6,113
0.73	Venice, approximately 49.7 miles south of the location proposed for the Project diversion structure.	3,809

Source: DOTD 2015

For its 1.5-mile reach in the vicinity of the location proposed for the Project diversion structure, LA 23 is a four-lane divided highway, with two 12-foot-wide through lanes, paved 4-foot-wide inside shoulders, paved 10-foot-wide outside shoulders, a 36-foot-wide depressed median, and open ditch drainage. The design speed and posted speed limit is 65 MPH. Access is uncontrolled; driveways and side roads intersect the highway at five locations. Total DOTD right-of-way along this reach is approximately 190 feet.

To identify existing traffic capacity and safety on LA 23, CPRA commissioned a traffic study (see Appendix I) along LA 23 from W. Ravenna Rd. to the Plaquemines Parish Access Rd., a distance of approximately 2.0 miles. The AADT along the section of LA 23 passing the proposed Project site during this timeframe was 9,300 vehicles. Level of Service (LOS) evaluations were used to measure operational conditions for the roadway using six letter grades (LOS A represents free-flow traffic; LOS F represents operational failure due to excess traffic). The study found that during peak traffic times, the existing roadway intersections operate at a LOS A or B, indicating that the current roadway has sufficient capacity with no major queuing or delays.

As part of the traffic study, crash data were reviewed along the roadway from 2012 to 2016, during which time 19 crashes occurred. Ten of the 19 crashes consisted of single-vehicle collisions with objects other than another vehicle or person, including road-departure collisions due to wildlife crossings, vehicle-wildlife collisions, and collisions with construction-related obstructions. Five of the 19 crashes were due to collisions with wildlife crossing the road. Five of the crashes were construction-related collisions that occurred in a construction zone near the intersection of LA 23 and W.

Ravenna Road; these collisions were caused by a lane transition that led to a concrete barrier separating two lanes. The construction activities at this location were completed in 2015. There were three rear-end crashes caused by human error such as high speed, distractions, or driving too closely to the car in front. In addition, there were two left-turn crashes at intersections reportedly due to the driver not seeing an oncoming vehicle. One crash was due to objects in the roadway, one was due to weather conditions, and one was associated with a vehicle making a right turn. There was one motorcycle crash believed to be due to intoxication.

Most of the crashes (11) did not involve bodily injuries. However, five of the crashes did include moderate (non-incapacitating) or severe (incapacitating) bodily injuries. Three crashes resulted in complaints of pain, with possible injuries. None of the 19 crashes were fatal. See Appendix I for the full traffic study.

3.22.2 Rail

Railroads on the northern and eastern boundaries of the Project area service industries on the Mississippi River's west bank from Donaldsonville eastward to Gretna, then southward to the location of the proposed Project. Other railroads provide important east-west track through central portions of the Project area, connecting the Mississippi River and the New Orleans MPA to Bayou Lafourche and Thibodaux (see Figure 3.22-1). These railroads are described further below.

The Union Pacific Railroad (UP) operates Class 1 rail along the Project area's northern boundary between LA 18 and LA 3127, from Donaldsonville to Gretna (DOTD 2008). Traversing Ascension, St. James, St. John the Baptist, St. Charles, and Jefferson Parishes, this rail services industries located along the Mississippi River's west bank. It intersects the Project area's only rail crossing over the river, the Huey P. Long Bridge, and it connects to rail running southward from Gretna as well as the east-west rail that connects the New Orleans metropolitan area to Thibodaux. Upriver from Donaldsonville, UP continues west to Baton Rouge where it intersects an east-west rail route along US 190, then north and west to Alexandria, where it connects to UP and Kansas City Southern northern routes towards Shreveport, Ruston, and Monroe.

The Burlington Northern-Santa Fe Railroad (BNSF), UP, and Amtrak operate the Class 1 east-west rail through the central portions of the Project area, along US 90, from Thibodaux to Gretna, the southernmost east-west rail in Louisiana (DOTD 2008). Traversing Lafourche, St. Charles, and Jefferson Parishes, this BNSF/UP/Amtrak rail connects Thibodaux, Raceland, and Des Allemands, intersects with the UP rail near the Mississippi River between Luling and Waggaman, continues east to intersect rail crossing the Mississippi River via the Huey P. Long Bridge, and continues east to Gretna. West of Thibodaux, the BNSF/UP/Amtrak rail parallels US 90 to Lafayette where it connects to an east-west rail along I-10. In Raceland, the BNSF/UP/Amtrak rail intersects a Louisiana and Delta Railroad that services industry along the east bank of Bayou Lafourche to a point between Lockport and Larose.

The New Orleans Public Belt Railroad operates the Mississippi River crossing via the Huey P. Long Bridge, which services the Port of New Orleans and connects to Class 1 interstate rail routes; west along I-10/US 61, north along I-55, northeast along US 11, and east along US 90.

The Rio Grande Pacific Corporation owns the NOGC Railroad, a short line rail traversing Jefferson and Plaquemines Parishes along the west bank of the Mississippi River on the Project area's eastern boundary, from a connection with UP in Westwego to the Gouldsboro yard in Gretna to Myrtle Grove. Approximately 32 miles in length, NOGC provides freight service to more than 20 switching and industrial customers. It also operates the 4.5-mile Hooper Spur south of Harvey and is the only railroad operating east of Avondale. Predominant shipments include a variety of food products, oils, grains, petroleum products, chemicals, and steel products. NOGC typically operates its rail Monday through Friday from 6:00 a.m. to midnight (Rio Grande Pacific Corporation 2018).

NOGC's largest customers include Kinder Morgan (in Harvey), Chevron (in Belle Chasse), and CHS, (in Myrtle Grove). Its rail currently extends across the site of the proposed Project location to a point approximately 0.2-mile south of the proposed Project intake structure (or 1.0 mile south of CHS Myrtle Grove). Operations in the vicinity of the proposed Project include those at the Alliance Refinery and at CHS, adjacent and to the north of the proposed Project, and the rail south of CHS, which is used for temporary staging of rail cars at NOGC's south extent.

NOGC plans to develop a new route through Jefferson and Plaquemines Parishes to eliminate its current route through Gretna, Terrytown, and Belle Chasse to reduce safety concerns in those communities and enable residential and commercial growth and potential LA 23 expansion along the current rail route (Rio Grande Pacific Corporation 2016). The new route would lengthen NOGC's Hooper spur southward along the Harvey Canal and Peters Road to the GIWW, then east to connect to the existing route along LA 23 south of the NAS-JRB facility. NOGC's plans for future expansion include the extension of its rail approximately 4.5 miles south to reach Kinder Morgan's International Marine Terminal south of Myrtle Grove.

3.23 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE ASSESSMENT

A HTRW assessment was conducted for the Project area in January 2018 and updated in January 2020 to identify any potential recognized environmental conditions (RECs) located in or adjacent to the Project area that have, or may have in the past, adversely impacted environmental conditions (see Appendix J for Phase I Environmental Site Assessment [CPRA 2020b]). As defined in the American Society for Testing and Materials (ASTM) E1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, a REC indicates "the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property under conditions that indicate an existing release, a past release, or a material threat of a future 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). As part of the assessment, a search of federal, state, and local governmental databases was conducted to identify RECs within a 1.0-mile radius of the proposed construction footprint (see Chapter 2, Figure 2.8-1) and the outfall area. In addition, a site investigation was performed within the Project construction footprint and immediate outfall area. The results are summarized below.

3.23.1 Records Review

A total of 536 sites and facilities within 1.0 mile of the location proposed for the Project diversion structure and outfall area were registered in the databases searched (see Table 3.23-1). As described below, none of these facilities constitutes a REC that is likely to have affected the property.

Table 3.23-1
Potential REC Sites Identified in Federal, State, and Tribal Databases

Database[a]	Acronym	Sites Identified[b,c]
Federal		
Aerometric Information Retrieval System/Air Facility Subsystem	AIRSAFS	3
Biennial Reporting System	BRS	0
Clandestine Drug Laboratory Locations	CDL	0
USEPA Docket Data	DOCKETS	0
Federal Engineering Institutional Control Sites	EC	0
Emergency Response Notification System	ERNSLA	192
Enforcement and Compliance History Information	ECHORO6	11
Facility Registry System	FRSLA	16
Hazardous Materials Incident Reporting System	HMIRSR06	1
Integrated Compliance Information System (Formerly Dockets)	ICIS	3
Integrated Compliance Information System National Pollutant Discharge Elimination System	ICISNPDES	8
Land Use Control Information System	LUCIS	0
Material Licensing Tracking System	MLTS	0
National Pollutant Discharge Elimination System	NPDESR06	0
PCB Activity Database System	PADS	0
Permit Compliance System	PCSR06	0
Resource Conservation and Recovery Act (RCRA) Sites with Controls	RCRASC	0
Comprehensive Environmental Response, Compensation, and Liability Information System Liens	SFLIENS	0
Section Seven Tracking System	SSTS	0
Toxics Release Inventory	TRI	0
Toxic Substance Control Act Inventory	TSCA	0
No Longer Regulated Resource Conservation & Recovery Act Generator Facilities	NLRRCRAG	0
Resource Conservation & Recovery Act – Generator Facilities	RCRAGR06	4
Resource Conservation & Recovery Act – Non Generator Facilities	RCRANGR06	0
Historical Gas Stations	HISTPST	0
Mine Safety and Health Administration Master Index File	MSHA	0
Mineral Resource Data System	MRDS	0

Table 3.23-1
Potential REC Sites Identified in Federal, State, and Tribal Databases

Database[a]	Acronym	Sites Identified[b,c]
Brownfields Management System	BF	0
Comprehensive Environmental Response, Compensation & Liability Information System	CERCLIS	0
Delisted National Priorities List	DNPL	0
No Further Remedial Action Planned Sites	NFRAP	0
No Longer Regulated Resource Conservation & Recovery Act Non-Corrective Action Report Treatment, Storage, and Disposal Facilities	NLRRCRAT	0
Open Dump Inventory	ODI	0
Resource Conservation & Recovery Act – Non-CORRACTS Treatment, Storage & Disposal Facilities	RCRAT	1
Superfund Enterprise Management System	SEMS	1
Superfund Enterprise Management System Archived Site Inventory	SEMSARCH	1
Department of Defense Sites	DOD	0
Formerly Used Defense Sites	FUDS	0
No Longer Regulated Resource Conservation & Recovery Act Corrective Action Facilities	NLRRCRAC	0
National Priorities List	NPL	0
Proposed National Priorities List	PNPL	0
Resource Conservation Recovery Act – Corrective Action Facilities	RCRAC	1
Resource Conservation & Recovery Act – Subject to Corrective Action Facilities	RCRASUBC	0
Record of Decision System	RODS	0
Federal Sub-total		*242*
State (LA)		
Asbestos Demolition and Renovation Notification Projects	ASBESTOS	0
Clandestine Drug Laboratory Locations	CDL	0
Sites With Controls	IC	0
Listing of Louisiana DEQ Liens	LIENS	0
Spills Listing	SPILLS	25
Waste Tire Generator List	WASTETIRE	0
Dry Cleaning Facilities	DCR	0
No Longer Reported Underground Storage Tanks	NLRUST	0
Underground Storage Tanks	UST	1
Approved Hurricane Debris Dump Sites	ADS	0
Historical Leaking Underground Storage Tanks	HLUST	0
Leaking Underground Storage Tanks	LUST	0
Recycling Facilities	RCY	2
Solid Waste Landfills	SWLF	1
Voluntary Remediation Program Sites	VRP	0
Waste Pits[d]	WP	265
Confirmed and Potential Sites Inventory	CPI	0
State Sub-total		*294*

Table 3.23-1
Potential REC Sites Identified in Federal, State, and Tribal Databases

Database[a]	Acronym	Sites Identified[b,c]
Tribal		
Underground Storage Tanks on Tribal Lands	USTR06	0
Leaking Underground Storage Tanks on Tribal Lands	LUSTR06	0
Open Dump Inventory on Tribal Lands	ODINDIAN	0
Indian Reservations	INDIANRES	0
Tribal Sub-total		*0*
ALL DATABASES TOTAL		**536**

Source: CPRA 2020b

a Unless otherwise identified, databases listed in this table include those databases compliant with ASTM 1527-13 requirements.

b The search radius included a 1.0-mile buffer surrounding all Project-related construction and outfall areas.

c Sites listed include those sites with a known location. Listings with unknown locations are not discussed herein, but are included in the GeoSearch Radius Report for the Phase I Environmental Site Assessment.

d Waste pits reported are associated with active, inactive, or abandoned oil and/or gas wells.

3.23.1.1 Releases of Hazardous Substances

The Emergency Response Notification System (ERNS) database reported 192 releases of petroleum and hazardous substances within 1.0 mile of the location proposed for the Project diversion structure and outfall area from 1991 to 2012. The releases were generally a result of equipment malfunctions, overfilling of tanks, or responses to weather events. Of the reported releases, most were releases to the atmosphere related to flaring events and the remaining were either releases to the Mississippi River, releases to soils, or releases to unknown media. A majority of these releases were reported at the Alliance Refinery, located 0.7-mile north of the proposed diversion structure. Limited information is available for each release. However, these releases occurred outside of the proposed construction footprint or were routinely contained and addressed.

3.23.1.2 Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) database includes federally regulated facilities that generate, store, dispose of, or handle hazardous wastes, and facilities that may be subject to corrective action. A total of four RCRA generators were identified within the search radius, none of which are located in the areas of active proposed Project construction (see Table 3.23-1). These include federally regulated facilities that generate an amount of hazardous waste each month that exceeds the federal reporting threshold, requiring a registration as a generator of RCRA waste. Of these RCRA generator facilities, only one (the Alliance Refinery) had any listed violations.

The Alliance Refinery was listed in the database search as a RCRA generator and a RCRA Corrective Action facility and had multiple cited violations from 1986 to

2016. This facility received a “no further action” letter associated with violations and was then placed on the Non-Corrective Action Treatment, Storage, and Disposal (TSD) list for facilities that have completed RCRA corrective actions. There are no reported outstanding violations at this facility.

3.23.1.3 Superfund Sites

The Superfund Enterprise Management System (SEMS) database includes facilities with known clean-up and enforcement activities taking place at USEPA Superfund sites. Superfund sites are designated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which gives the USEPA funds and authority to remediate contaminated sites when there is not a viable responsible party. An emergency response cleanup known as the Conoco Phillips Belle Chasse Explosion, approximately 0.7-mile north of the location proposed for the Project diversion structure was listed in the SEMS database; however, affected media were removed from the facility property and it was not assigned status as a Superfund site. Additionally, one facility (the Alliance Refinery) was listed as a site formerly considered for Superfund status in the SEMS Archived Site Inventory database. The Alliance Refinery was owned by the Gulf Oil Company at the time that Superfund listing was considered. It was assessed for listing on the Superfund site in 1984; however, in 1985, following a USEPA preliminary assessment, the facility was not listed. Both of these properties are outside of areas planned for active proposed Project construction and therefore are not considered RECs that have likely affected the Project site.

3.23.1.4 Underground Storage Tanks

One petroleum storage tank facility was identified within the search radius. The facility, Plaquemines Processing and Recovery LLC, previously contained two underground storage tanks (USTs). The facility was located approximately 0.7-mile north of the location proposed for the Project diversion structure. Two 1,000-gallon USTs, which were installed in 1974, reportedly contained gasoline and have been permanently removed from the ground.

3.23.1.5 Landfills

One solid waste landfill was reported at the Alliance Refinery, approximately 0.7-mile north of the location proposed for the Project diversion structure. The active industrial landfill site is operating under LDEQ Permit P-0247R1-M2 and is not considered a REC.

3.23.1.6 Waste Pits

Although the database search showed a total of 265 waste pits located within the search radius, only 16 waste pit facilities were reported within the outfall area near the proposed Project footprint. All of these reported waste pits are associated with inactive/abandoned oil and/or gas wells. Thirteen sites are oil/gas wells whose status is listed as abandoned/inactive. Eight of these wells condition of containment is listed as adequate. The remaining five wells list inadequate containment, but the wellheads have been plugged and abandoned. A tank battery and process heater were also identified in this area. Both were inactive/abandoned and had adequate containment in 1996. Separators, adjacent to the process heater was reported active with inadequate containment in 1996. For each of these 16 waste pit listings, investigators observed no evidence of the feature during the field reconnaissance and thus are not further classified as RECs.

Adjacent facilities including Alliance Refinery, Plaquemines Processing and Recovery, Entergy Service Center, and Woodland Borrow Pits were reviewed and no adverse environmental concerns that may have impacted the Project footprint were found.

Water well records obtained from federal and state databases were also reviewed. Approximately 66 water wells were identified within 0.25-mile of the construction footprint and immediate outfall area. Within the construction footprint approximately 10 water wells were identified. Most of these were piezometers, which have been plugged and abandoned.

Oil and gas well records maintained by LDNR indicate 883 wells within 0.25-mile of the construction footprint and outfall area but none are within the construction footprint. Fifty-five wells are adjacent to the outfall structure. These wells extend approximately two miles downstream of the outfall structure. All of these wells were dry and plugged or plugged and abandoned. Four of these wells also have expired permits in the LDNR SONRIS database.

The National Pipeline Mapping System's Public Viewer website was reviewed for pipeline information. An active hazardous liquid pipeline (crude oil) owned by Shell Pipeline is located within the construction footprint running northwest to southeast through the immediate outfall area in the Barataria Basin. No other pipelines but the Shell Pipeline appear to be located within the immediate outfall area or access channels of the construction footprint. An active gas transmission pipeline (natural gas) owned by Phillips 66 Alliance and a hazardous liquid pipeline (crude oil) owned by Shell Pipeline are located adjacent to the property running west from the Alliance Refinery to the Barataria Basin. Another active gas transmission pipeline (natural gas) owned by Phillips 66 Alliance is located farther north adjacent to the property running west from the Alliance Refinery to the Barataria Basin. Multiple other active natural gas and crude oil pipelines traverse the outfall area or are adjacent to it.

3.23.2 Field Survey

A site reconnaissance and field survey were performed within the Project construction footprint and outfall area. The majority of the property within the construction footprint is land with a small, submerged portion located within the construction outfall area and access canals in the Barataria Basin. There are a few roadways or paved areas located within the Project area. The property within the construction footprint is primarily pasture land and undeveloped forested land. Debris including storage containers; buckets and drums; plastic bottles; small appliances; old tools; tires; scrap metal; farm equipment; old vehicles; and woody debris were observed within the Project area.

Within the Project footprint or adjacent to the Project footprint on the eastern side of LA 23 the following were observed: abandoned shed; abandoned barn; grain silos, pipes, and pad; metal waste pile; possible former home site; Entergy office and yard; and cellular tower. There were no observations of stained soil, stressed vegetation, or other adverse environmental concerns noted with these observed sites.

Within the Project construction footprint and outfall area of the construction footprint on the western side of LA 23 the following were observed: abandoned wooden house; collapsed windmill and artesian well; broken pipe and artesian well; partial camp structure; and submerged oil well pipe. There was no evidence of adverse environmental concerns around the abandoned house or partial camp structure. The artesian wells were observed to be free flowing from broken pipes and neither appear on the Louisiana Water Well Registry. The submerged oil well pipe was a corroded steel oil well pipe protruding from the water near the center of the West Access Canal within the construction footprint access area. The pipe appeared similar in diameter and nature of other previously cut off and abandoned oil well pipes observed. There were no other structures, poles, or pilings observed. The pipe was observed on a day when the water levels in the marsh were approximately two to three feet lower due to wind activity. It is likely that the pipe would not be visible under normal water level conditions. There was no evidence of any leaks, sheen, staining, or other adverse environmental impacts from the pipe. The location and nature of the pipe may pose a construction or navigation hazard to the proposed Project if dredging or travel occurs in the area. It was not clear whether the pipe had been capped or plugged from the surface.

Within the outfall area, the following were observed: multiple camp structures; submerged oil well pipes; capsized boats; oil field facilities; well platforms; pipelines. Debris was observed at these various facilities. Oil and gas facility debris associated with old and abandoned facilities was observed including old platforms, pilings, lines, vessels, and tanks. Debris associated with camps included building materials, PVC pipes, appliances, containers, drums, furniture, broken pipes, old boats and fishing vessels. During the reconnaissance of the outfall area, investigators observed no evidence of leaks, spills, stains, stressed vegetation, hydrocarbon sheen, or odors. However, multiple underwater obstructions were encountered while observing the sites. For further details on these observed sites, see Appendix J.

3.24 CULTURAL RESOURCES

Cultural resources are defined as any evidence of past human activity that connects the way of life or culture of a group of people to their environment. Examples of cultural resources include archaeological sites, objects, structures, and landscapes. Documented cultural resources are assigned temporal affiliations, such as prehistoric and historic, depending on the age of the resource. Section 3.24.1 below provides a brief overview of the temporal background of the Project area.

Cultural resources are evaluated against an established set of criteria described in 36 CFR 60.4 [a–d]) to determine their significance or value to the existing body of knowledge and whether they should be considered eligible for inclusion in the National Register of Historic Places (NRHP). Those resources determined eligible for or listed in the NRHP are placed into a smaller subset of significant resources, called historic properties. Section 3.24.2 below provides additional detail regarding cultural resource compliance of the proposed Project.

3.24.1 Prehistoric and Historical Background of the Project Area

Archaeologists working in southern Louisiana generally agree that human activity in the region can be assigned to five major chronological periods based on unique cultural or technological developments observed in the archaeological site record. Brief summaries of each period are provided below (Vandagriff and Keen 2014):

- Paleoindian period (11,500 Before Common Era [BCE] – 8,000 BCE). This period includes the earliest archaeological evidence of human activity in the southeastern United States. The Paleoindian period is characterized by small groups of nomadic hunter-gatherers who manufactured long lanceolate projectile points and hunted big game.

- Archaic period (8000 BCE – 800 BCE). This period is usually divided into three smaller periods (Early, Middle, and Late Archaic). Archaic groups were still small, nomadic groups. Subsistence shifted from reliance on big game to a variety of smaller fauna.

- Woodland period (800 BCE – Common Era [CE] 1200). This period is primarily marked by the shift toward larger, socially complex, semi-sedentary groups who often returned to previous camps on a seasonal basis. People associated with the Woodland period are credited with the development of ceramic vessels, the use of elaborate burial practices, and widespread trade.

- Mississippian period (CE 1200 – 1700). The archaeological evidence associated with this period indicates that people began forming large, socially stratified, sedentary groups. The hallmark of this period is the development of agriculture as the primary form of subsistence.

- Historic period (CE 1700 – 1940s). The beginning of the Historic period in southern Louisiana is marked by Spanish and French exploration, settlement, and contact with Native Americans. The land was later transferred to the United States in the Louisiana Purchase of 1803. In the mid-1830s, the St. Rosalie Sugar Plantation (site 16PL107) was established within the Project area (Cropley et al. 2017). The development of cities and large plantations continued to flourish throughout much of the 1800s (Vandagriff and Keen 2014).

3.24.2 Cultural Resources Compliance

In accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, federal agencies must consider the effects of their undertakings on historic properties and must also afford the Advisory Council on Historic Preservation (ACHP) the opportunity to comment on them. The process by which federal agencies must comply with Section 106 is codified in 36 CFR Part 800. For undertakings authorized by a DA permit, the USACE has established its own set of procedures for fulfilling its Section 106 obligations; these procedures are outlined in Appendix C of 33 CFR Part 325.

As part of the Section 106 process, the lead federal agency (USACE) and consulting parties must develop an Area of Potential Effects (APE), which is defined by 36 CFR 800.16(d) as "…the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

A Department of the Army memorandum titled Revised Interim Guidance for Implementing Appendix C of 33 CFR Part 325 with the Revised ACHP Regulations at 36 CFR 800, April 25, 2005 provides the following definitions and examples of the types of effects that should be considered in establishing an APE: "A direct effect is caused by the undertaking and occurs at the same time and place. Examples of direct effects include demolition, excavation, grading, and other forms of ground disturbance. An indirect effect is also caused by the undertaking but occurs later in time or is farther removed in distance and is still reasonably foreseeable. Examples of indirect effects include visual and noise impacts resulting from the undertaking…."

These definitions were used to develop the proposed Project APE, which was approved by all consulting parties during a teleconference consultation meeting held on November 28, 2018. That meeting was hosted by the CEMVN and included the Louisiana SHPO, CPRA and its contractors, as well as the other agencies identified as consulting parties including the USDOI, NOAA, and the ACHP. Although none of the seven invited Native American tribal organizations attended the meeting, all opinions received from the invited Tribal Nations would be considered. It was decided that the Project APE would include both a "Construction Impacts APE" and "Operational Impacts APE" as follows:

- Construction Impacts APE: the area affected by the construction of the proposed Project diversion complex and auxiliary structures. This area includes the footprint of the diversion channel, a buffer outside the east and west conveyance channel guide levees, locations of the LA 23 and NOGC Railroad realignments, and the outfall transition feature in the immediate basin outfall that would be dredged to enhance water conveyance and sediment deposition in the initial years of operation. In total, the Construction Impacts APE includes approximately 3,095 acres.

- Operational Impacts APE: the outfall area in the Barataria Basin where operation of the proposed Project sediment diversion would transport sediment-laden water, filling water bottoms and both creating new wetlands and sustaining existing wetlands that would otherwise be lost with no action. In total, the Operational Impacts APE currently includes 70,630 acres.

3.24.3 Cultural Resources in the Project Areas of Potential Effect

Background research indicates that eight archaeological resources have been previously identified within the Construction Impacts APE. An additional 30 known resources are documented within the Operational Impacts APE. In general, most of the archaeological resources are classified as prehistoric shell middens composed of layers of Rangia shells and ceramic sherds commonly associated with the both the Coles Creek (AD 700 – 1000) (Woodland) and/or Plaquemine (AD 1200 – 1500) (Mississippian) cultural periods, which are characterized by increasingly complex sociopolitical organization, as well as complex earth work, or mound building. Sites associated with both cultural periods are often identified in marsh areas on the natural levees of old channels of the Mississippi River (Neuman 1984). Most of the midden sites were initially recorded in 1952 by archaeologists from LSU or in 1979 by Coastal Environments, Inc. (Louisiana State Site Forms, Gagliano et al. 1979). In addition, many of the midden sites were subsequently revisited in 1984 by R. Christopher Goodwin & Associates, Inc. (RCG&A) (Goodwin et al. 1985), and more recently between 2010 and 2012 by HDR Engineering, Inc. (HDR Inc.), as part of the DWH oil spill response (no report found). Both RCG&A and HDR Inc. cite a significant amount of disturbance and/or destruction of midden sites resulting from wave action, erosion, and or submergence associated with landform subsidence.

Historic sites, cemeteries, and standing structures are most commonly recorded along the west bank of the Mississippi River within the Construction Impacts APE and range in age from the antebellum period to the mid-twentieth century industrial/modern period and typically included sites associated with plantations, farmsteads, and/or house sites. Site 16PL107, the historic St. Rosalie Plantation, an 1800s sugar plantation, is a good example of a historic resource located within the Construction Impacts APE. To date, HDR completed a Phase I survey and RCG&A completed Phase II National Register eligibility testing investigations at 16PL107 within the Project construction footprint. More recently, ELOS Environmental, LLC (ELOS) completed additional Phase II work at the site and conducted cemetery investigations nearby (Healey and Huey 2020 DRAFT). These investigations are described below in Section 3.24.4. In addition, according to the Louisiana SHPO database, the Lake Hermitage Cemetery (also identified as the Bieber Cemetery) and the Deer Range Cemetery in Suzie Bayou are located along the eastern boundary of the Operational Impacts APE. Both are comprised of small community/ family cemeteries that have interments dated as recently as 2013 and 2010, respectively.

3.24.4 Investigations and Compliance

In 2014, HDR Inc. completed a Phase I survey of the general areas proposed for placement of the diversion structure and outfall within the Construction Impacts APE (Vandagriff and Keen 2014). The survey confirmed that a portion of site 16PL107 (the St. Rosalie Sugar Plantation) was located within the Construction Impacts APE but recommended this portion ineligible for the NRHP. Louisiana SHPO did not concur with this recommendation and requested Phase II NRHP testing. In April 2017, RCG&A conducted Phase II NRHP-eligibility testing on the southern portion of the site located within the MBSD construction footprint (Cropley et al. 2017). The tested portion was recommended not NRHP eligible; on September 22, 2017, the Louisiana SHPO concurred.

More recently, in 2019 and 2020, Phase II testing was conducted by ELOS within the central and northern portions of the St. Rosalie Plantation site, 16PL107 (Healey et al. 2020). ELOS identified two discrete areas (Locus 1 and Locus 2), which have been tentatively identified as the location of the plantation's slave/workers' quarters (Locus 1) and the sugar house and associated facilities (Locus 2). Site 16PL107, Locus 1 is within the Construction APE and construction footprint. ELOS's associated cemetery investigations suggested the presence of human remains within the boundary of 16PL107 and the presence of at least one in-ground coffin with several other suspected graves to the west of 16PL107. This area to the west is now identified as the St. Rosalie Plantation Cemetery No. 2 and has been assigned trinomial 16PL280. ELOS's findings are still under agency review and have not been confirmed or determined final. However, based on the information available and a review of the Construction APE and proposed MBSD Project construction footprint, Site 16PL280, as presently delineated, is outside the Construction APE and the footprints of the Project's proposed structures. In February through March 2022, RCG&A conducted Phase II NRHP-eligibility testing on the Locus 1 portion of 16PL107 within the MBSD construction footprint (Kirk et al. 2022). As a result of this investigation, CEMVN determined, and SHPO concurred, that the portion of 16PL107 within the proposed Project construction footprint is eligible for the NRHP.

Also in 2019, RCG&A completed an additional Phase I survey of four previously unsurveyed areas within the Construction Impacts APE and of high probability areas identified within the Operational Impacts APE (Cropley et al. 2020). RCG&A's Phase I investigations in 2019 did not include 16PL107. RCG&A did not identify any new archaeological sites within the Construction Impacts APE. However, multiple previously recorded prehistoric shell midden sites were confirmed present in the Operational Impacts APE. Given the inability to fully assess several previously recorded midden sites, the Louisiana SHPO indicated in its April 7, 2020 letter to USACE that several of the previously recorded sites should be considered to have an undetermined NRHP eligibility. In addition, RCG&A recorded two new archaeological sites (16JE236 and 16JE237) within the Operational Impacts APE. Site 16JE236 is a prehistoric shell midden situated along the western bankline of the Barataria Bay Waterway in the basin. The site appears to represent the redeposited and reworked remains of a shell deposit intermixed with modern refuse. Based on these findings, RCG&A recommended that

Site 16JE236 does not possess those qualities of significance and integrity as defined by the NRHP Criteria for Evaluation (36 CFR 60.4 [a-d]). No additional testing and evaluation of Site 16JE236 was recommended. On April 7, 2020, the Louisiana SHPO concurred that the redeposited portion was ineligible but that the original site location be considered undetermined with regard to NRHP eligibility.

Site 16JE237 is a prehistoric shell midden situated along the southern bank of the Texaco Canal in the basin. The surface deposit of shell and artifacts appears to represent a reworked and redeposited shell midden; however, the underlying deposits identified at the site appear to remain intact. Therefore, RCG&A recommended additional work at Site 16JE237 to determine if the site contains deposits likely to yield additional information important to prehistory or history in accordance with NRHP Criterion D.

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