Essential Fish Habitat Assessment
for the
Bay Aquatic Beneficial Use Sites
Galveston Bay, Texas

***Prepared for*:**
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS, ABBREVIATIONS & INITIALISMS

BABUS	Bay Aquatic Beneficial Use Sites
CFR	Code of Federal Regulations
cy	cubic yards
DMMP	Dredged Material Management Plan
EA	Environmental Assessment
ECIP	Expansion Channel Improvements Project
EFH	essential fish habitat
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FIFR	Final Integrated Feasibility Report
GMFMC	Gulf of Mexico Fishery Management Council
HAPC	Habitat Areas of Particular Concern
HSC	Houston Ship Channel
MAFMC	Mid-Atlantic Fishery Management Council
MLLW	mean lower low water
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ODMDS	ocean dredged material disposal site
O&M	operations and maintenance
ppm	parts per million
SAFMC	South Atlantic Fishery Management Council
SMMP	Site Management and Monitoring Plan
TPWD	Texas Parks & Wildlife Department
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code

1 INTRODUCTION

The U.S. Army Corps of Engineers, Galveston District (USACE) has prepared an Environmental Assessment (EA) in accordance with the National Environmental Policy Act (NEPA), Public Law 91–190, and regulations for implementing the procedural provisions of the NEPA, 40 Code of Federal Regulations (CFR) 1500–1508. The EA evaluates potential impacts associated with the Bay Aquatic Beneficial Use Sites (BABUS) project construction and operation and compares those impacts with those of the no-action alternative. The EA serves to evaluate practicable alternative BABUS locations, assess effects anticipated from the proposed Project, and propose best management practices and measures to avoid and minimize any identified anticipated adverse effects. This Essential Fish Habitat (EFH) Assessment was prepared to address potential impacts to EFH present in and around the project area for the proposed action.

The existing Houston Ship Channel (HSC) spans 52 miles of federal navigation channels through three counties. This important series of federal navigation channels have been modified, starting at least as far back as 1905, to better accommodate vessel traffic. Several additional modifications to these channels have taken place since this time (USACE 2019). The latest modification project, titled the HSC Expansion Channel Improvements Project (ECIP), is the planned deepening, widening, and re-configuration of several portions of these channels. These proposed changes are planned to address existing inefficiencies in accommodating current and projected container and bulk freighter vessel size and fleet size. See the Final Integrated Feasibility Report (FIFR) and Environmental Impact Statement (EIS) for the HSC ECIP by USACE (2019) for more information. There are several placement areas and beneficial use areas adjacent to the HSC for placement of some of the HSC dredged material. New work and maintenance-dredged (operations and maintenance [O&M]) material from several areas of the HSC is also planned to be disposed of at the Galveston ocean dredged material disposal site (ODMDS). However, the planned improvements to the HSC will increase the volume of O&M material from the HSC. Non-federal service facilities adjacent to the HSC needing to modify and (or) maintain their berths are also constrained by the limited availability of placement areas Due to limited capacity of the placement areas and beneficial use areas for the increased volume of dredged material, there is a need for a new placement area for this material for the next 50 years of O&M dredging (USACE 2019).

1.1 Proposed Action & Project Area

The proposed action is the construction of the BABUS for the placement of primarily O&M dredged material (Figure 1-1). Since the BABUS project is in the conceptual stage, the exact configuration of the BABUS, and position within the project footprint, has not yet been determined. The current design of the BABUS project has a footprint that does not exceed approximately 4,500 acres. The project area is in upper Galveston Bay, southeast of Atkinson Island (and its associated BU PAs), north of the Mid Bay Placement Area (Blue Water Atoll), and east of the HSC. Upper Galveston Bay is bordered by Chambers and Harris counties, Texas. The project area is submerged land in Chambers County owned by the State of Texas and managed by the Texas General Land Office. The project area is subtidal and has an average bottom elevation of -8 feet (-2.4 m) mean lower low water (MLLW) (USACE 2022). The area is transected by two recreational boating channels: Five Mile Cut Channel and North Boaters Cut. One or both channels may require dredging to a width and depth sufficient to accommodate bottom-dump scows and (or) hopper dredges for delivery of dredged material to the BABUS.

The project will consist of two types of PAs. The first type is an excavated BU PA created by excavating the bay bottom and using that material to construct confining dikes. These dikes would serve as the outer perimeter of the PA and may be reinforced with riprap or other similar materials as needed to prevent erosion. The current design has the crests of the confining dikes having a elevation between 4 and 8 feet (2.4 m) MLLW. The second type of PA will be marsh fill areas for beneficial use of dredged material. The interiors of the BABUS PAs would be filled gradually with material dredged from areas of the HSC north of Morgans Point (mile 26.2) (DMMP [Appendix R of the FIFR-EIS by USACE 2019]). The placement of the material would occur over the projected 50-year period or until the estimated capacity of approximately 100 million cy is reached.

The beneficial use PA (shown in the center of the project area in Figure 2-1) is anticipated to be excavated to a depth of -70 feet (-21.3 m) MLLW, dependent on the results of further engineering and design work, to maximize dredged material capacity. Following initial excavation, the interior of this PA would temporarily be a deep basin accessible via North Boaters Cut or Five Mile Cut Channel. A gap in the exterior dike will be provided to allow passage of the scows/dredges. Upon completion of the construction of the exterior containment dike and bay bottom excavation to the maximum depth and extent practicable, the excavated area will be filled with dredged material using dump scows until the depth prevents scows from entering the area. After this point, the dike will be closed and the material will be placed using a pipeline dredge. The containment dikes have the potential to host a variety of aquatic and emergent habitats, including oyster reef. The types of habitats and their placement along these dikes will be decided based on further engineering and design work.

The marsh fill areas are anticipated to be filled with dredged material. The containment dikes around these areas will be constructed of bay bottom material excavated from within the dredged material PA. The outer slopes of these containment dikes are anticipated to provide habitat benefits, such as intertidal marsh and oyster reef, that are similar to those to be created on the dikes of the dredged material PA. The details for how the dikes are to be constructed, and the habitats they will support, are dependent on the results of further engineering and design efforts. The elevation of the interior of the marsh fill areas would be raised from the existing bay bottom elevation (averaging -8 feet [2.4 m] MLLW) to intertidal elevations of 0 to +3.5 feet (0–1.07 m) MLLW for the potential to create beneficial use intertidal marsh and bird island habitats. Once the interior of the marsh fill areas have reached the desired elevation, the dike will be cut at strategic locations to allow for tidal exchange of bay water in and out while continuing to provide erosion protection.

Once the excavated beneficial use PA and the marsh fill areas are filled to their desired elevations and the 100 million cy capacity is reached, it is anticipated that new marsh habitat and (or) upland habitats could be created on the upper surface of the BABUS. The habitats would be designed to accommodate various desirable wetland and aquatic species. The BABUS would also be expected to provide refuge for migratory birds along the northern Gulf coast during migrations, and to add to the productivity of bird islands along the Galveston Bay migratory corridor. Thus, the proposed action is intended to aid in the USACE's requirements and directives for increasing BU of dredged material to at least 70% of all dredged material by 2030 (USACE 2023).

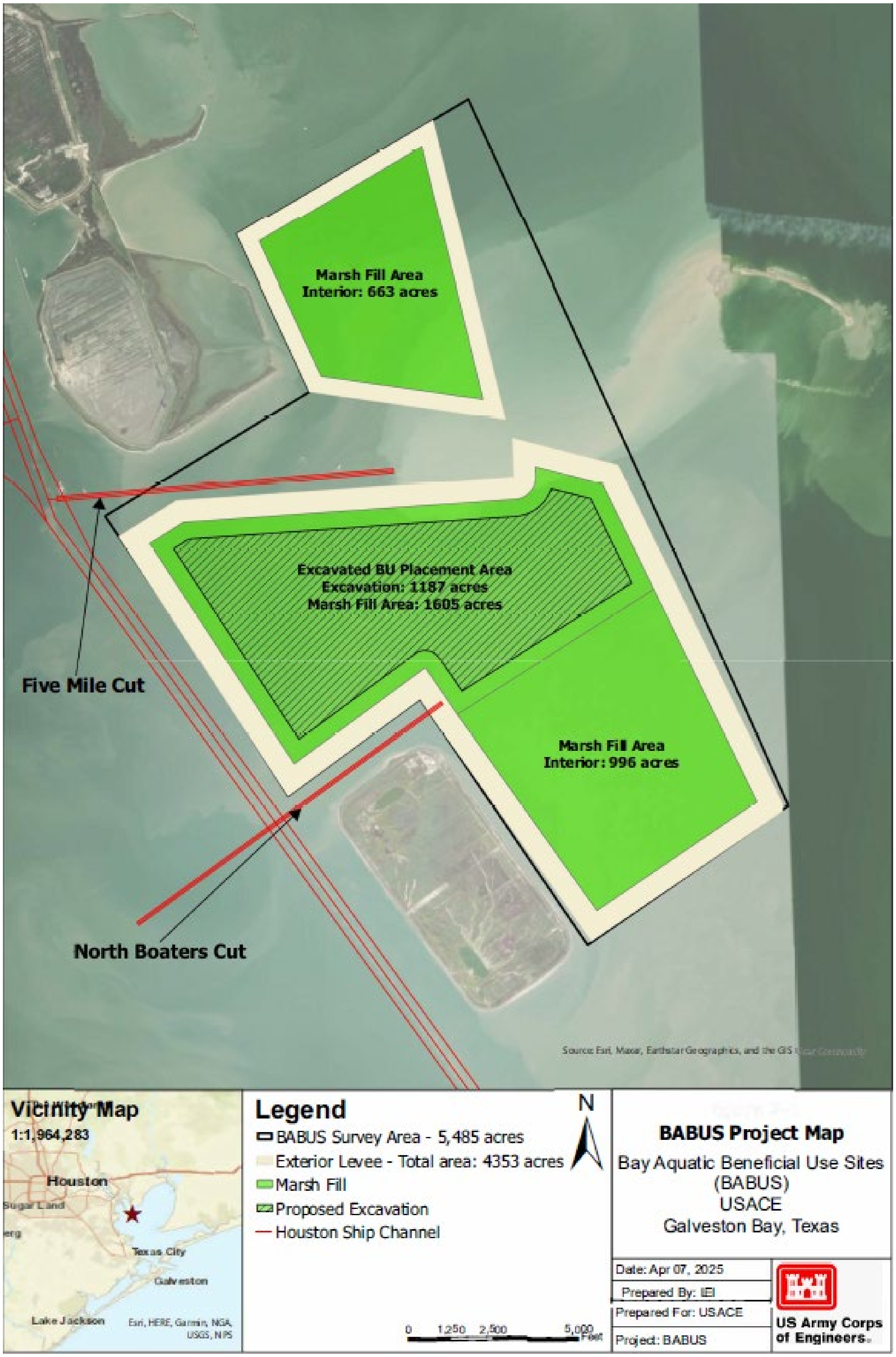

Figure 1-1. Conceptual Design of the Proposed Action: Bay Aquatic Beneficial Use Sites in Upper Galveston Bay

2 ESSENTIAL FISH HABITAT

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act ([MSA] 16 U. S. Code [U.S.C.] 1855 (b)), including the Sustainable Fisheries Act (16 U.S.C. 1801) amendment of 1996, projects with potential impact to EFH must be analyzed. EFH is defined by the National Marine Fisheries Service (NMFS) (2004) and approved by the Secretary of Commerce acting through NMFS (50 CFR § 600.10) as '…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity...' (MSA § 3[10]).

The Gulf of Mexico Fishery Management Council (GMFMC) implements regulations through NMFS for species in its management region. This council is responsible for managing and conserving various fish and invertebrates between state waters and the eastern extent of the exclusive economic zone (200 nautical miles offshore) off the Gulf coast of Texas and neighboring states (GMFMC 2017). The NMFS Office of Sustainable Fisheries provides oversight and support for the GMFMC through the development of national policies, guidance, and regulations. The Highly Migratory Species Management Division of NMFS manages an additional four major groups of pelagic fishes. These include several species of sharks, tunas, billfishes, and swordfish (National Oceanic and Atmospheric Administration [NOAA] 2009). The South Atlantic Fishery Management Council (SAFMC) and Mid-Atlantic Fishery Management Council (MAFMC) do not have jurisdiction along Texas coastal and inshore waters. However, some species managed by these councils have EFH identified along the Texas coast (NMFS 2008) as these councils can designate EFH outside their respective regions of jurisdiction (Geo-Marine 2008).

2.1 Existing Estuarine Habitat Types

The proposed project area is located within Eco-region 4 (eastern Texas [including Galveston Bay] to western Louisiana) as identified by the GMFMC (2004, 2005). The categories of EFH in the project area include estuarine water column, estuarine mud substrate, and estuarine shell substrate including oyster reefs. These habitats are designated as EFH for federally managed fisheries species because they provide nursery, foraging, and refuge habitats that support various economically important marine fishery species such as spotted seatrout (*Cynoscion nebulosus*), flounder (*Paralichthys* spp.), Atlantic croaker (*Micropogonias undulatus*), black drum (*Pogonias cromis*), gulf menhaden (*Brevoortia patronus*), striped mullet (*Mugil cephalus*), and blue crab (*Callinectes sapidus*). Such estuarine-dependent organisms are targeted in fisheries and also serve as prey for other fisheries managed by the GMFMC (e.g., red drum, mackerels, snappers, and groupers) and highly migratory species managed by NOAA Fisheries, such as billfishes and sharks. These habitats also provide other essential estuarine support functions, including: (1) providing a physically recognizable structure and substrate for refuge and attachment above and below the sediment surface; (2) binding sediments; (3) preventing erosion; (4) collecting organic and inorganic material by slowing currents; and (5) providing nutrients and detrital matter to the Galveston Bay estuary (USACE 2019).

2.1.1 Estuarine Water Column

Existing conditions—The water column within the project area has an average depth of -8 feet MLLW. A literature search found no evidence of thermoclines, haloclines, or hypoxic zones in the project area. The project area, like most of the Galveston Bay complex, is subjected to water currents caused by tides, riverine input of freshwater, and wind-driven currents. The bay is estuarine with a varying salinity gradient that is influenced by tide, rain events, and river flow. River flow entering the bay averages 24,279,600 m^3/day according to Engle et al. (2007). These authors also reported that salinity in summer averages 18 parts per thousand in the bay and the average annual water temperature is 29.5°C. The hurricane barrier constructed to protect Galveston Island and Texas City is thought to cause a reduction in salinity within the Galveston

Bay estuary by retaining freshwater for longer periods than if the barrier had not been built (Stickney 1984).

A water sample was collected 3 feet above the -49.3 feet MLLW sediment surface by submergible pump in May 2024 from near Morgans Point Cut, adjacent and west of the project area, and was analyzed for water chemistry parameters (ANAMAR 2024). The water sample had a salinity of 2.3 parts per thousand and was collected during high-incoming tide. Turbidity was measured at 170.0 Nephelometric Turbidity Units. Total suspended solids was 7.69 mg/L and TOC was 7.69 mg/L (ANAMAR 2024). These results are comparable to the results of water samples collected in June 2019 from the same station and reported by ANAMAR (2019).

Predicted impacts—Turbidity within the estuarine water column at the project area would increase beyond ambient levels during, and immediately following, construction of the containment dikes, dredging of the central portion of the PA, and dredged material placement. Dissolved oxygen levels are likely to decrease during construction and placement activities. This increase in turbidity and decrease in dissolved oxygen levels would dissipate within hours following completion of each placement episode. Estuarine organisms within the bay are generally evolutionarily prepared for such stressors and have mechanisms that allow them to survive such ephemeral perturbations successfully. The incorporation of oyster beds into the project may help reduce turbidity over time, once established. Therefore, impacts to the estuarine water column due to the project are anticipated to be temporary and minor.

2.1.2 Estuarine Mud Substrate

Existing conditions—The project area, like much of Galveston Bay, is dominated by soft mud substrate (Galveston Bay Estuary Program 2024).

Grain size results for sediment borings to -70 to -80 feet MLLW along the HSC reach adjacent to, and south of, the BABUS project area indicated variable percentages of sands, silts, and clays within the profile (USACE 2022). Sediment was collected by grab sampler in May 2024 from two locations between Beacon 76 and the southern portion of Morgans Point Cut, west and adjacent to the project area, in depths of -49.3 to -47.3 feet MLLW (ANAMAR 2024). Photos of the sediment samples are shown in Figure 2-1. The sediment was composited and analyzed for physical, chemical, toxicological, and bioaccumulation parameters. The sediment composite sample was predominantly silt (77.8%) with clay (10.3%) and some sand (11.9%). TOC measured 0.80% and total solids measured 45.1% (ANAMAR 2024).

Predicted impacts—The substrate of the containment dikes would be comparable to the estuarine mud substrate already found within the project area as they would be created with native sediment dredged from within the project area. The placement of dredged material within the project area would change the bathymetry of the area from an average bottom elevation of -8 feet MLLW to a variety of sediment elevations from as deep as -70 feet (21 m) MLLW, to intertidal habitats, and upland habitat having a maximum elevation of +8 feet (2.4 m) MLLW.

Much of the project area’s estuarine mud substrate will eventually be converted to emergent and terrestrial habitat for federally managed and protected species. This will occur once the beneficial use PA and the marsh fill areas are eventually filled with dredged material, providing new marsh habitat and (or) upland habitats on the upper surface of the BABUS. The habitats would be designed to accommodate various desirable wetland and aquatic species. These habitats are expected to be provide needed refuge for migratory birds to add to the productivity of bird islands along the Galveston Bay migratory corridor.

Overall, impacts to estuarine mud substrate would be substantial and permanent, but would be beneficial by creating new habitats.

Figure 2-2. Sediment Samples H-MR-24-04A and B Collected by Grab Sampler in May 2024 from Two Locations West and Adjacent to the project area

Source: Photos from electronic Appendix I of ANAMAR (2024)

2.1.3 Oyster Reef and Estuarine Shell Substrate

Existing conditions—As stated in the main body of the EA, the entire BABUS project footprint was surveyed by Lloyd Engineering (2025) for oyster habitat and submerged aquatic vegetation (including seagrasses) using side-scan sonar in December 2023 and October 2024 with ground-truthing taking place in April, October, and November 2024. These efforts, along with supplemental data from a 2018 side-scan survey by Texas A&M University, elucidated the occurrence, distribution, and types of shell substrate within the project area.

The project area includes 88.2 acres of oyster resources, amounting to 1.6% of the 5,485 acres of area surveyed by Lloyd Engineering (2025) (Figure 2-2). Scattered oysters over mud bottom (brown habitat) accounted for 23.9 acres, which was 0.4% of the survey area and 27.1% of the aerial coverage of all oyster resources. Viable oyster habitat totaled 64.3 acres, which was 1.2% of the survey area and 72.9% of the aerial coverage of all oyster resources. No buried shell (black habitat) was observed during the survey. The remaining 5,396.8 acres of bay bottom within the survey area was mud bottom devoid of shell. Areas of contiguous viable oyster habitat ranged from 0.04 to 38.9 acres, with a mean size of 1.9 acres. Most consolidated reef habitat appeared to be associated with oil and gas well infrastructure or remnant drilling cuttings from past oil and gas well drilling. These associations were also observed in side-scan sonar survey results by BOB Hydrographics (2025). Other areas of oyster reef were associated with locations of side-casted clay sediment from dredging activities conducted prior to current regulations. These oyster habitats have the potential to grow and expand beyond their current areas if suitable hard structure is provided (see the survey report in Appendix A). However, Lloyd Engineering (2025) noted the paucity of suitable hardbottom habitat in the area, potentially limiting expansion of these habitats without amending the project area with additional suitable hard substrate.

Pits created from historical extraction/mining of oyster beds, referred to as oyster pits, may be present within the project area (USACE 2022). Recent studies through Texas A&M University are aiming to identify the current presence of oyster mining pits and their potential impacts on the project's execution, as past studies have historically found pits up to 80 feet (24 m) deep in shallow water estuaries that pose risks to water quality from low dissolved oxygen levels and potential release of hydrogen sulfide (Hensen 1993). However, no evidence of such pits was found in the project area based on their survey results (see the survey report in Appendix A).

Mitigation of potential impacts—The 23.9 acres of scattered oysters over mud bottom and the 64.3 acres of viable oyster habitat within the project area would be either directly or indirectly impacted by the project. The oysters are likely to be dredged up or buried in dredged material during construction of the BABUS, exposed to turbidity, or experience changes in flow patterns resulting from the proposed action. It is possible for some or all the oysters to be relocated elsewhere within the 4,500-acre project area but outside of the PA and marsh fill areas. It is also possible that the oysters may be relocated to portions of hard structure, where feasible, on the exterior dikes, following construction of the outer perimeter of the PA. The project concept includes hard structure such as riprap or other armoring of the exterior containment dikes in combination with a shallow sloping living shoreline which may be suitable for oyster reef colonization.

Mitigation for oyster impacts is expected to be at a 1:1 ratio of acres impacted to acres relocated or created. The onsite relocation approach is currently being considered for the oyster resources of the project area. Alternatively, candidate sites for oyster reef mitigation from Appendix P-1 of the FIFR-EIS by USACE (2019) may be explored as potential relocation areas elsewhere within Galveston Bay. With proposed relocation and/or habitat creation as mitigation, negative effects of the project to oysters would be temporary and minor.

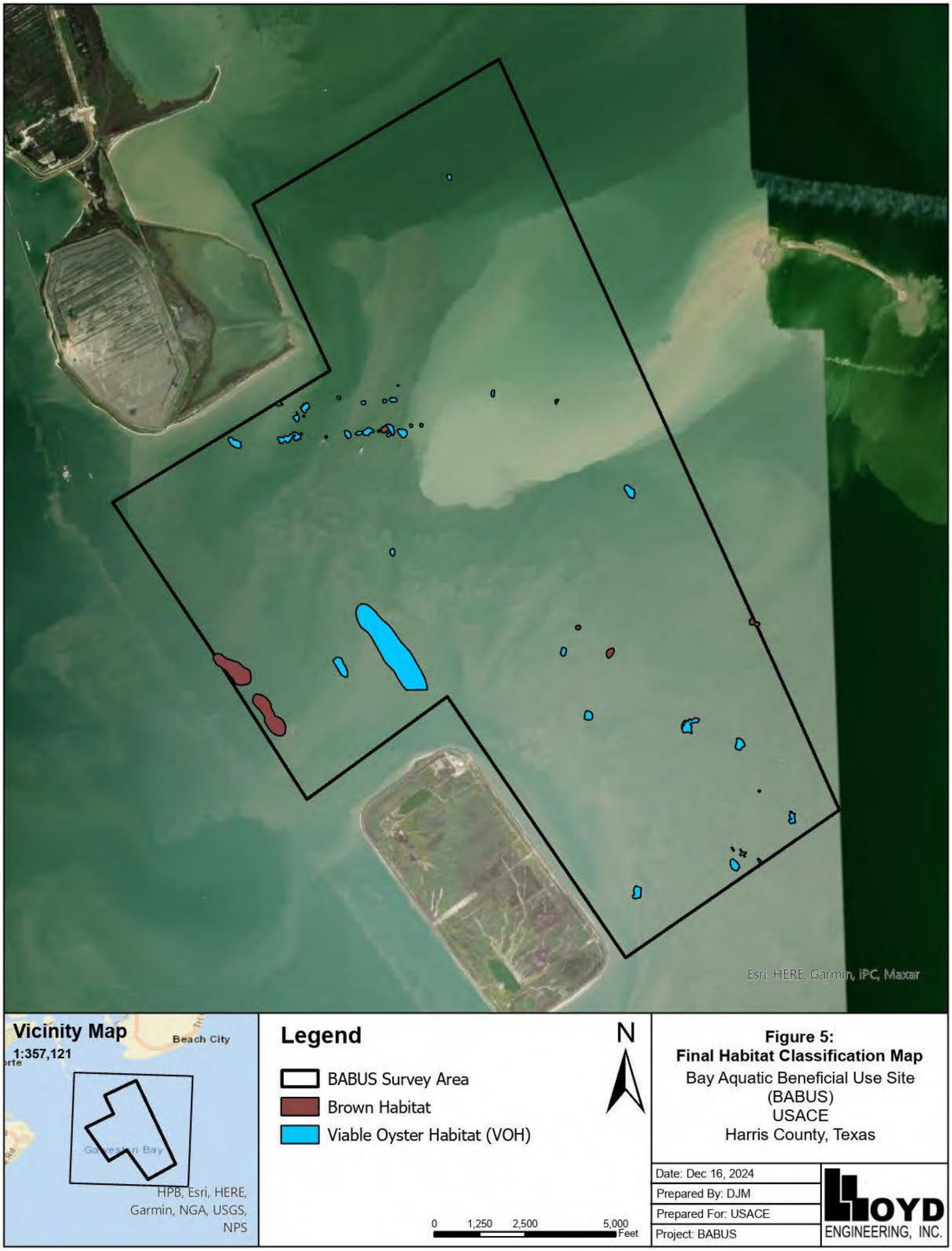

Figure 2-2. Oyster Habitat, and Other Estuarine Shell Substrate, Within the 5,485-acre Survey Area that Includes the Project Area of the Proposed Action

Source: Modified from Figure 5 of the oyster resources survey report by Lloyd Engineering (2025)

2.1.4 Other Estuarine Habitats

Seagrass habitat, or other submerged aquatic habitat, is absent from the project area, or adjacent areas, based on the survey conducted by Lloyd Engineering (2025). The project area is open bay water; it is devoid of emergent estuarine marsh habitat or other emergent or terrestrial habitats.

2.2 Federally Managed Fish and Invertebrate Species

This subsection identifies EFH and Habitat Areas of Particular Concern (HAPC) based on descriptions from several guidance documents by NOAA and fishery management councils. These documents include SAFMC (1998a, b), GMFMC (1998, 2004, 2005), NOAA (2009), MAFMC and NMFS (2011), and GMFMC and NMFS (2016). The NOAA Fisheries Essential Fish Habitat Mapper (NOAA Fisheries 2025 [https://www.habitat.noaa.gov/apps/efhmapper/]) online spatial database was used for supplemental information. No HAPC were identified within Galveston Bay based on a literature search.

EFH within Galveston Bay address the following groups of fishery-managed taxa:

- Shrimp EFH (GMFMC 2004, GMFMC and NMFS 2016, NOAA Fisheries 2025)
  - Brown shrimp (*Penaeus aztecus*) EFH for post-larval, juvenile, and subadult life stages
  - Pink shrimp (*Penaeus duorarum*) EFH for late post-larval, juvenile, sub-adult, and adult life stages
  - White shrimp (*Penaeus setiferus*) EFH for late post-larval, juvenile, sub-adult, and adult life stages
- Red Drum EFH (GMFMC and NMFS 2016, NOAA Fisheries 2025)
  - Red drum (*Sciaenops ocellatus*) all life stages EFH
- Reef Fish EFH (GMFMC and NMFS 2016, NOAA Fisheries 2025)
  - 31 species in 6 families of 4 orders
    - Perciformes: Lutjanidae (11 species), Serranidae (11 species), Malacanthidae (3 species), Carangiformes: Carangidae (4 species), Tetraodontiformes: Balistidae (1 species), and Labriformes: Labridae (1 species)
  - All life stages EFH
- Coastal Migratory Pelagics EFH (GMFMC and NMFS 2016, NOAA Fisheries 2025)
  - King mackerel (*Scomberomorus cavalla*) all life stages EFH
  - Spanish mackerel (*Scomberomorus maculatus*) all life stages EFH
  - Cobia (*Rachycentron canadum*) all life stages EFH
- Atlantic Highly Migratory Species (species-specific EFH) (NMFS 2017, NOAA Fisheries 2025)
  - Blacktip shark (*Carcharhinus limbatus*) neonate and young-of-year EFH
  - Bull shark (*C. leucas*) neonate, young-of-year, juvenile, and adult EFH
  - Spinner shark (*C. brevipinna*) neonate and young-of-year EFH
  - Bonnethead (*Sphyrna tiburo*) neonate and young-of-year EFH

Of the above groups of fishery-managed taxa having EFH in the region, the following species have EFH that are applicable to the project area based on a list of species-specific information provided in the NOAA Fisheries Inland EFH Mapper (https://efhtools.github.io/InlandEFH/Mapper.html):

- Brown shrimp post-larval, juvenile, and subadult EFH
- Pink shrimp juvenile and subadult EFH
- White shrimp post-larval, juvenile, subadult, adult, and spawning adult EFH
- Red drum eggs, larvae, post-larvae, juvenile, and adult EFH
- Spanish mackerel juvenile and adult EFH
- Gray snapper (*Lutjanus griseus*) adult EFH
- Lane snapper (*Lutjanus synagris*) larvae, post-larvae, and juvenile EFH
- Red grouper (*Epinephelus morio*) early juvenile EFH
- Cobia eggs and larvae EFH

To the above list can be added the blacktip shark, bull shark, spinner shark, and bonnethead.

Each of these species are addressed below, including summaries of their life history parameters.

Oyster reef habitat also fits the definition of EFH in MSA § 3(10), is discussed and described as-such by Coen et al. (1999), and is present within the project area based on recent surveys by Lloyd Engineering (2025). Oyster reef habitat is addressed as a component of EFH for federally managed species in Eco-region 4 (eastern Texas [including Galveston Bay] to western Louisiana) by the GMFMC (2004, 2005). Oysters and oyster reef habitat are discussed and addressed in this document as EFH and are also discussed under Wetlands and Special Aquatic Sites in Subsection 4.6 of the EA.

2.2.1 Brown, Pink and White Shrimp

EFH for brown, pink, and white shrimp includes estuarine nursery areas, offshore habitats, and connecting waterways for spawning and growth to maturity (SAFMC 1998a). Nursery areas included as EFH consist of tidal freshwater, coastal wetlands (e.g., intertidal marshes, tidal forests, mangroves), estuaries, nearshore flats, and submerged aquatic vegetation. HAPC do not include Galveston Bay, but include other coastal inlets, all state-identified nursery habitats of importance to this group, and state-identified overwintering areas (SAFMC 1998a). Tidal creeks and salt marshes serving as nurseries are perhaps the most important habitats for penaeid shrimp (SAFMC 1998a and b).

EFH for brown, pink, and white shrimp is identified by GMFMC (2004, 2005), GMFMC and NMFS (2016), and NOAA Fisheries (2025) addressing post-larval, juvenile, subadult, adult, and (or) spawning adults. Galveston Bay, including the project area, is part of this EFH (Figure 2-3). No HAPC were identified in Galveston Bay by these authors.

These three penaeid shrimp species include Galveston Bay within their respective ranges and occur from inshore waters to about 110 m depth (Tavares 2002). Preferred substrates include mud, sand, peat, and shell bottom. These species can occur within estuaries at least during their early life history stages (Tavares 2002). The white shrimp is most abundant in brackish water estuaries over soft mud and clay bottom. Post-larvae and juveniles live and grow within estuaries (Tavares 2002). Adults of brown and pink shrimp are nocturnal (white shrimp are more diurnal) (Tavares 2002), although even nocturnal species may be active by day during highly turbid conditions.

The abundance of these and other penaeid shrimp may correspond with the availability of favored substrates (SAFMC 1998b). For instance, pink shrimp appear to show a positive correlation with coarse grain and calcareous substrate (SAFMC 1998b). White and brown shrimp appear to favor soft (muddy or peaty) sediment near to shore and occur in dense concentrations there (SAFMC 1998b and 2009).

Spawning takes place over several months, from about March through September (Carson 1944). Hatching occurs approximately 14 hours after the eggs are laid (Carson 1944). Larvae can occur in marine or estuarine waters, where they live within the water column and consume zooplankton (SAFMC 1998b). Post-larvae are generally benthic. In northern areas, some post-larvae may overwinter buried within the substrate. In this region, post-larvae may use inshore emergent vegetation such as smooth cordgrass (*Spartina alterniflora*) and rush (*Juncus* spp.), where they are able to obtain enough food for rapid growth (SAFMC 1998b). These emergent vegetated habitats are thus critically important. Within these habitats, sediment mixtures of mud appear to be favored by juveniles. A brackish salinity regime is also favored by juveniles, although various studies have contradicted one another on the degree of importance of low salinity (SAFMC 1998b). As juveniles approach adult size, they migrate towards waters having higher salinities. The largest juveniles and adults are generally found in the highest salinity regimes, including open marine waters (SAFMC 1998b). Some studies indicate that temperature range and food availability have greater impact on growth than does salinity. Juveniles appeared to grow little or not at all in 16°C, but growth rates increased rapidly above 20°C in one study (SAFMC 1998b). Excessively cold winters have been known to cause mortality in all life stages and are thought to contribute to reduced landings following such events.

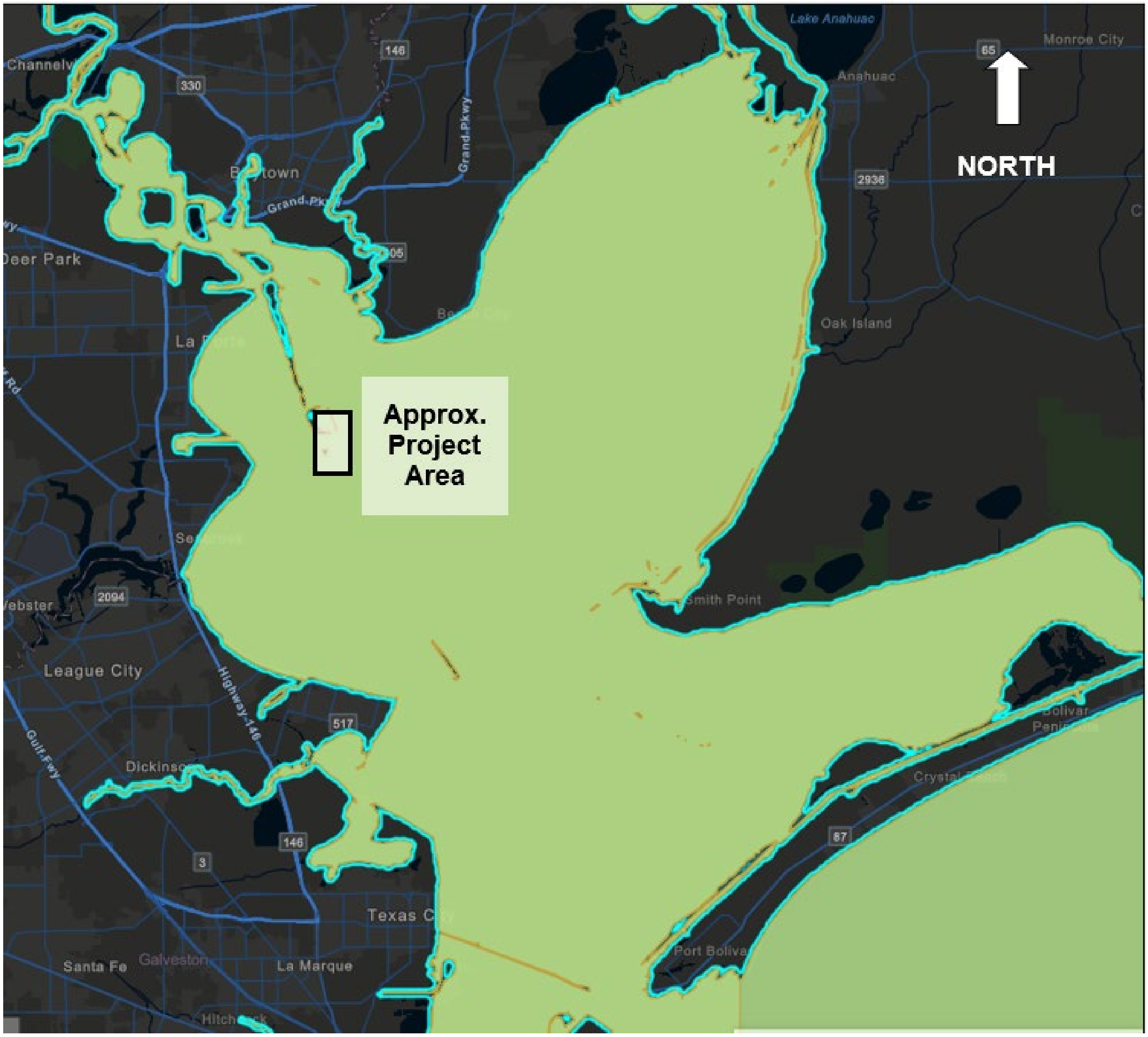

Figure 2-3. EFH for Several Life Stages of Brown, Pink, and White Shrimp in Galveston Bay, Texas

Note: The shrimp EFH is shown as green fill with a blue outline in the image above and refers to all three species of shrimp and multiple life stages according to the NOAA Fisheries (2025) EFH Mapper.
Source: Figure taken from NOAA Fisheries (2025) EFH Mapper

2.2.2 Red Drum

Red drum eggs, larvae, post-larvae, juvenile, and adult EFH were determined to include Galveston Bay, including the project area, according to GMFMC and NMFS (2016) and NOAA Fisheries (2025) (Figure 2-4).

Red drum are found over sand and silty sand bottoms in coastal waters of the northern and northeastern Gulf of Mexico and much of the Atlantic coast of the U.S. (Chao 2002, McEachran and Fechhelm 2005). Juveniles are most often found in estuaries. The species is abundant in intertidal zones of the southeastern United States, including Texas (Chao 2002). Red drum appear to undergo seasonal migrations, wandering as far north as Long Island during the warmer months of the year. In Texas waters adult red drum migrate from estuaries to offshore waters in summer, and they spawn offshore in fall, favoring waters just outside of barrier islands (Shipp

1986). This species feeds heavily on crustaceans along with mollusks and fishes (Chao 2002, McEachran and Fechhelm 2005).

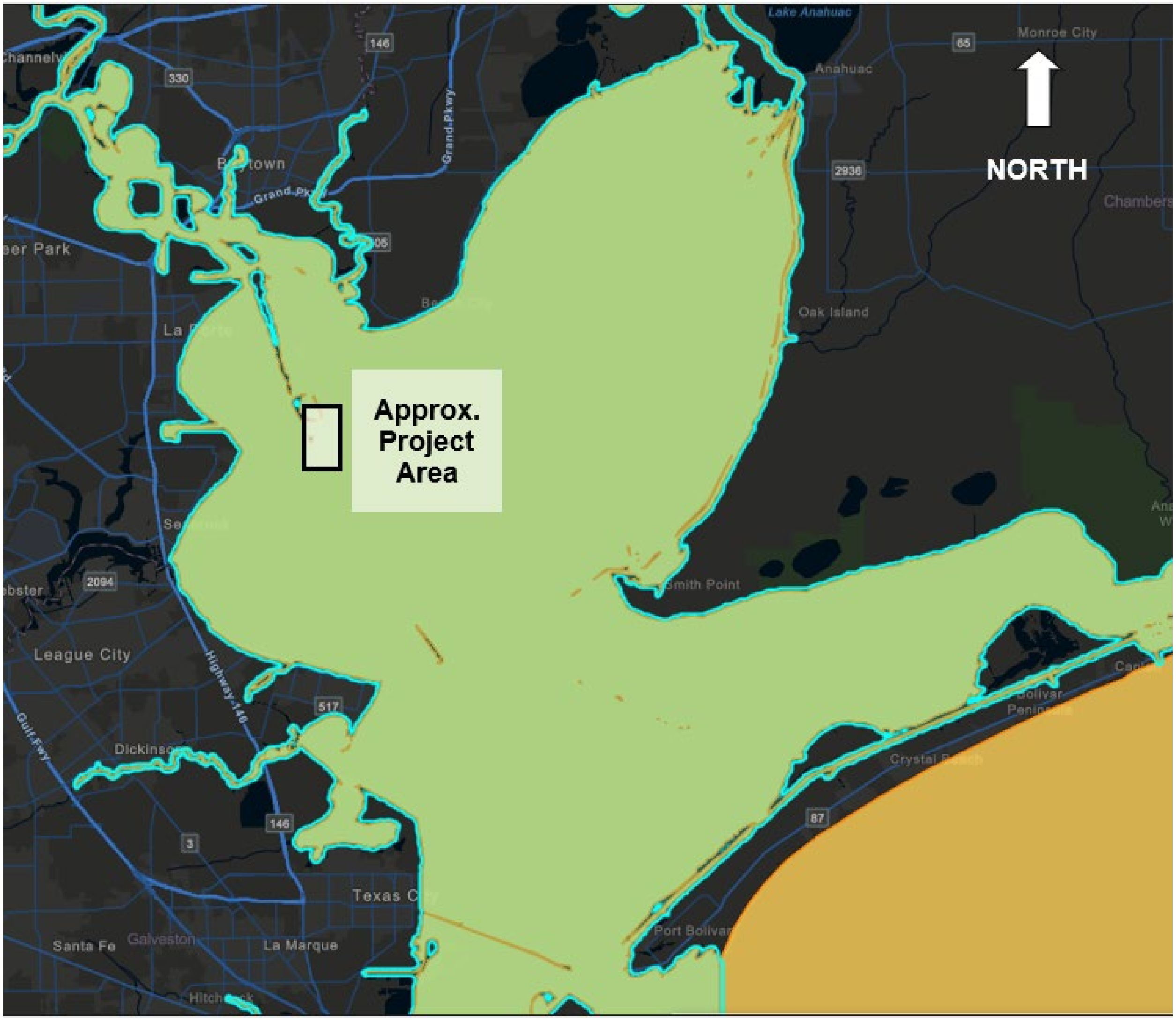

Figure 2-4. EFH for Several Life Stages of Red Drum in Galveston Bay, Texas

Note: The red drum EFH is shown as green fill with a blue outline in the image above and refers to all life stages of red drum, except for spawning adults, according to the NOAA Fisheries (2025) EFH Mapper.

Source: Figure taken from NOAA Fisheries (2025) EFH Mapper

2.2.3 Spanish Mackerel

Galveston Bay, including the project area, includes EFH for all life stages of Spanish mackerel according to GMFMC and NMFS (2016) and NOAA Fisheries (2025) (Figure 2-5).

The Spanish mackerel is found in coastal and estuarine waters of the southeastern U.S., including Texas (Collette 2002b, Adams et al. 2003). Terres Ceron et al. (2023) found a negative correlation between the trend of increasing average temperatures during spring and fall in Galveston Bay over the period 1982–2019 and abundance of Spanish mackerel in the bay. These authors attributed the increasing average temperatures over this period to climate change. The range of the Spanish mackerel, and other cool water species such as southern flounder (*Paralichthys lethostigma*), appears to be retracting northward according to Terres Ceron et al. (2023).

Spawning takes place from spring through summer (Powell 1975, Adams et al. 2003), and the species is thought to spawn repeatedly in a season (Powell 1975). Larvae are found throughout the summer (Powell 1975, Collette 2002b). Texas nearshore and estuarine waters are used as juvenile nursery areas (Collette 2002b), including areas along unprotected beaches.

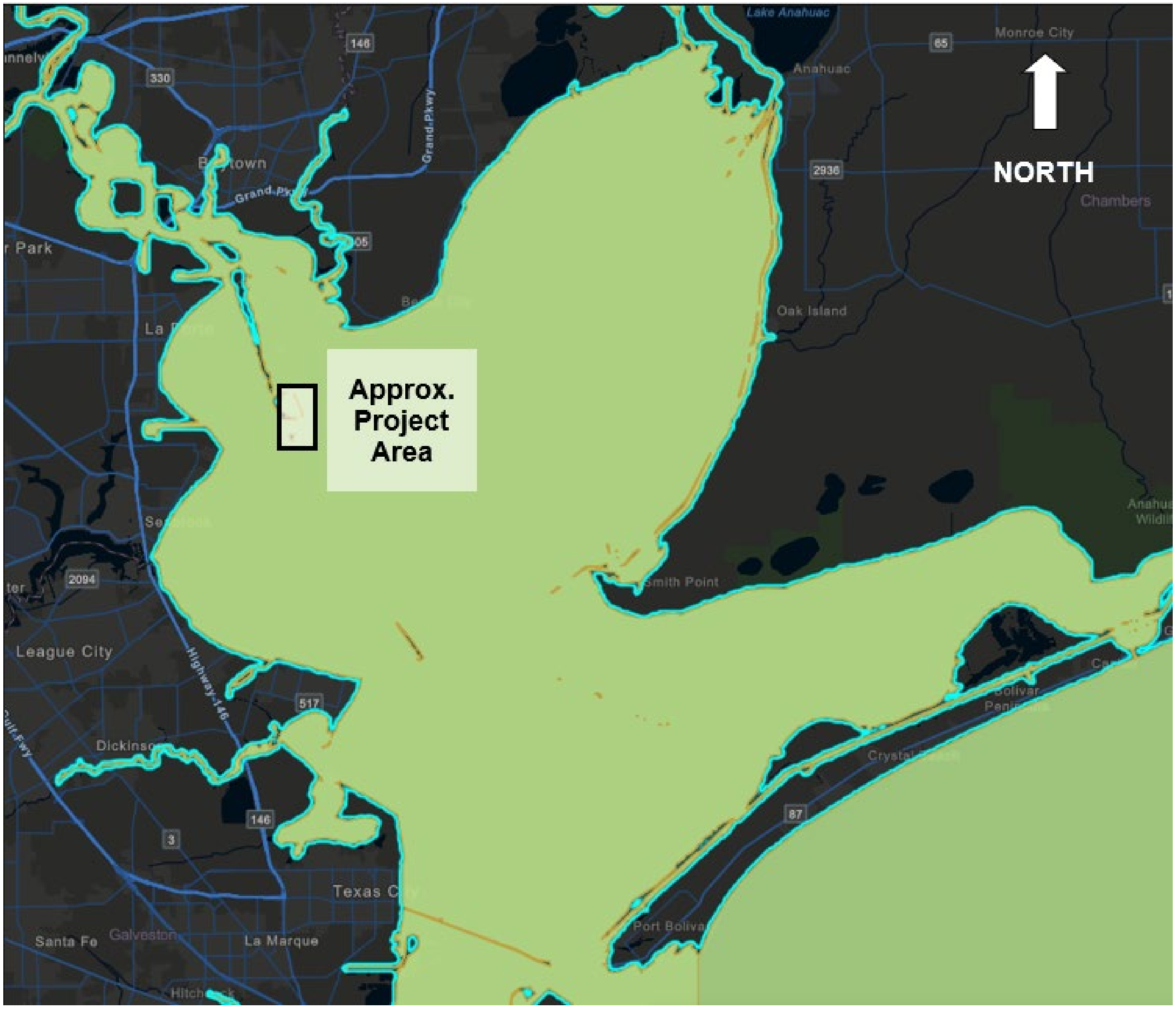

Figure 2-5. EFH for All Life Stages of Spanish Mackerel in Galveston Bay, Texas

Note: The Spanish mackerel EFH is shown as green fill with a blue outline in the image above and refers to all life stages according to the NOAA Fisheries (2025) EFH Mapper.

Source: Figure taken from NOAA Fisheries (2025) EFH Mapper

2.2.4 Gray and Lane Snapper

Galveston Bay, including the project area, includes EFH for all life stages of gray and lane snapper according to GMFMC and NMFS (2016) and NOAA Fisheries (2025) (Figure 2-6).

Gray and lane snapper are generally benthic during later life stages, often inhabiting structured benthic habitats as adults (SAFMC 1998b, 2009). Some of the more obvious structures are coral reefs, artificial reefs, hardbottom, ledges, cavities, and sloping softbottom surfaces. Juveniles of both species inhabit inshore and estuarine habitats such as seagrass beds, mangroves, lagoons, and bays (SAFMC 1998b, 2009).

A search of the Texas Parks & Wildlife's (TPWD) Texas Artificial Reefs interactive mapping application (https://tpwd.texas.gov/gis/ris/artificialreefs/) resulted in no artificial reefs having been permitted, created, and managed in Galveston Bay. However, non-permitted artificial reefs are likely to occur within the bay. Non-permitted structures may consist of piles of hard materials placed by anglers and these structured habitats potentially harbor gray and lane snapper as well as other snapper species.

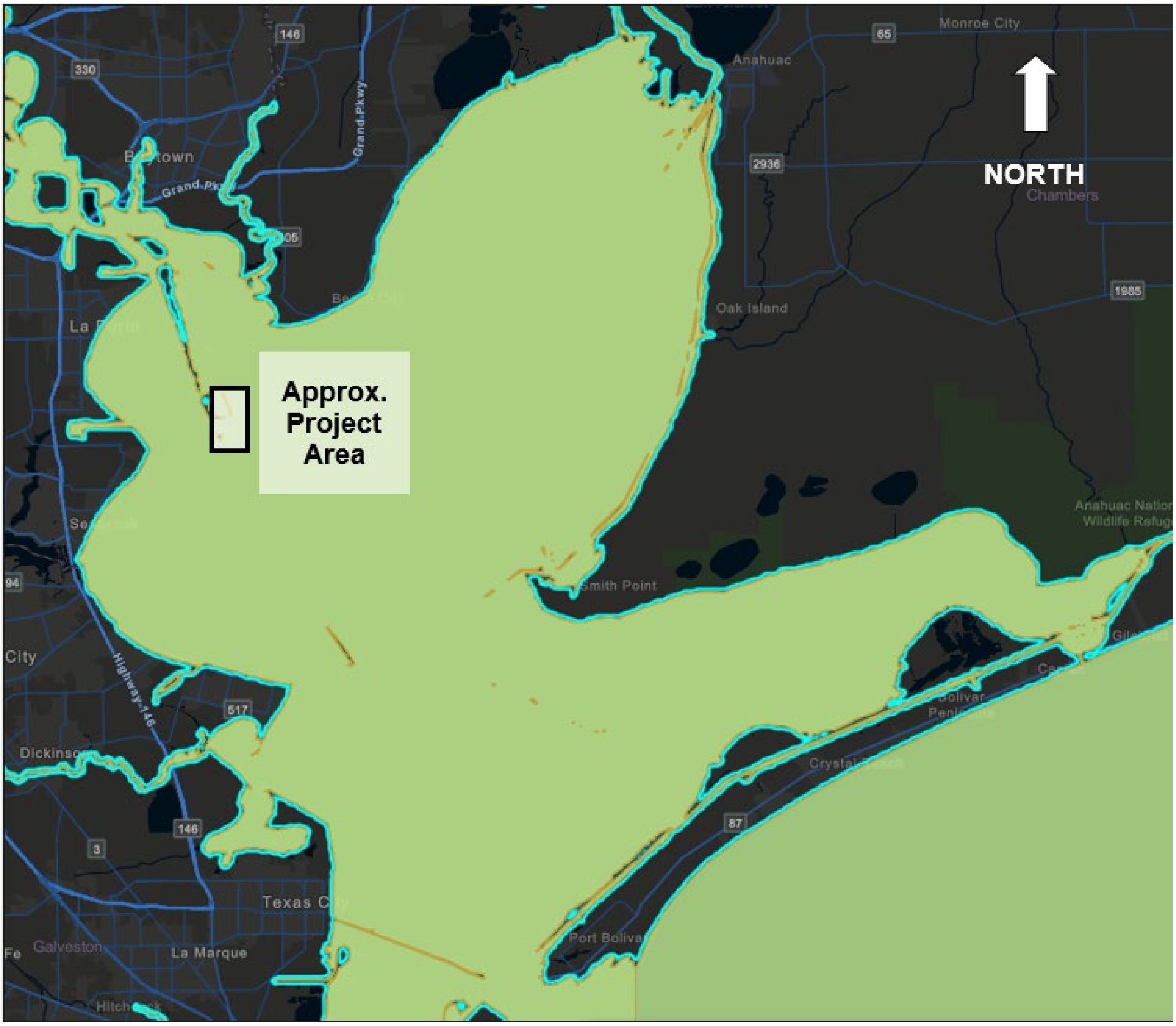

Figure 2-6. EFH for All Life Stages of Gray and Lane Snapper in Galveston Bay, Texas

Note: The gray and lane snapper EFH is shown as green fill with a blue outline in the image above and refers to all life stages according to the NOAA Fisheries (2025) EFH Mapper.

Source: Figure taken from NOAA Fisheries (2025) EFH Mapper

2.2.5 Red Grouper

Galveston Bay, including the project area, includes EFH for all life stages of red grouper according to GMFMC and NMFS (2016) and NOAA Fisheries (2025) (Figure 2-7).

Red grouper, and other serranids, are predatory, are generally demersal, and are found at varying depths (inshore to approaching 200 m) (Heemstra et al. 2002). Red grouper are typically associated with structured habitat such as rocky substrates, but juvenile life stages are instead associated with seagrass beds (Heemstra et al. 2002, McEachran and Fechhelm 2005). This species often exhibits site specificity (Heemstra et al. 2002). Prey consists of a combination of invertebrates (especially cephalopods and crustaceans) and fishes (Heemstra et al. 2002).

Reproduction is poorly known for serranids. Members of the group are hermaphrodites, some of which are protogynous, while others are synchronous hermaphrodites (Heemstra et al. 2002). Certain grouper species spawn in large aggregations at specific sites, making them susceptible to overfishing (Heemstra et al. 2002). Many serranids grow rather slowly, and this K-selected life history trait limits their ability to recover from the effects of overfishing (Heemstra et al. 2002).

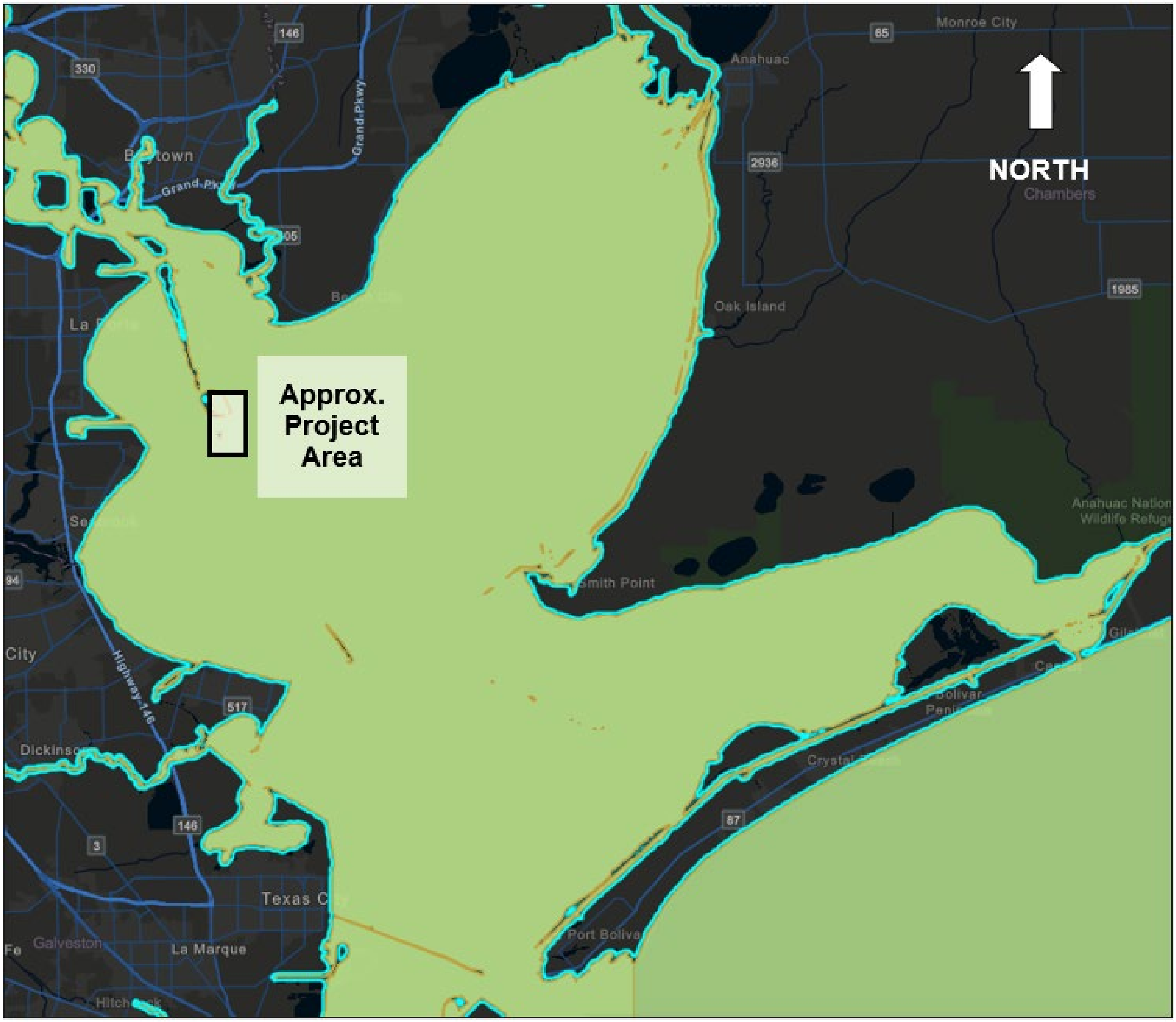

Figure 2-7. EFH for All Life Stages of Red Grouper in Galveston Bay, Texas

Note: The red grouper EFH is shown as green fill with a blue outline in the image above and refers to all life stages according to the NOAA Fisheries (2025) EFH Mapper.

Source: Figure taken from NOAA Fisheries (2025) EFH Mapper

2.2.6 Cobia

Galveston Bay, including the project area, includes EFH for all life stages of cobia according to GMFMC and NMFS (2016) and NOAA Fisheries (2025) (Figure 2-8).

Cobia are distributed along the U.S. Gulf and Atlantic coasts (Adams et al. 2003). Cobia migrate southward and into deeper water during fall and winter and return to nearshore waters in spring and summer. Off the southeastern United States, the species spawns from April to September (Adams et al. 2003). Cobia grow fast considering their large size and females reach maturity around age 2. As cobia increase in size, their choice of focal prey switches from portunid crabs to predominantly forage fishes (Adams et al. 2003). Cobia are found above structured habitat such as reefs and rocky substrates in open continental shelf waters (Kells and Carpenter 2011) up to 1,200 m deep (Collette 2002a). The species is less often found in estuaries (Collette 2002a).

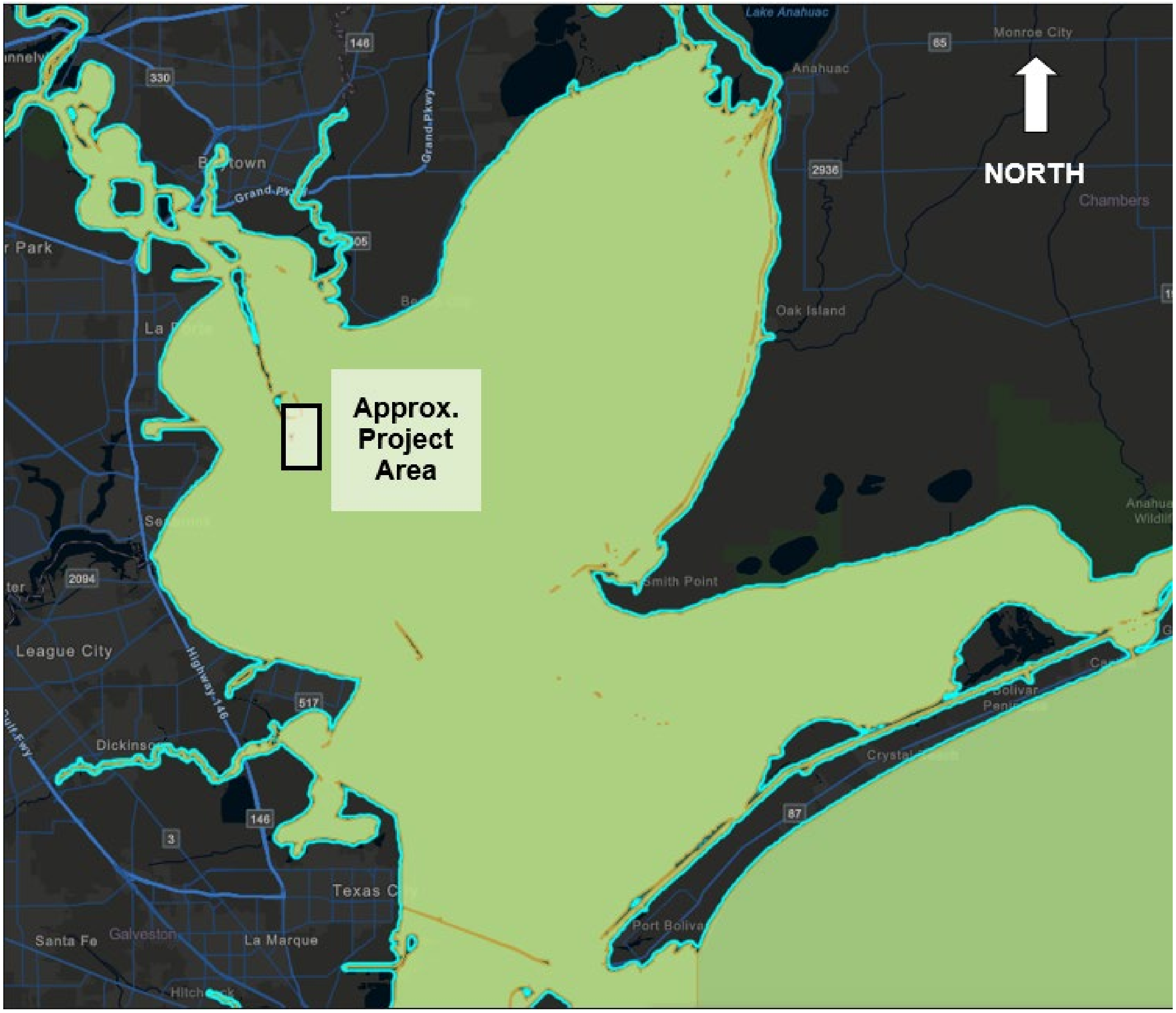

Figure 2-8. EFH for All Life Stages of Cobia in Galveston Bay, Texas

Note: The cobia EFH is shown as green fill with a blue outline in the image above and refers to all life stages according to the NOAA Fisheries (2025) EFH Mapper.

Source: Figure taken from NOAA Fisheries (2025) EFH Mapper

2.2.7 Blacktip Shark

Galveston Bay, including the project area, includes EFH for neonate blacktip sharks according to NMFS (2017) and NOAA Fisheries (2025) (Figure 2-9).

Blacktip sharks were the second-most abundant species of shark caught in Texas bays during a study of shark nurseries of Texas by Jones and Grace (2002). These authors captured adult blacktip sharks in Galveston Bay, along with several other Texas bay systems. Blacktip sharks are abundant along the Gulf coast of the United States (Castro 1983, 2011; Castro et al. 1999). Brood size ranges from one to eight young, each measuring 55 to 60 cm total length (TL), born in late May to early June in shallow mud-bottomed coastal nurseries in the southeastern U.S. and Gulf Coast (Castro et al. 1999, Castro 2011). Reproduction is biannual (Castro et al. 1999). Neonates use water depths of from 2.1 to 6.0 m according to a study by Carlson (2002). Jones and Grace (2002) reported that young-of-year blacktip sharks were most abundant in the Galveston Bay system (including West Bay and Trinity Bay), and Corpus Christi Bay system, compared to other Texas bays that they studied. Juveniles use both nearshore and estuarine waters (NOAA 2009). Juveniles and adult blacktip sharks migrate north and south along the eastern seaboard, and migrations are temperature-driven (NOAA 2009).

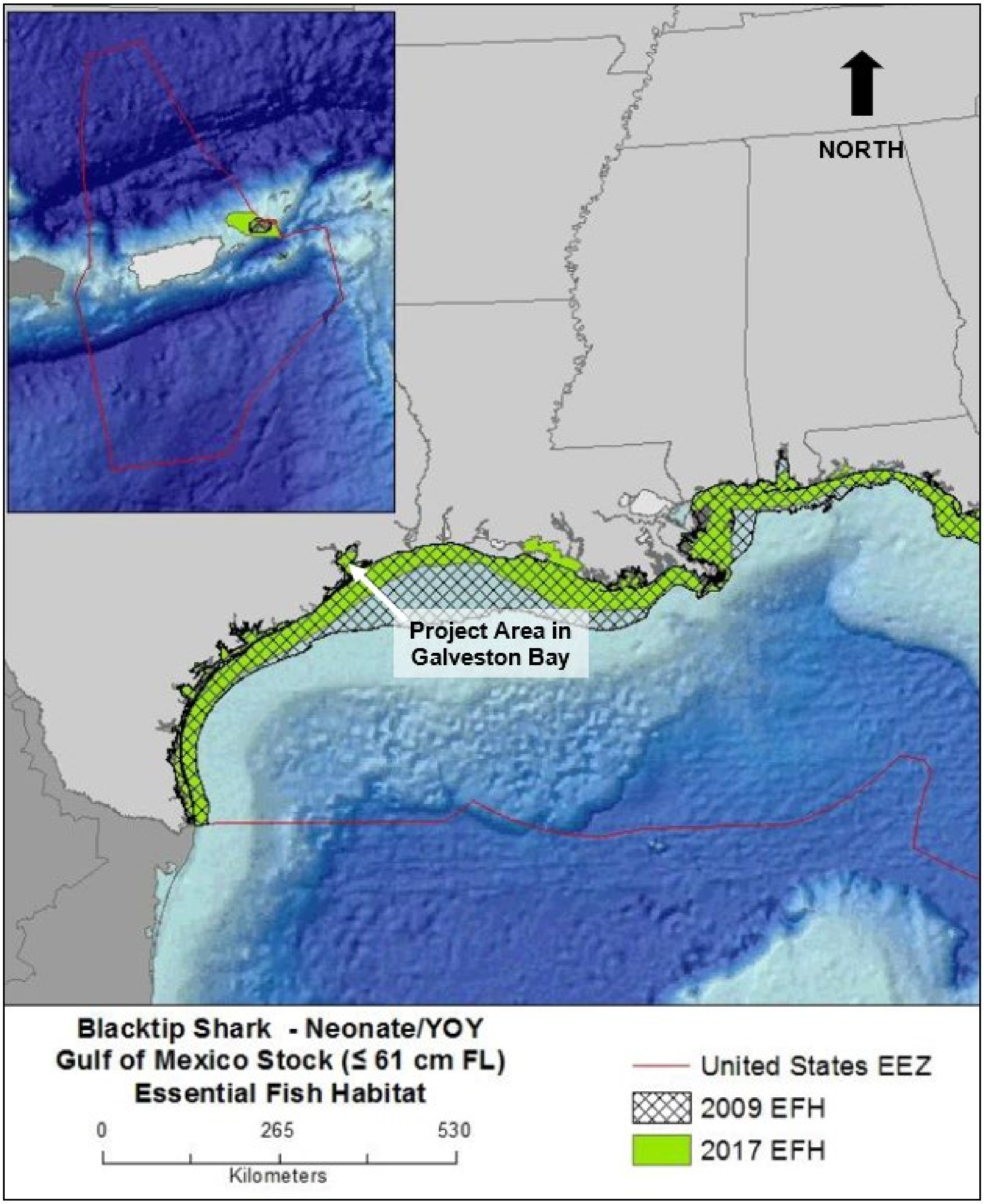

Figure 2-9. EFH for Neonate and young-of-year Blacktip Sharks in Texas Coastal Waters, including Galveston Bay

Note: The neonate blacktip EFH is shown as green fill as currently delineated according to NMFS (2017).
Source: Modified from Figure G 30 of NMFS (2017)

2.2.8 Bull Shark

Galveston Bay, including the project area, includes EFH for neonate and young-of-year, juvenile, and adult life stages of bull sharks according to NMFS (2017) and NOAA Fisheries (2025) (Figure 2-10).

The bull shark was the most abundant species of shark caught in Texas bays during a study of shark nurseries of Texas by Jones and Grace (2002). Terres Ceron et al. (2023) found a positive correlation between the trend of increasing average temperatures during spring and fall in Galveston Bay over the period 1982–2019 and increasing abundance of bull sharks in the bay. These authors attributed the increasing average temperatures over this period to climate change.

Bull sharks are thought to breed biannually (Castro et al. 1999, Castro 2011). Gestation is estimated at 10 to 11 months (Castro et al. 1999). Brood size is one to 10 young, each measuring approximately 75 cm TL (Castro et al. 1999). Gulf of Mexico estuaries provide nursery areas for this species (Castro et al. 1999), as do coastal lagoons (Snelson et al. 1984). Estuarine habitats used by young bull sharks often have very low salinity (Castro 1999). Young bull sharks in inshore nurseries are susceptible to mortality during cold winters (Dodrill 1977). Jones and Grace (2002) reported capturing young-of-year bull sharks, ranging from 833 to 975 mm TL, in Texas bays starting each May and captures of this year class continued through summer and into fall.

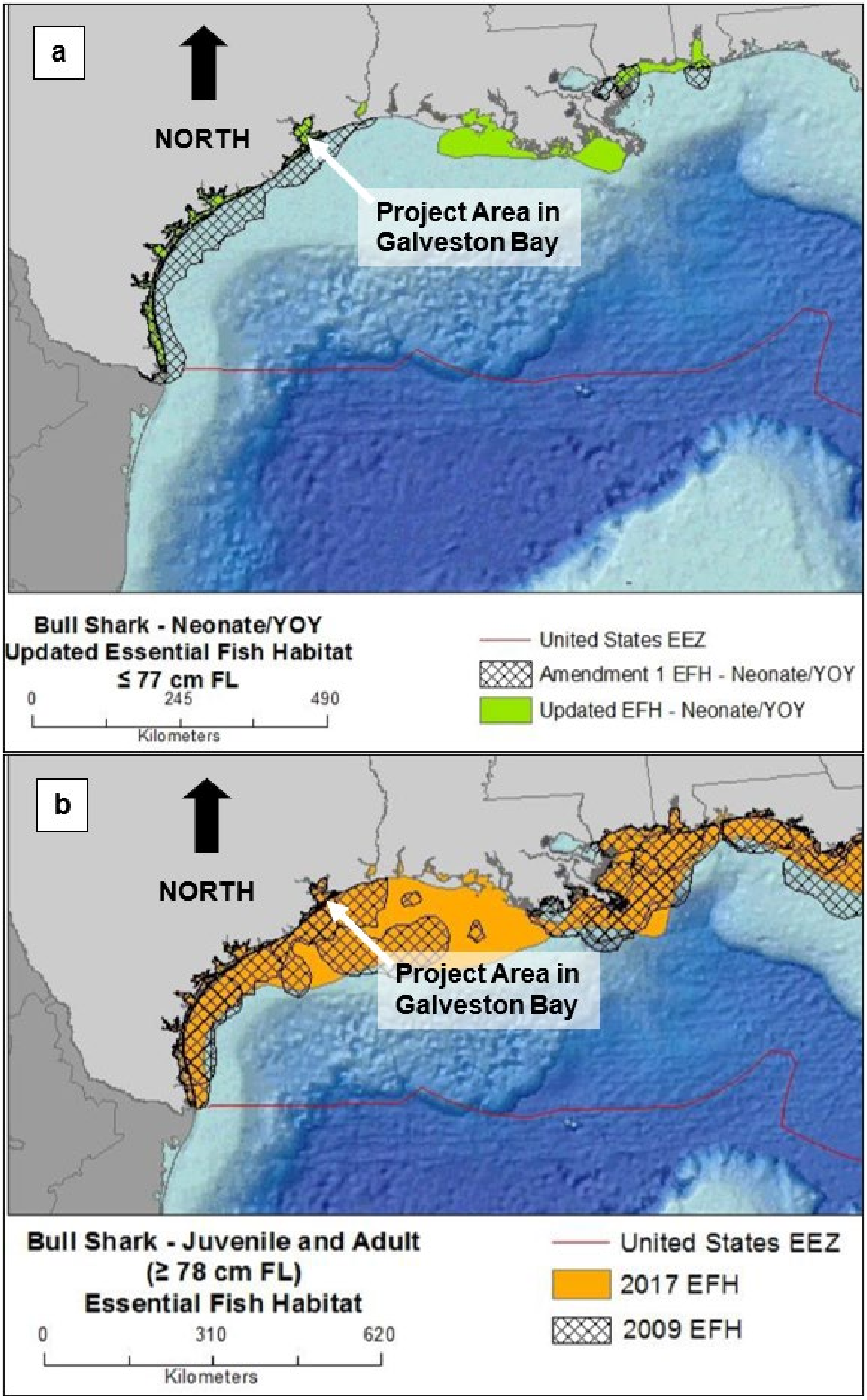

Figure 2-10. EFH for Neonate and Young-of-year (a) and Juvenile and Adult Bull Sharks (b) in Texas Coastal Waters, including Galveston Bay

Note: The neonate bull shark EFH is shown in green fill in the top image while juvenile and adult bull shark EFH are shown as orange fill in the bottom image. The green and orange fill shown represent currently delineated EFH according to NMFS (2017).

Source: Modified from Figures G 32 and G 33 of NMFS (2017)

2.2.9 Spinner Shark

Galveston Bay, including the project area, includes EFH for neonate and young-of-year spinner sharks according to NMFS (2017) and NOAA Fisheries (2025) (Figure 2-11).

Spinner sharks were caught in Galveston Bay, along with several other Texas bays, during a study of shark nurseries of Texas by Jones and Grace (2002). However, these authors reported that this species occurred in relatively low abundance in these bays. The spinner shark has a biannual reproductive cycle (Castro et al. 1999). Neonates measure 58 to 65 cm TL and are born in late May to early June (Castro 2011). Brood size is six to eight young (Castro 2011). Nursery areas are shallow coastal waters (Castro et al. 1999, Castro 2011). Life stages of spinner sharks caught in Galveston Bay included young-of-year and juveniles of age 1+ years old (Jones and Grace 2002).

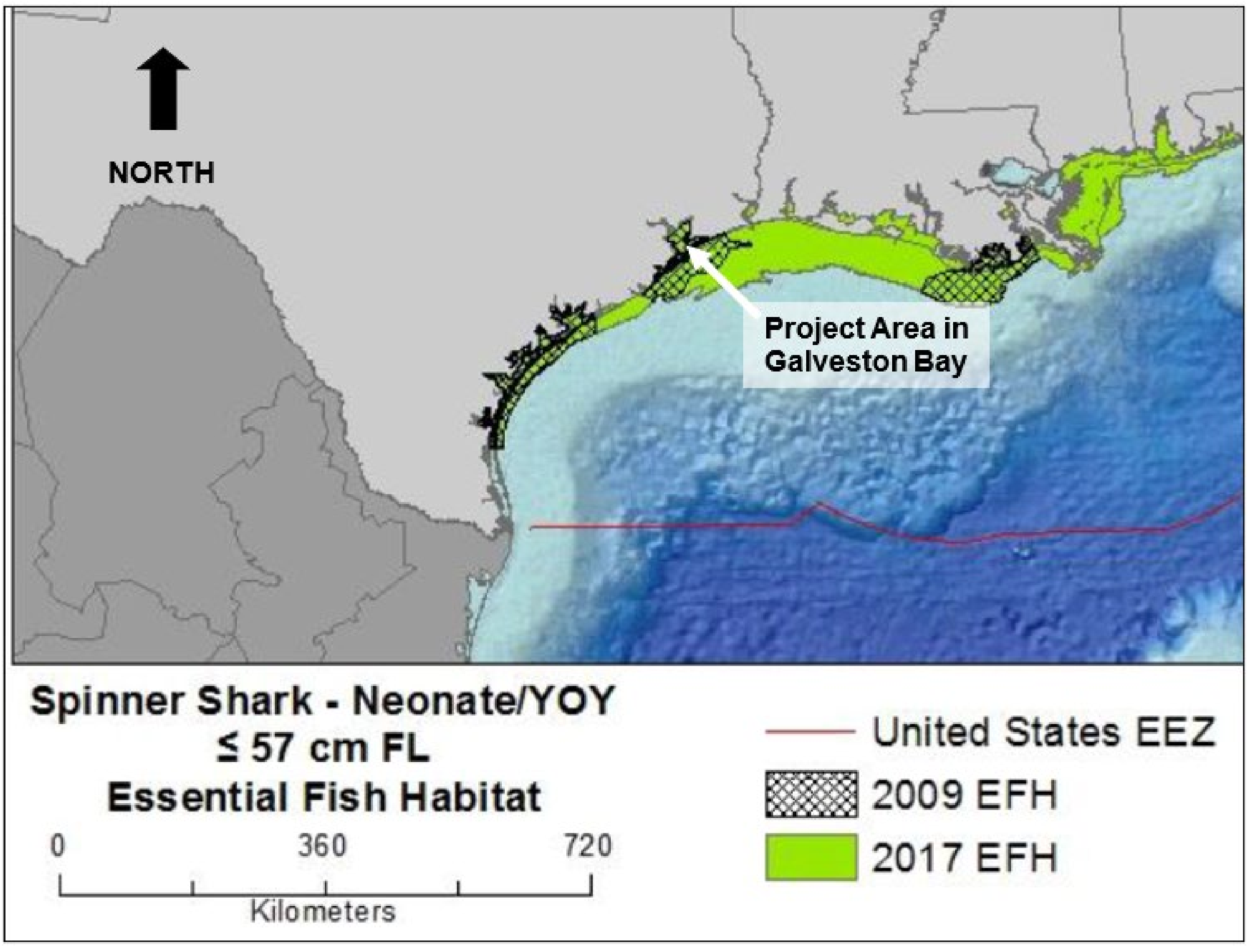

Figure 2-11. EFH for Neonate and Young-of-year Spinner Sharks in Texas Coastal Waters, including Galveston Bay

Note: The neonate spinner shark EFH is shown as green fill as currently delineated according to NMFS (2017).
Source: Modified from Figure G 45 of NMFS (2017)

2.2.10 Bonnethead

Galveston Bay, including the project area, includes EFH for neonate and young-of-year bonnetheads according to NMFS (2017) and NOAA Fisheries (2025) (Figure 2-12).

Bonnetheads of all ages were caught in all major bay systems of Texas during a study of shark nurseries of Texas by Jones and Grace (2002). The species prefers water temperatures above 21°C and depths of 10 to 80 m (Castro 2011). Bonnetheads have a short (4.5 to 5 months) gestation period and an annual reproductive cycle (Castro et al. 1999). Brood size is 8 to 12 young (Castro et al. 1999). Neonates measure 27 to 35 cm TL (Castro et al. 1999). Jones and Grace (2002) reported that young-of-year bonnetheads were most abundant in April in Texas bays. These authors found that insufficient numbers of captures of neonate-sized bonnetheads prevented the identification of probable nursery areas in Texas bays. However, parturition has been reported to occur in fall in other parts of this species' range (Parsons 1993).

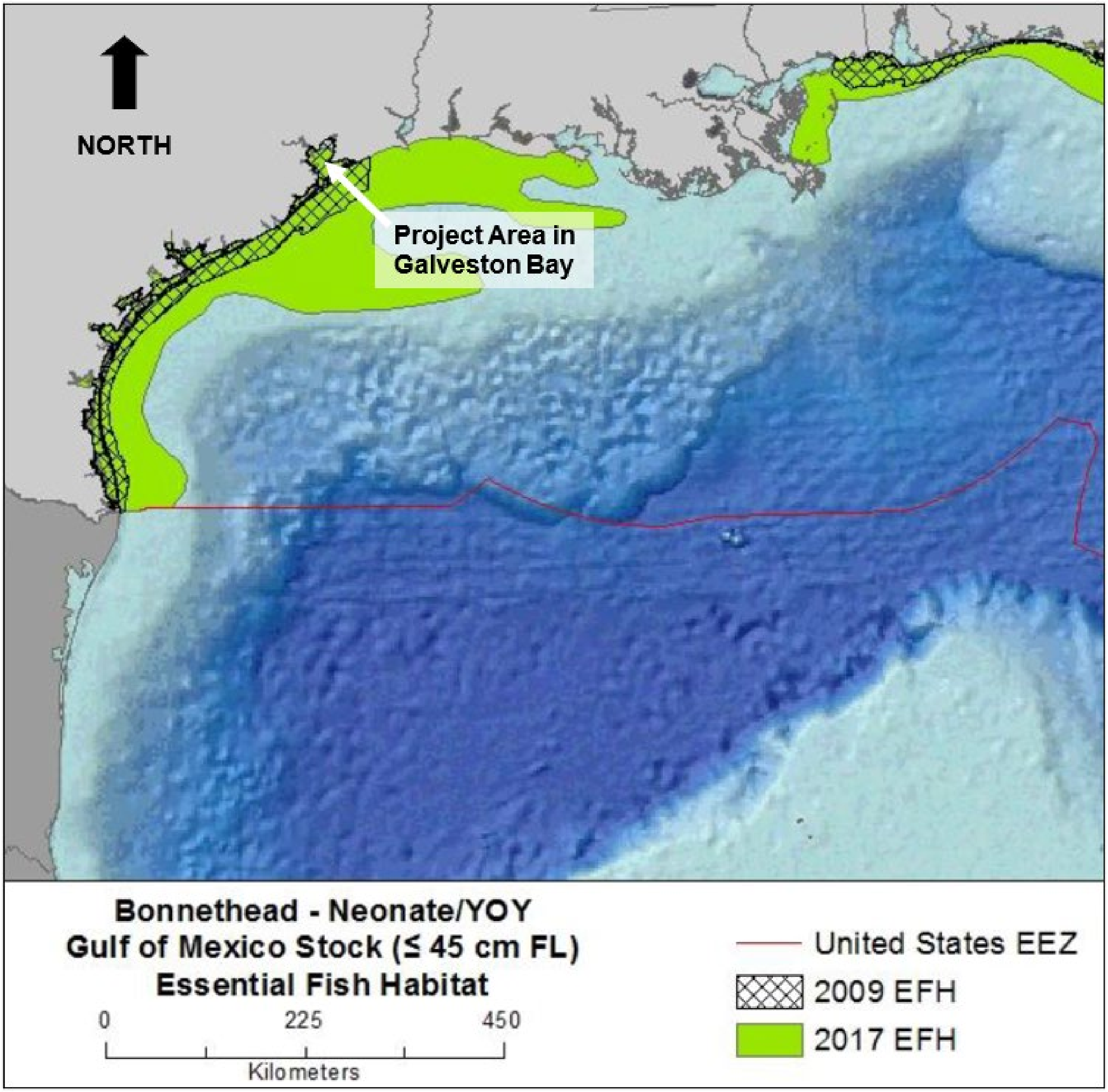

Figure 2-3. EFH for Neonate and Young-of-year Bonnetheads in the Northen Gulf Coast, including Galveston Bay, Texas

Note: The neonate bonnethead EFH is shown as green fill as currently delineated according to NMFS (2017).
Source: Modified from Figure G 52 of NMFS (2017)

2.3 Recreational and Commercial Fisheries

As discussed and described in Subsection 4.7 of the EA, there are hundreds of species of shellfish and finfishes that utilize Galveston Bay and are of recreational and (or) commercial importance. Many of such species likely utilize or pass through the project area at least occasionally. Fishery resources within the bay are the most lucrative of any bay within Texas. These resources annually generate approximately 33 percent of the total commercial fishing revenue and 50 percent of the total recreational fishing revenue for Texas (Lester and Gonzales 2010). Most of the recreational revenue is generated via the pursuit of finfishes while most of the commercial revenue is attributed to the shrimp fishery (Lester and Gonzales 2010). Some of the most common species of the bay include brown shrimp, white shrimp, blue crab, Gulf menhaden, Atlantic croaker, spotted seatrout, gray snapper, and southern flounder (Galveston Bay Estuary Program 2024).

2.3.1 Life Histories of Selected Species

Penaeid shrimp— Spawning takes place over several months, from about March through September (Carson 1944). Hatching takes place in approximately 14 hours (Carson 1944). Larvae can occur in marine waters, where they live within the water column and consume zooplankton (SAFMC 1998b). Post-larvae are generally benthic. In northern areas, some post-larvae may overwinter buried within the substrate (SAFMC 1998b). In the northern Gulf of Mexico, post-larvae may use inshore emergent vegetation such as smooth cordgrass (Spartina alterniflora) and rush (Juncus spp.), where they are able to obtain enough food for rapid growth (SAFMC 1998b). These emergent vegetated habitats are thus critically important (SAFMC 1998b). Within these habitats, sediment mixtures of mud appear to be favored by juveniles, as is a brackish salinity regime (SAFMC 1998b). However, various studies have contradicted one another on the degree of importance of low salinities (SAFMC 1998b). As juveniles approach adult size, they migrate towards waters having higher salinities (SAFMC 1998b). The largest juveniles and adults are generally found in the highest salinity regimes, including open marine waters (SAFMC 1998b). Some studies indicate that temperature range and food availability have greater impact on growth than does salinity (SAFMC 1998b). Juveniles appeared to grow little or not at all in 16°C, but growth rates increased rapidly above 20°C in one study (SAFMC 1998b). Excessively cold winters have been known to cause mortality in all life and are thought to contribute to reduced landings following such events (SAFMC 1998b).

Blue crab—Post-larval blue crab can be found in Galveston Bay. Early larval stages are found in the lower estuary and adjacent marine waters. Late larval stage blue crab occur mainly in the open Gulf, entering the estuary just prior to adopting an epibenthic adult life stage (Perry and McIlwain 1986). The species spawns in the northern Gulf of Mexico in coastal and estuarine waters in the spring, summer, and fall (Perry and McIlwain 1986). Juvenile blue crab are found on soft mud (Perry and McIlwain 1986). Adult males often wander into low salinity waters and even freshwater habitats. Mature females prefer the higher salinities of the lower estuary and adjacent marine waters (Perry and McIlwain 1986). Blue crab are opportunistic epibenthic feeders on a wide variety of food items. The species tends to feed on whatever is most abundant at a given area, including but not limited to other crustaceans (including other blue crab), mollusks, fishes, and detritus (Perry and McIlwain 1986). The species is in-turn important prey to fishes, sea turtles, and birds.

Atlantic croaker—Eggs and larvae of this species occur in open Gulf waters and are pelagic, normally occurring during the late fall to early winter (McEachran and Fechhelm 2005). Larval and juvenile croaker move closer to shore and begin to enter Galveston Bay and other Texas estuaries. Estuarine habitats used by this species include seagrass, saltmarsh, and tidal creek habitats, including both mud and sand substrates (McEachran and Fechhelm 2005). In early fall and through the winter months, adult croaker migrate out of the bay and other estuaries to nearshore and offshore waters to spawn. Spawning peaks during October through November. Fish older than one year are less abundant in the bay but low numbers can be found around oyster reefs, bridges, piers, and other high-relief structures over deeper water (McEachran and Fechhelm 2005). Mature croaker are found offshore and inhabit muddy or sandy bottoms. Adults tolerate a wide range of salinities but are most often associated with salinities ranging from 6 to 20 ppm. Temperatures of from 27° to 31°C are associated with optimal growth in this species (McEachran and Fechhelm 2005). Atlantic croaker feed primarily on polychaete worms, crustaceans, and mollusks (Springer and Woodburn 1960).

Gray snapper—This and other species of snappers are typically epibenthic and nocturnal predators inhabiting inshore waters to depths of approximately 550 m (Anderson 2002, McEachran and Fechhelm 2005). Adult gray snapper typically inhabit reef structure or rocky areas (Anderson 2002). This species preys on crustaceans and fishes (Anderson 2002). Spawning occurs in summer for continental populations, including those of Texas (Anderson 2002). Spawning occurs at night and sometimes coincides with spring tides (Anderson 2002). Females spawn multiple times during a given season (Anderson 2002). Eggs are fertilized near-surface after an ascending courtship ritual (Anderson 2002). Eggs and larvae are pelagic (Anderson 2002). Larvae are photo-sensitive, avoiding the surface during the day but distributing themselves more evenly after dark (Anderson 2002). This and other snappers exhibit K-selected life history traits, including slow growth and late maturation (Anderson 2002).

Southern flounder—This species is the dominant species of large paralichthyid flounder in the northern Gulf of Mexico (Munroe 2002). Southern flounder occurs over soft sediments (mud, clay, silt) in estuaries and coastal areas out to 40 depth. A wide range of temperature and salinity ranges are suitable (Munroe 2002). Summers are generally spent in brackish water estuaries but the species moves offshore to deeper marine waters in fall and winter, for spawning. Sexual maturity is reached at about two years of age. Spawning in the Gulf of Mexico occurs at depths of 20 to 60 m and during September through April (peaking during November through January) (Munroe 2002). Juveniles begin to migrate into Texas bays when water temperatures are as low as 14°C, but immigration peaks when temperatures average 16°C. Post-spawned adults re-enter Texas bays as early as February to April (Munroe 2002). Southern flounder are voracious predators. Adult feed mostly on fishes but also take crabs and shrimp. Juveniles feed mainly on small benthic invertebrates (Munroe 2002).

3 ASSESSMENT OF IMPACTS TO ESSENTIAL FISH HABITAT

In general, the designation and use of the BABUS could potentially produce the following adverse environmental effects:

- Temporary water column perturbations (turbidity plumes, release of chemical contaminants, lowering dissolved oxygen concentrations)
- Mortality of benthic organisms
- Changing the bathymetry of the site
- Altering the sediment composition of the site

The following sections discuss the potential effects of dredged material placement at the proposed BABUS site. Turbidity and sedimentation are thought to be primary causes of impacts to EFH.

Dredged material is anticipated to originate from the HSC, generally above Morgans Point (mile 26.2) (DMMP [Appendix R of the FIFR-EIS by USACE 2019]). Because the HSC and the BABUS site within Galveston Bay are located within the same estuary, the composition of dredged sediment originating from the HSC is expected to be somewhat comparable to the substrate currently found at the area proposed for the BABUS.

3.1 Turbidity and Water Quality

The behavior of dredged material during placement can be separated into three main phases as follows:

Convective descent (the primary phase) occurs when the sediment cloud falls under the influence of gravity and its initial momentum is imparted by gravity.

Dynamic collapse (the secondary phase) occurs when the descending cloud either impacts the bottom or arrives at a level of neutral buoyancy, at which time descent is retarded and horizontal spreading dominates.

Passive transport-dispersion (the tertiary phase) commences when material transport and spreading are determined mostly by ambient currents and turbulence rather than by the dynamics of the placement operation.

3.1.1 Minimization of Water Quality Impacts Through Multi-Tiered Testing

Although short-term water quality (primarily turbidity) impacts during placement and construction operations are unavoidable, tiered testing of dredged material helps minimize the potential for significant impacts to water quality. In accordance with the requirements and procedures defined in U.S. Environmental Protection Agency (EPA) ocean dumping regulations (40 CFR Parts 220, 225, 227, and 228), the suitability of dredged material proposed for placement in the ocean must be demonstrated through appropriate physical, chemical, and biological testing. 40 CFR § 227.6 prohibits the placement of certain contaminants other than trace chemical constituents of dredged material. Further, regulatory decisions rely on assessments of the potential for unacceptable adverse impacts based on persistence, toxicity, and bioaccumulation of the constituents instead of specific numerical limits (EPA and USACE 1991).

Determining the suitability of dredged material involves a multi-tiered testing procedure. Lower tiers use existing or easily obtained information and limited chemical testing to predict effects. If it is predicted that the dredged material has any potential for significant adverse effects, higher tiers are activated. Water column and benthic bioassay and bioaccumulation tests are used in higher tiers to determine effects on representative marine organisms.

In Tier II testing, water column impacts are assessed in terms of the limiting permissible concentration, which is the portion of dredged material that remains in the water column and is the amount of a given analyte or parameter that will not exceed marine water quality criteria (EPA and USACE 1991). Dissolved chemical contaminants are analyzed and the results are compared to the water quality criteria after consideration of the initial mixing period (EPA and USACE 1991). This process allows an indirect evaluation of any potential biological effect in the water column (EPA and USACE 1991).

Water column bioassay studies consider the effects (after allowing for initial mixing) of suspended particulates and dissolved contaminants on appropriately sensitive phytoplankton or zooplankton, crustaceans or mollusks, and fishes (EPA and USACE 2008). At least one species from each of these three groups is required in the bioassays, resulting in a minimum of three series of tests for each dredged material sample, along with the control sample, and the dilution water sample (EPA and USACE 2008). Examples of species used in bioassay tests for water column toxicity of dredged material include the eastern oyster (*Crassostrea virginica*) for zooplankton, blue mussel (*Mytilus edulis*) for mollusks, opossum shrimp (*Americamysis bahia*) for crustaceans, and inland silverside (*Menidia beryllina*) for fish (EPA and USACE 2008).

Considerable effort is placed on establishing the effects of dredged material on the benthic environment in Tier III testing. A conservative approach is used to evaluate the potential physical impacts of the dredged material using whole-sediment bioassays. Analysis of chemical contaminants is used to assess potential effects of dredged material chemistry on the environment, including bioaccumulated impacts. Sediment chemistry analysis is used to identify contaminants of concern (if any) but cannot be used to predict biological effects (40 CFR Part 227, EPA and USACE 1991) because effects are dependent on their bioavailability. To determine the bioavailability of chemical contaminants, appropriately sensitive deposit-feeding bivalves such as the bent-nose clam (*Macoma nasuta*) or the file yoldia (*Yoldia limatula*) and burrowing polychaete worms such as *Alitta virens* or members of the genus *Arenicola* are used as test subjects in laboratory-controlled bioaccumulation bioassays (EPA and USACE 1991, 2008). Bioaccumulation testing is undertaken for a 28-day period (EPA and USACE 2008). For benthic effects toxicity analysis, test subjects are chosen to best represent filter-feeding, deposit-feeding, and burrowing behavioral adaptations (40 CFR Part 227, EPA and USACE 2008). Species chosen to represent these adaptations include the gammarid amphipod *Ampelisca abdita*, the opossum shrimp *Americamysis bahia*, and the polychaete worm *Neanthes arenaceodentata* in laboratory-controlled toxicity tests (EPA and USACE 2008). Toxicity tests are run for 10 days (EPA and USACE 2008).

3.1.2 Potential Impacts to Larval Invertebrates and Fishes

Impacts to zooplankton, including planktonic larvae of federally managed invertebrates and fishes, resulting from dredged material placement may include mortality due to entrainment in the sediment plume and interference with filter-feeding caused by a temporary increase in suspended sediments. Pelagic eggs of fish can be smothered by re-suspended sediment (Suedel 2011). These impacts are expected to be short-term and localized and are not expected to significantly affect planktonic conditions in the region, especially considering that steps are taken in Tier II of the above-mentioned testing procedure to evaluate and prevent deleterious effects on zooplankton and other organisms of the water column before the dredged material is deemed suitable for ocean disposal or open water placement.

3.1.3 Potential Impacts to Pelagic Fishes

Though information is limited, most studies on the effects of dredging and dredged material disposal/placement on fish communities have focused on larvae and eggs in estuarine environments (e.g., Auld and Schubel 1978, Johnston and Wildish 1981). Results from these studies suggest that if the placement of dredged material does not significantly affect these sensitive life stages, fishes and commercial fisheries will be similarly unaffected by placement events (EPA 1993).

Pelagic fishes and other actively swimming organisms are generally not adversely affected by dredged material placement due to their high mobility (EPA 1983). During a placement event, the greatest impacts to pelagic fishes may be from increased turbidity within the sediment plume, which may temporarily limit the feeding efficiency of visually oriented predators and reduce the oxygen exchange capacity of their gills via the clogging of opercular cavities and gill filaments (Doudoroff 1957, EPA 1993) and the physical abrasion of filtering and respiratory organs (Suedel 2011). Younger juveniles may be more susceptible to the effects of released dredged material (EPA 1995). The reduction in oxygen exchange capacity in the gills of young juveniles and the effects of decreased dissolved oxygen associated with a turbidity plume can be more pronounced compared to effects on adults and older juveniles. However, highly mobile fishes are likely to avoid the sediment plume. It is possible that dredged material deposition at a nearshore placement area provides attractive foraging opportunities for actively predacious species by temporary displacement of epibenthic forage species. There are no artificial reefs within the immediate vicinity of the proposed placement area, and no impacts are expected to such habitat.

Turbidity tests done by Wallen (1951) using montmorillonite clay (a 2:1 smectite clay) particles and 16 warm-water fish species showed no behavioral changes in fish until the turbidity levels were very high (nearing 20,000 parts per million [ppm] of silicone dioxide). Further, the Wallen (1951) study showed that most fish withstood concentrations above 50,000 ppm before mortality took place, and many of the fish were able to endure concentrations of more than 100,000 ppm for a week or longer before succumbing when turbidity reached between 175,000 and 225,000 ppm. In highly turbid conditions, harmful dissolved substances (whether natural or man-made) can impair the gas exchange capacity of the gills at least as much as can particulate matter (Doudoroff 1957). The impairment of gill function in advanced life stages of fish ascribable to chemically inert suspended particles can apparently only occur when turbidity is exceedingly high (Doudoroff 1957), and so it is thought to only minimally affect fish gill functions during placement activities.

Placement activities at the site are expected to minimally affect pelagic fishes. Only a localized area will be affected by placement operations, and fish populations are not geographically limited to the placement area or marsh fill areas of the BABUS; therefore, the presence of such species within the affected area during placement operations is expected to be minimal. Pelagic fishes traveling through the immediate area may modify their route during discharge operations. Adult fishes within and immediately adjacent to the placement area may experience a temporary reduction in the oxygen exchange capacity of their gills due to clogging and physical abrasion (Suedel 2011). A minor decrease in dissolved oxygen can occur due to an increase in the biological oxygen demand associated with the dredged material. Additional stress in adult fishes can occur due to avoidance reactions (EPA 1995). Reproductive behavior of fishes has also been suggested to be impacted during placement activities (Suedel 2011). However, conditions that could impact pelagic fishes are expected to be short-term (measurable in hours) and localized (limited to the placement area), and the effects on adults and larger juveniles living within the water column are not expected to be significant given their ability to quickly avoid the localized area of placement activities.

3.2 Sedimentation

Dredged material placement at the proposed BABUS is expected to result in accumulation of dredged material over the bay bottom, changes in bathymetry, and changes in sediment characteristics within the site. A monitoring program could detect a potential concern and aid in the prevention of any adverse effects.

As explained in Subsection 3.1.1, dredged material proposed for placement at the BABUS from the HSC will first undergo stringent bioassay and chemical testing designed to minimize water column impacts, benthic toxicity effects, and bioaccumulation of contaminants. Placement of dredged material that is determined to be suitable for ocean disposal or open water placement is not expected to produce significant long-term environmental effects related to sediment chemistry and contaminants of concern. Changes in sediment grain size composition may alter the benthic community structure. However, based on previous benthic studies, permanent or long-term adverse impacts to benthic infauna are not expected.

3.2.2 Potential Impacts to Demersal Fishes and Shrimp

Placement of dredged material at the BABUS is expected to create an immediate local effect on demersal fishes and epibenthic invertebrates. The immediate local effect of dredged material placement would be the burial of taxa such as penaeid shrimp, searobins (*Prionotus* spp.), sand flounders (Paralichthyidae), and the blackcheek tonguefish (*Symphurus plagiusa*) as well as their epifaunal and infaunal prey. After dredged material is placed, much of the fine-grained sediment remains suspended near the ocean floor (Hirsch et al. 1978). This can cause stress in fishes in part due to the reduction of oxygen exchange capacity in the gills due to clogging and physical abrasion (EPA 1995, Suedel 2011). Larger juveniles and adults can avoid the suspended material by moving out of the area, but smaller juveniles are more vulnerable and susceptible to stress (Science Applications International Corp. 1986). Post-placement recovery of the local demersal fish populations may take 14 to 22 months, and recovery of the epibenthic invertebrate populations may take over two years, based on a dredge recolonization study in San Diego Bay conducted by Mooney (2010).

However, given the planned continuous or punctuated use of the BABUS over a 50-year period, local demersal fishes and epibenthic invertebrates may not fully recover between placement events. Over the long term, dredged material placement at the BABUS may result in a localized decrease in demersal fish species diversity and abundance. These reductions could be caused, in part, by reduced food availability (EPA 1995).

Benthic infaunal and epifaunal populations, which are the main food sources for demersal fishes, decline when placement occurs frequently because these food sources are unable to re-establish themselves (Science Applications International Corp. 1986). Some recovery of the benthic community occurs within months, but complete recovery of the original benthic communities requires about 1 to 3 years according to studies by Germano and Rhoads (1984), Dillon (1984), and Scott et al. (1987). However, the duration between disturbance by dredged material placement and evidence of recovery of the benthic infaunal community varies widely between sites. As shown in Table 3-1 below, a review of the available literature shows a benthic infaunal mean recovery time of 9.8 months but with a range of from 1 month to over 30 months (Wilber and Clarke 2007 and sources in Table 3-1). When placement occurs more often than yearly, the benthic community will likely experience reduced diversity and will support a more limited demersal fish community (EPA 1995).

Table 3-1. Estimated Recovery Times of Infaunal Communities Following Dredged Material Placement Compiled from Previous Studies Worldwide

Site	Regional Climate	Water Depth (m)	Predominant Sediment Type	Changes to Sediment Type? (yes, no)	Mechanism of Recovery [1]	Recovery Time (months)	Reference(s) [2]
Columbia River, OR/WA	Cold	Shallow	Fine sand, clay	No	All life stages	>10	Richardson et al. (1977)
Quebec, Canada	Cold	55	Fine sand	Yes	All life stages	>24	Harvey et al. (1998)
Port Valdez, AK	Cold	15–23	Mud	No	Larval	>30	Blanchard and Feder (2003)
Puget Sound, WA	Cold	60	Silt, clay, sand	No	Adult recruitment	9	Bingham (1978)
Western Baltic Sea	Cold	19	Fine sand	No	Adult recruitment	<24	Powilleit et al. (2006)
Weser Estuary, Germany	Cold	16	Silt, sand	Yes	Undetermined	>8	Witt et al. (2004)
New S. Wales, Australia	Temperate	6	Fine sand	No	Adult recruitment	3	Smith and Rule (2001)
Gulfport, MS	Temperate	3	Silt, clay	Yes	Adult recruitment	12	Wilber et al. (2007)
Corpus Christi, TX	Temperate	3	Silt, clay	No	All life stages	<12	Ray and Clarke (1999)
Coastal Louisiana	Temperate	3	Silt, clay	No	Undetermined	5	Flemer et al. (1997)
Sewee Bay, SC	Temperate	3	Silt, clay	Yes	Adult recruitment	6	Van Dolah et al. (1979)
Dawho River, SC	Temperate	<5	Silt, clay	Yes	Adult recruitment	3	Van Dolah et al. (1984)
Delaware Bay	Temperate	Shallow	Silt, clay	No	Undetermined	>5	Leathern et al. (1973)
New S. Wales, Australia	Temperate	Shallow	Silt, clay, sand	No	Adult recruitment	1	Jones (1986)
Mobile Bay, AL	Temperate	3	Mud	No	Adult recruitment	3	Clarke and Miller-Way (1992)
Coos Bay, OR	Temperate	8	Silt, clay	No	Adult recruitment	1	McCauley et al. (1977)
James River, VA	Temperate	3	Fluid mud	No	All life stages	3	Diaz and Boesch (1977), Diaz (1994)
Southern Brazil	Temperate	19	Silt, clay, fine	Yes	Adult recruitment	<9	Angonesi et al. (2006)
Queensland, Australia	Subtropical	11	Silt, clay	Yes	Adult recruitment	3	Cruz-Motta and Collins (2004)
Mirs Bay, Hong Kong	Subtropical	19	Sand, gravel	Yes	Undetermined	<24	Valente et al. (1999)
					MEAN (± SD)	**9.8 ± 8.8**	
					RANGE	**1 – >30**	

[1] Mechanism of recovery is usually speculated but refers to the primary type of recruitment thought to have contributed to recovery at a given disposal/placement area.
[2] References can be found in Table 1 of Wilber and Clarke (2007): https://westerndredging.org/index.php/woda-conference-presentations/category/60-session-3d-environmental-aspects-of-dredging.
Source: Modified from Table 1 of Wilber and Clarke (2007)

3.2.3 Potential Impacts to Oyster Reefs

The 23.9 acres of scattered live oysters over mud bottom and the 64.3 acres of viable oyster habitat within the project area (as surveyed by Lloyd Engineering 2025) would be either directly or indirectly impacted. Such impacts are predicted to include being dredged up or buried in dredged material during construction of the BABUS, exposed to turbidity, or experience changes in flow patterns resulting from the proposed action. Construction of hard structure on the exterior dike(s) of the BABUS would provide for future oyster colonization habitat and (or) to relocate existing oysters there. An onsite relocation approach is currently being formulated with the goal of mitigating the loss of oyster habitat within the project footprint.

3.3 Proposed Mitigative Measures and Guidelines for Essential Fish Habitat Protection

3.3.1 Oyster Mitigation

As discussed and described in Section 6 of the EA, mitigation for impacts to the 64.3 acres of consolidated oyster reef habitat and 23.9 acres of scattered shell habitat is proposed at a minimum of 1:1 area ratio. Individual single oyster reefs and consolidated hard structure will be relocated to preserve the integrity of the reef whenever practicable. It is possible for some or all the oysters to be relocated elsewhere within the 4,500-acre project area but outside of the PA and marsh fill areas. It is also possible that the oysters may be relocated to hard structure on portions of the exterior dikes, following construction of the outer perimeter of the PA. The project concept includes hard structure such as riprap or other armoring of the exterior containment dikes in combination with a shallow sloping living shoreline which may be suitable for oyster reef colonization.

Temporary impacts to oyster reefs due to relocation or construction impacts will be minimized or avoided by using protected stock-piling locations that are sheltered from turbidity impacts and burial. The location for temporary relocations during construction, and long-term relocations, are still to be determined following the project design phase of the project and coordination with local experts. The project design includes a large area of exterior shallow slope dikes, and the use of hard structures for oysters to colonize. Any live oyster habitat that could not be relocated will be replaced with new oyster habitat to meet the 1:1 mitigation commitment. Alternatively, candidate sites for oyster reef mitigation from Appendix P-1 of the FIFR-EIS by USACE (2019) may be explored as potential relocation areas elsewhere within Galveston Bay.

Continued coordination with TPWD and NOAA Fisheries regarding implementation of mitigation will occur throughout the engineering and construction of the project. Relocation or other habitat creation as mitigation would follow recommendations from TPWD and NOAA Fisheries. Survivability monitoring will occur after relocation or habitat creation to ensure the successful completion of required 1:1 area ratio mitigation.

3.3.2 Mitigation of Sedimentation

Short-term and long-term impacts related to changes in bathymetry and sediment composition resulting from dredged material placement at the BABUS are unavoidable. To minimize the significance and monitor impacts of placement activities on the site, several measures should be included in the future Site Management and Monitoring Plan for the BABUS:

- Periodic monitoring of the site and surrounding area to determine changes in bathymetry, sediment composition, short-term and long-term fate of materials, and benthic community structure.

- Placement of material should be confined to only the placement area and the marsh fill areas. Release zones may be further defined within these features of the BABUS to better contain and minimize effects of dredged material placement within a specified time.
- An electronic tracking system used to provide surveillance of the transportation and placement of dredged material at the BABUS.

To reduce the effects of suspended sediments on epifauna, very-fine-grained sediments should be deposited in the smallest area possible so that the least amount of benthic habitat is affected per dredging and placement cycle (Hirsch et al. 1978). However, sandy sediment should be dispersed over a larger area. A thin layer of sandy sediment would allow epifaunal invertebrates and demersal fishes the best chance of surviving burial (Hirsch et al. 1978).

3.3.3 Guidelines for Essential Fish Habitat Protection

GMFMC has developed guidelines that should be incorporated into project plans to minimize impacts to fishing and related activities. Listed below are the guidelines developed for navigation channel-related activities, including the placement of dredged material (GMFMC 2005). These guidelines will be considered for inclusion during the construction of the BABUS.

- **Project Implementation:** Environmentally critical habitats have been avoided as much as possible.
- Pipes used in the hydraulic dredging process will be placed and adjusted in a way that avoids impacts to sensitive habitats such as oyster reef. **Project Implementation:** The oyster areas will be delineated and avoided as much as possible. Pontoon floats are typically used with hydraulic pipelines for dredging projects in Galveston Bay and would be used as conditions allow. These floats avoid dragging the pipelines along the bay bottom.
- Excavated materials will be beneficially used to the extent practicable. **Project Implementation:** Dredged material placement during the predicted 50 years of O&M dredging have been accounted for in the proposed action. Construction of the new BABUS will convert unvegetated homogenous bay bottom to relatively productive and important intertidal habitat and bird island habitat. The acreage for the proposed new beneficial use area is still being determined but is expected to amount to a large portion of the 4,500-acre project area.

4 CONCLUSIONS

The entire BABUS project footprint was surveyed by Lloyd Engineering (2025) for oyster habitat and submerged aquatic plants (including seagrasses) using side-scan sonar in December 2023 and October 2024. An oyster habitat groundtruthing field effort took place in April, October, and November 2024 (Lloyd Engineering 2025). Another survey was conducted by BOB Hydrographics, LLC during October 2024 and March 2025 using a combination of side-scan sonar and magnetometer remote sensing as part of a cultural resources investigation. The survey area extended over the entire project area and included a 50-meter (164-foot) buffer around the project area, for a total surveyed area of 5,362 acres (BOB Hydrographics 2025). These surveys collectively identified any hardbottom resources, along with other notable natural and anthropogenic features within the BABUS project area. The results of these surveys indicate that oyster resources, and anthropogenic features such as petroleum wells, piping, and drilling side-castings (drill cuttings), were the only hardbottom areas within BABUS project area.

Prior to placement of dredged material at the BABUS, rigorous tiered testing system will be undertaken to assess the impacts of the liquid, suspended-particulate, and solid phases of dredged material proposed for ocean disposal or open water placement before the material can be determined suitable for ocean disposal (40 CFR Part 227, EPA and USACE 2008). Such testing is designed to ensure that effects to benthic resources are minimized.

EFH exists throughout the study area for several species and species-groups. Effects to the water column, such as increased turbidity, are expected to be temporary. Direct effects of sedimentation are not expected to be substantial due to the mobility of most federally managed species that may occur within the BABUS project area and the lack of geographic constraints within the project area within the larger Galveston Bay complex. Benthic infaunal organisms and sessile organisms that serve as prey or provide microhabitats to managed species are expected to be affected by construction and dredged material placement activities. Species and species groups preferring soft sediment (e.g., penaeid shrimp) may find the placement of fine sediment attractive and may even benefit from placement activities. Overall, the effects on EFH in the area are expected to be minimal.

Populations of federally managed sport and commercial fish species within the Galveston Bay complex help support important regional fisheries. EFH occurs in and around the BABUS project area for several fish species and three species of penaeid shrimp and include important habitats such as oyster reefs. Federally managed species populations are not likely to experience a negative effect considering that:

- O&M dredged material from the HSC is typically soft sediment suitable for some of these species; and
- The BABUS project area is a tiny fraction of the total area designated as EFH within Galveston Bay by NOAA.

EFH for several federally managed species occurs within Galveston Bay. No significant effects are expected to occur for the large, highly mobile species. No evidence was found for the presence of corals or other non-oyster hardbottom resources at the BABUS project area. Limited effects to larval fishes may occur during active placement and construction activity, however. For these reasons, only minimal effects are expected for reef fish.

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