APPENDIX J
ESSENTIAL FISH HABITAT ASSESSMENT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMNS AND ABBREVIATIONS

µPa	micro Pascals
ac	acre
BOEM	Bureau of Ocean Energy Management
BWTT	Bluewater Texas Terminal, LLC
CCSC	Corpus Christi Ship Channel
CFR	Code of Federal Regulations
cm	centimeter
dB	decibels
DPS	distinct population segments
DWH	Deepwater Horizon
DWP	Deepwater Port
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
ERL	effects range low
ERM	effects range median
ESA	Endangered Species Act of 1973
FERC	Federal Energy Regulatory Commission
FFWCC	Florida Fish and Wildlife Conservation Commission
FMP	Fishery management plans
ft	feet
ft/sec	feet per second
GIWW	Gulf Intracoastal Waterway
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
gpm	gallons per minute
ha	hectare
HAPC	habitat areas of particular concern
HDD	horizontal directional drill
km	kilometer
LNG	liquefied natural gas
m	meter
m/s	meters per second
m^3	cubic meters
MAOP	maximum allowed operating pressure
mg/yr	million gallons per year
MHT	mean high tide
mi	mile
mm	millimeter
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NGL	natural gas liquids
nm	nautical mile
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resource Damage Assessment
NWF	National Wildlife Federation
P.L.	Public Law
POCC	Port of Corpus Christi

PLEM	pipeline end manifold
Project	Bluewater Single Point Mooring (SPM) Project
RMS	root mean square
SAV	submerged aquatic vegetation
SEAMAP	Southeast Area Monitoring and Assessment Program
SELcum	cumulative sound exposure level
SPM	single point mooring
TCEQ	Texas Commission on Environmental Quality
TPWD	Texas Park and Wildlife Department
TSS	total suspended solids
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USDOT	U.S. Department of Transportation
VLCC	very large crude carriers

1 Introduction

The fisheries of the United States are managed within a framework of overlapping federal, state, interstate, and tribal authorities. The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), Public Law (P.L.) 104-297, 16 United States Code (U.S.C.) 1801 et seq., established eight Fishery Management Councils responsible for protecting and managing certain fisheries within specific geographic jurisdictions. The councils are required to prepare fishery management plans (FMP) to regulate commercial and recreational fishing and to identify Essential Fish Habitat (EFH) for managed species. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). As required by the MSFCMA, this EFH Assessment has been developed for the Proposed Bluewater Single Point Mooring (SPM) Project (Project) to include a description of the proposed action, an analysis of the potential impacts on both the managed species and their designated EFH, and proposed mitigation measures selected to minimize expected Project effects.

Bluewater Texas Terminal, LLC (BWTT) is proposing to construct, own, and operate a Deepwater Port (DWP), associated pipeline infrastructure, and a booster station collectively known as Project, to provide a safe and environmentally responsible solution for the export of abundant domestic crude oil supplies from major shale basins. The Proposed Project involves the design, engineering, and construction of a DWP, 56.5 miles (mi) of pipeline infrastructure, and the Harbor Island Booster Station. The Proposed Project is described in three distinguishable segments by locality including "offshore", "inshore", and "onshore".

Inshore Components associated with the Proposed Project are defined as those components located between the western Redfish Bay MHT line and the MHT line located at the interface of San Jose Island and the GOM. Inshore Project Components include approximately 7.2 mi (11.4 km) of two new 30-inch-diameter crude oil pipelines, and an approximate 19-acre (ac; 7.7 hectares [ha]) Harbor Island Booster Station located on Harbor Island. Offshore Components associated with the Proposed Project are defined as those components located seaward of the mean high tide (MHT) line located at the interface of San Jose Island and the Gulf of Mexico (GOM). The Offshore Project Components include approximately 27.1 mi (43.7 km) of two new 30-inch-diameter crude oil pipelines extending to two SPM buoy systems.

The Project area considered for EFH encompasses estuarine, and marine waters within the immediate vicinity of BWTT's Inshore Pipelines, Offshore Pipelines, and both SPM buoys (which make up the SPM buoy systems). While Onshore Pipelines are proposed for the Project, they will not cross EFH. The Project area is further described in Section 3, below.

1.1 Fishery Management Plans

Marine fisheries in the Project area are under primary jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC), established under authority of the MSFCMA. The GMFMC works together with National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) to manage commercially and recreationally important marine fish stocks and to prepare FMPs for target species. The GMFMC defines six FMPs for the GOM: shrimp, red drum, reef fish, coastal migratory pelagics, corals, and spiny lobster. In addition, NMFS' Highly Migratory Species Division manages an FMP for highly migratory species (sharks, tuna, billfish, and swordfish) as they cross domestic and international boundaries.

The GMFMC and NMFS manage fisheries within the federal waters surrounding the Proposed Project area. Marine recreational and commercial fishing in Texas state waters (within 9 nautical miles [nm; 10 statute-miles] of the coastline) are the responsibility of the Texas Parks and Wildlife Department (TPWD). Coral EFH has been designated in the Western Planning Area but is about 24 mi (39 kilometer [km]) further offshore in water depths greater than 200 feet (ft) (61 meter [m]) (NMFS 2019). Similarly, EFH for the spiny lobster has been designated on the South Florida shelf and is outside of the Project area. As EFH for corals and the spiny lobster is outside of the

Project area, they are not discussed further. Managed species in the Project area are included under the following FMPs:

- Shrimp Fishery of the GOM, United States (U.S.) Waters;
- Red Drum Fishery of the GOM;
- Reef Fish of the GOM;
- Coastal Migratory Pelagic Resources in the GOM and South Atlantic; and
- Atlantic Highly Migratory Species.

Each of these FMPs has been developed for the management of one or more species. Those species are listed in Table 1. Many of the managed species are economically important as commercial and recreational fisheries. Five shrimp species are managed under the Shrimp FMP, the most abundant of which are brown and white shrimp. Adult shrimp are found over soft bottom estuarine, inshore, and offshore habitats throughout the GOM. Most species occur at depths up to 328.1 ft (100 m); however, royal red shrimp occur in deeper water (GMFMC 2016). Red drum occur throughout the GOM in a variety of habitats ranging from shallow estuarine waters to depths of approximately 131.2 ft (40 m) offshore and occur from Massachusetts along the western Atlantic coast to northern Mexico (GMFMC 2016). They are common in the majority of GOM estuaries, existing in a dynamic range of substrates including seagrass, sand, mud, and oyster reefs as well as in offshore habitats. This species can survive in waters ranging from fresh to highly saline; no optimum salinity has been determined (GMFMC 2016). Reef fish include species that live on or near coral reef or hard bottom habitat, such as snapper, grouper, tilefish, bass, triggerfish, and other species groups (GMFMC 2016).

Coastal Migratory Pelagic species include king mackerel, Spanish mackerel, and cobia; these species occur in the coastal and continental shelf waters throughout the GOM and to the northeastern U.S. Each of these species occurs in nearshore and pelagic open water (GMFMC 2004). NMFS' Highly Migratory Species Division manages an FMP for highly migratory species (sharks, tuna, billfish, and swordfish) as they cross domestic and international boundaries. These species use a variety of habitats throughout the GOM (NOAA 2017).

Table 1: Managed Species within the Project Area	
Shrimp	
brown shrimp (*Farfantepenaeus aztecus*)	pink shrimp (*Farfantepenaeus duorarum*)
white shrimp (*Litopenaeus setiferus*)	royal red shrimp (*Pleoticus robustus*)
Red Drum	
red drum (*Sciaenops ocellatus*)	
Reef Fish	
queen snapper (*Etelis oculatus*)	lane snapper (*Lutjanus synagris*)
mutton snapper (*Lutjanus analis*)	silk snapper (*Lutjanus vivanus*)
blackfin snapper (*Lutjanus buccanella)*	yellowtail snapper (*Ocyurus chrysurus*)
red snapper (*Lutjanus campechanus*)	wenchman (*Pristipomoides aquilonaris*)
cubera snapper (*Lutjanus cyanopterus*)	vermilion snapper (*Rhomboplites aurorubens*)
gray (mangrove) snapper (*Lutjanus griseus*)	speckled hind (*Epinephelus drummondhayi*)
yellowedge grouper (*Hyporthodus flavolimbatus*)	Nassau grouper (*Epinephelus striatus*)[a]
goliath grouper (*Epinephelus itajara*)	black grouper (*Mycteroperca bonaci*)
red grouper (*Epinephelus morio*)	yellowmouth grouper (*Mycteroperca interstitialis*)
warsaw grouper (*Epinephelus nigritus*)	gag (*Mycteroperca microlepis*)
snowy grouper (*Epinephelus niveatus*)	yellowfin grouper (*Mycteroperca venenosa*)
scamp grouper (*Mycteroperca phenax*)	blueline tilefish (*Caulolatilus microps*)
goldface tilefish (*Caulolatilus chrysops*)	tilefish (*Lopholatilus chamaeleonticeps*)
greater amberjack (*Seriola dumerili*)	almaco jack (*Seriola rivoliana*)
lesser amberjack (*Seriola fasciata*)	banded rudderfish (*Seriola zonata*)
gray triggerfish (*Balistes capriscus*)	hogfish (*Lachnolaimus maximus*)
Coastal Migratory Pelagic Fishes	
king mackerel (*Scomberomorus cavalla*)	Spanish mackerel (*Scomberomorus maculatus*)
cobia (*Rachycentron canadum*)	
Highly Migratory Species	
Atlantic albacore tuna (*Thunnus alalunga*)	Atlantic skipjack tuna (*Katsuwonus pelamis*)
Atlantic bigeye tuna (*Thunnus obesus*)	Atlantic yellowfin tuna (*Thunnus albacares*)
Atlantic bluefin tuna (*Thunnus thynnus*)	swordfish (*Xiphias gladius*)
blue marlin (*Makaira nigricans*)	sailfish (*Istiophorus platypterus*)
white marlin (*Kajikia albida*)	longbill spearfish (*Tetrapturus pfluegeri*)
basking shark (*Cetorhinus maximus*)	Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)
great hammerhead (*Sphyrna mokarran*)	blacknose shark (*Carcharhinus acronotus*)
scalloped hammerhead (*Sphyrna lewini*)[a]	Caribbean sharpnose (*Rhizoprionodon porosus*)
smooth hammerhead (*Sphyrna zygaena*)	finetooth shark (*Carcharhinus isodon*)
white shark (*Carcharodon carcharias*)	smalltail shark (*Carcharhinus porosus*)
nurse shark (*Ginglymostoma cirratum*)	bigeye sixgill shark (*Hexanchus nakamurai*)
bignose shark (*Carcharhinus altimus*)	sharpnose sevengill shark (*Heptranchias perlo*)
blacktip shark (*Carcharhinus limbatus*)	sixgill shark (*Hexanchus griseus*)
bull shark (*Carcharhinus leucas*)	longfin mako shark (*Isurus paucus*)
Caribbean reef shark (*Carcharhinus perezii*)	porbeagle shark (*Lamna nasus*)
dusky shark (*Carcharhinus obscurus*)	shortfin mako shark (*Isurus oxyrinchus*)
Galapagos shark (*Carcharhinus galapagensis*)	blue shark (*Prionace glauca*)

Table 1: Managed Species within the Project Area

lemon shark (*Negaprion brevirostris*)	oceanic whitetip shark (*Carcharhinus longimanus*)
narrowtooth shark (*Carcharhinus brachyurus*)	bigeye thresher shark (*Alopias superciliosus*)
night shark (*Carcharhinus signatus*)	common thresher shark (*Alopias vulpinus*)
sandbar shark (*Carcharhinus plumbeus*)	sand tiger shark (*Carcharias taurus*)
silky shark (*Carcharhinus falciformis*)	whale shark (*Rhincodon typus*)
spinner shark (*Carcharhinus brevipinna*)	Atlantic angel shark (*Squatina dumerili*)
tiger shark (*Galeocerdo cuvier*)	bonnethead shark (*Sphyrna tiburo*)
bigeye sand tiger (*Odontaspis noronhai*)	roundscale spearfish (*Tetrapturus georgii*)
smoothhound shark (*Mustelus canis*)	Gulf smoothhound (*Mustelus sinusmexicanus*)
Florida smoothhound (*Mustelus norrisi*)	

[a] The Nassau grouper is listed as federally threatened throughout its range. As a federally listed species, it is discussed in Section 8 of the Deepwater Port Application, where it is noted as a rare transient in the Project area.

[b] The scalloped hammerhead is listed under the Endangered Species Act (ESA); however, the scalloped hammerhead occurring in the GOM is the Northwest Atlantic and GOM distinct population segments (DPS), which is not listed under the ESA (79 FR 38213).

Sources: GMFMC 2016, NMFS 2006, NMFS 2019

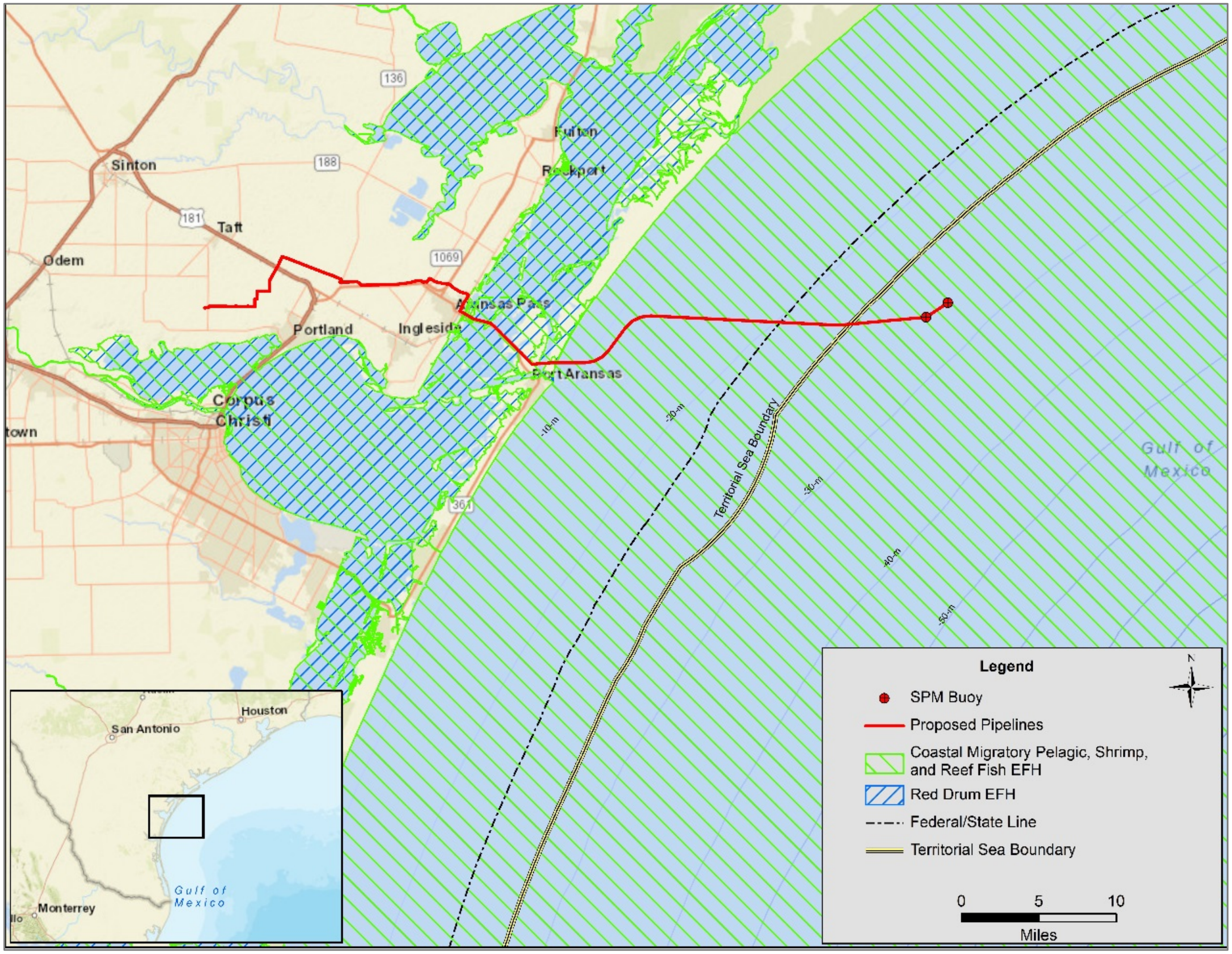
2 Essential Fish Habitat

As described above, EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," and specifically includes the "physical, chemical, and biological properties" of those waters (50 Code of Federal Regulations [CFR] 600.10). The term "fish" includes finfish, mollusks, crustaceans, and all other marine animal and plant life except birds, sea turtles, and mammals.

The GMFMC and NMFS have developed FMPs, which provide details on EFH and other management issues for commercially, recreationally, and ecologically important resources in the Project area, including shrimp, red drum, reef fishes, and Coastal Migratory Pelagic fishes. The entire northern coast of the GOM to a depth of about 600.4 ft (183 m) has been identified as EFH for at least one species.

With the exception of the highly migratory species, EFH is classified in terms of five life stages: eggs, larvae, juveniles, adults, and spawning adults. Eggs are the fertilized product of individuals that have spawned; they depend completely on their yolk-sac for nutrition in this unhatched phase. Larvae are individuals that have hatched and can capture prey. Juveniles are individuals that are not sexually mature but that have fully formed organ systems, similar to those of adults. Adults are sexually mature individuals that are not necessarily in spawning condition, and spawning adults are those individuals capable of producing offspring. Although EFH is designated for each managed species by life stage, EFH is generally depicted for each fishery as a whole. EFH designated in the Project area for the Shrimp, Red Drum, Reef Fish, and Coastal Migratory Pelagic FMPs is depicted in Figure 1. Figures 1 and 2 were developed using data from NMFS' online EFH mapper (NMFS 2019).

Figure 1: Essential Fish Habitat in the Project Area



Life stages of highly migratory species are grouped in three categories based on common habitat usage:

(1) spawning adults, eggs, and larvae;

(2) juveniles and subadults; and

(3) adults.

Eggs, larvae, spawning adults, and adults are defined above for other managed species. Subadults are individuals just reaching sexual maturity. The juvenile and subadult category for highly migratory species combines all life stages between age 1 year and maturity. EFH life stage categories for sharks are defined as neonates (which primarily include newborns and small young-of-the-year [YOY]), juveniles (including all immature sharks from young to older and late juveniles), and adults (sexually mature sharks— the largest size class). Young-of-the-year are individuals born within the past year. For most managed species, EFH is designated for each life stage according to its particular habitat needs. EFH for highly migratory species is designated by species; those species with EFH occurring in the vicinity of the Project are included in Figures 2a through 2c.

Figure 2a: Essential Fish Habitat for Highly Migratory Species in the Project Area

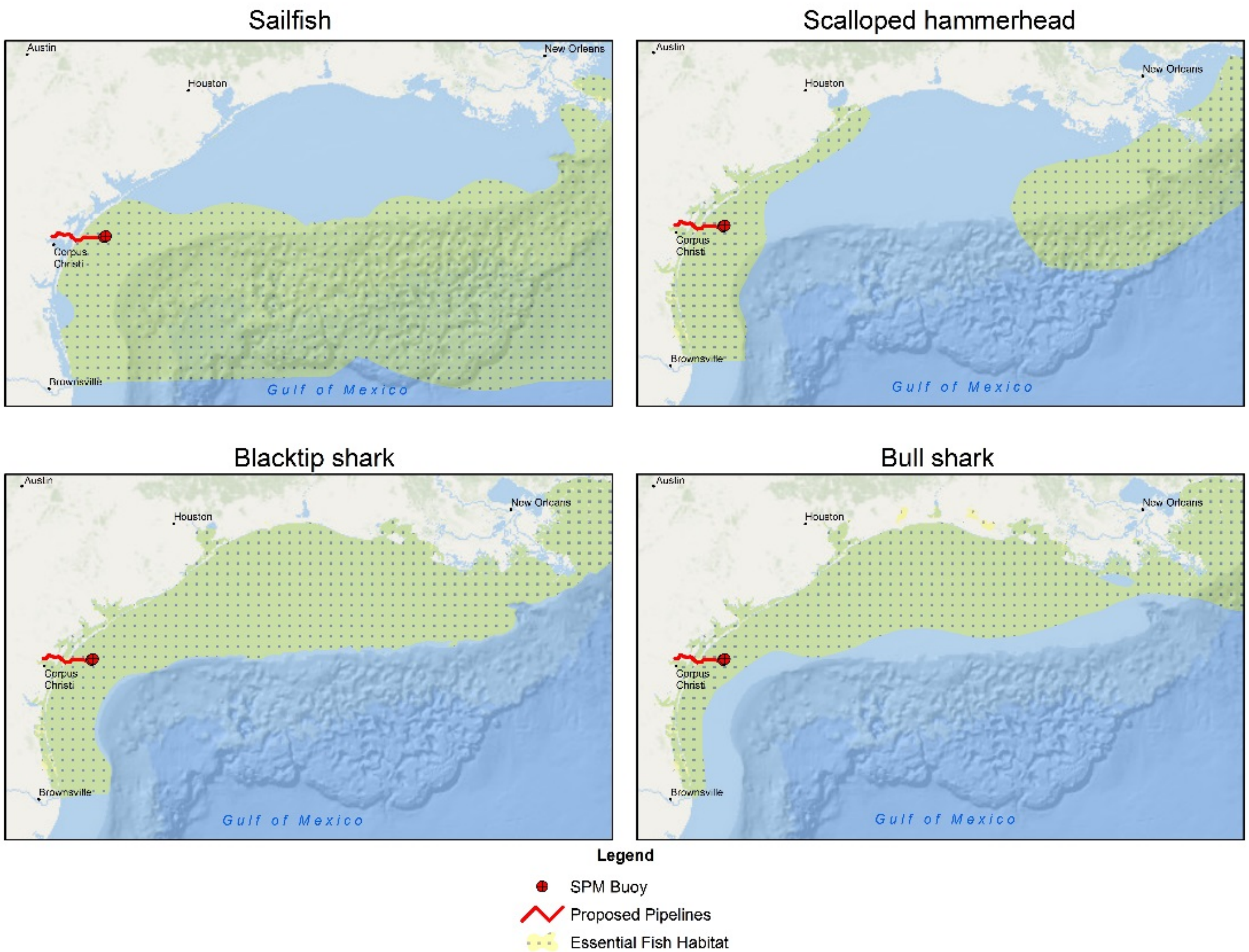


Figure 2b: Essential Fish Habitat for Highly Migratory Species in the Project Area

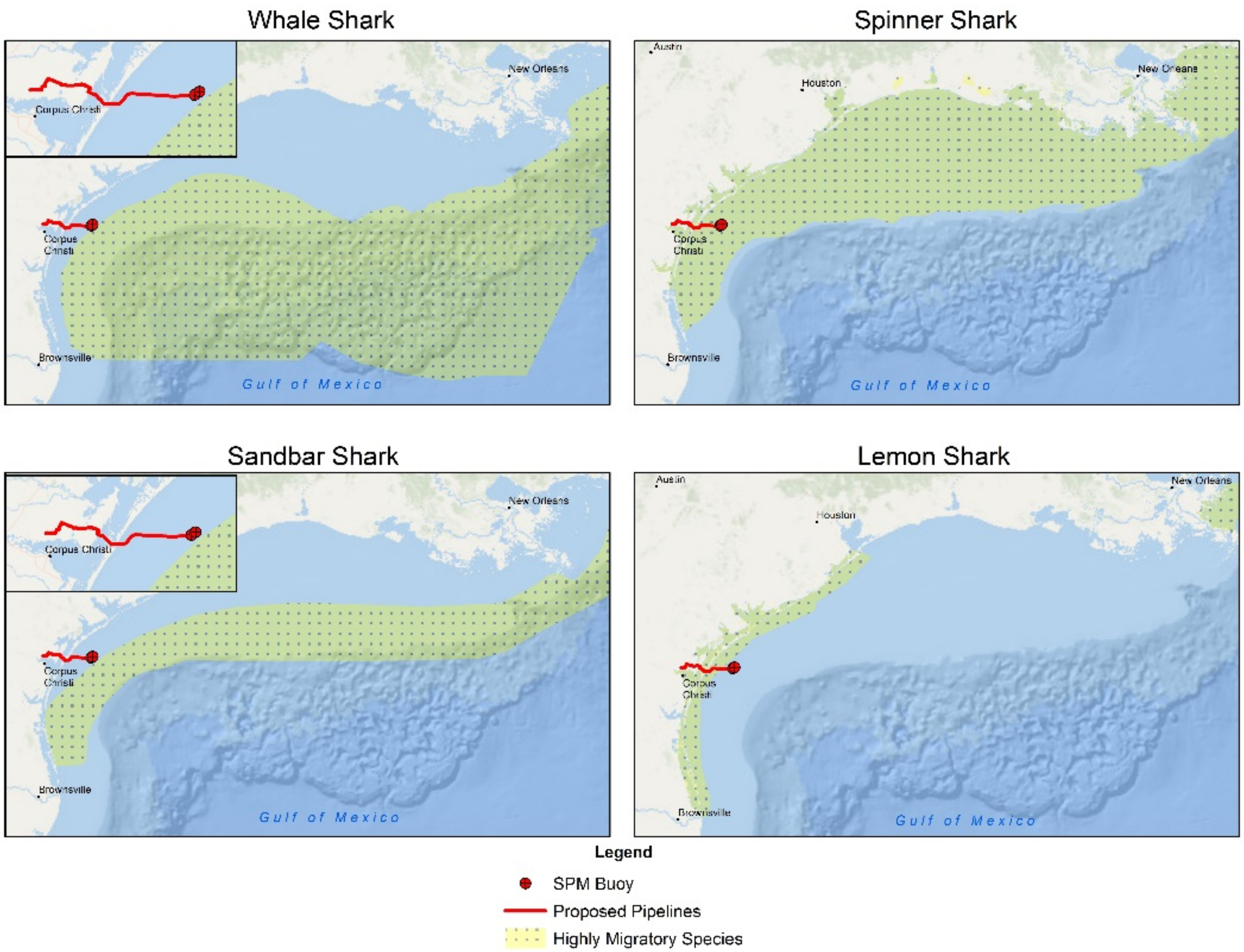
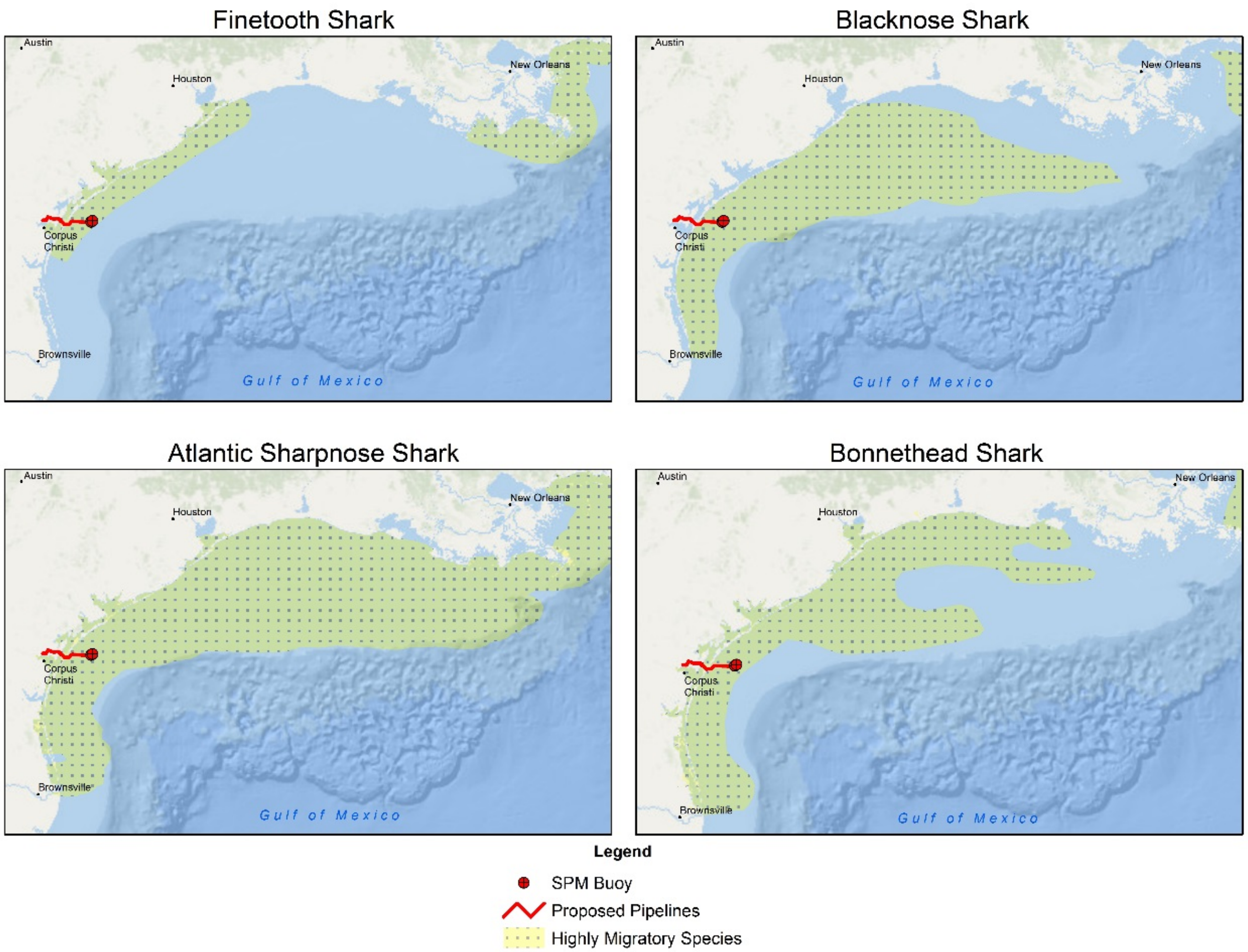


Figure 2c: Essential Fish Habitat for Highly Migratory Species in the Project Area



2.1 Habitat Areas of Particular Concern

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 be more scrutinized, and may be subject to additional conservation measures (NOAA 2015). The Project will not impact any designated HAPCs and the closest one (Stetson Bank) is about 142.9 mi (230.0 km) east of the SPM buoy systems.

2.2 Categories of Essential Fish Habitat

To develop EFH for the fisheries, the GMFMC and NMFS categorized substrates and biogenic features by zone and type. Habitat zones include estuarine (bays, estuaries, and waters inshore of barrier islands), nearshore (marine waters less than 59.1 ft [18 m] deep), and offshore (marine waters greater than 59.1 ft [18 m] deep). Habitat types are further classified into 12 categories that are distributed across the estuarine, nearshore, and offshore zones (Table 2) (GMFMC 2016). Based on review of publicly available data and the results of side-scan sonar the habitats present in the Project area include submerged aquatic vegetation (SAV), mangroves, *Sargassum*, estuarine wetlands, soft bottoms (including sand/shell bottoms), oyster reef, and the water column. These habitats are described in detail below. The seafloor composition in the Project area is depicted in Figure 3, using data obtained from the Florida Fish and Wildlife Conservation Commission (FFWCC 2019).

2.2.1 Submerged Aquatic Vegetation

SAV includes seagrasses, submerged flowering plants anchored to the seafloor that grow within bays, lagoons, and shallow coastal waters. These grasses require light for photosynthesis and are therefore highly dependent upon water quality and clarity for survival (Handley et al. 2007). Seagrasses support a large number of invertebrates and fish, many of which are commercially and recreationally important. Within the Project area, seagrasses are restricted to those areas inshore of the barrier islands and are prevalent in Redfish Bay, which will be crossed by the Inshore Pipelines. The generally shallow depths of Redfish Bay as well as the polyhaline conditions and the mandatory "no-prop" regulations enforced in the area support the growth of seagrass beds (TPWD 2019a). Redfish Bay supports all five of Texas' species of seagrass including shoal grass (*Halodule beaudettei*), star grass (*Halophilla engelmannii*), manatee grass (*Cymodocea filiformis*), turtle grass (*Thalassia testudinum*), and widgeon grass (*Ruppia maritima*); however, turtle grass and manatee grass are the predominant species, (USGS 2010, TPWD 2019b).

In February and March of 2019, BWTT conducted surveys of four irregularly-shaped polygons, which together encompassed all waters crossed by the Inshore Pipelines. The study areas covered a total of 288 ac (117 ha), as depicted in Figures 1 through 3 of Appendix I. The resources identified eight resource or substrate types within the study area; these resources are identified in Table 3.

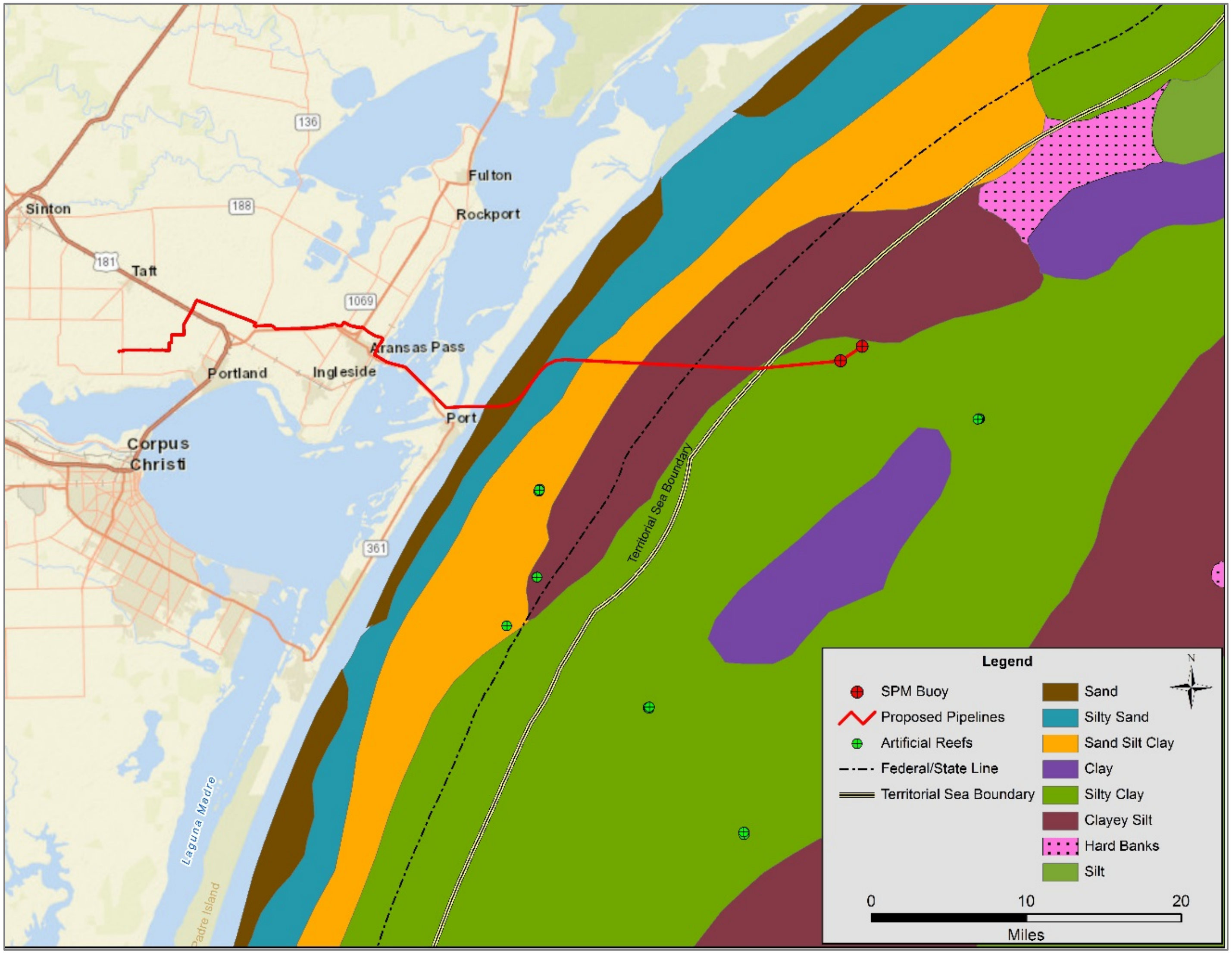
Based on the results of the benthic surveys, a total of 27.0 ac (10.9 ha) of seagrasses are present within the inshore survey polygons. Shoal grass was the only species identified and decreased in prevalence from Survey Site A to Survey Site D (see Table 3). Additional information on the seagrass areas identified, including figures of seagrass bed locations, is provided in Appendix I.

Table 2: EFH Habitat Types in the Project Area

Habitat Type	Associated Terms	Description	Presence within the Project Area
Submerged Aquatic Vegetation (SAV)	Seagrasses, benthic algae	Marine and vascular plants found in shallow estuaries and some nearshore habitats (Williams and Heck 2001). Algae may be epiphytic or may grow attached to shell/rubble. This habitat provides important nursery habitat for numerous species.	Inshore
Mangroves	--	Communities of halophytic trees and shrubs in typically soft sediments with regular tidal inundation, some freshwater inputs, and low to moderate wave energy. Found where the sea meets land and contain terrestrial and aquatic elements.	Inshore
Drift algae	Sargassum	Floating mats of seaweed that travels through the GOM with the currents and supports a diverse assemblage of marine organisms.	Offshore
Emergent marshes	Tidal wetlands, salt marshes, tidal creeks, rives/streams	Vegetated wetlands with typically soft sediments, regular tidal inundation, some freshwater inputs, and low to moderate wave energy. Found where the sea or body of water meets land and contain terrestrial and aquatic elements.	Inshore
Soft bottoms	Mud, clay, silt	Areas where the bottom sediments are soft mud, clay, or silt. Shrimp and many demersal species of fish often actively select for this substrate type.	Inshore/Offshore
Sand/shell bottoms	Sand	Areas where the bottom sediments consist of soft sand and/or shell. Generally included in the term “soft bottom”.	Inshore/Offshore
Hard bottoms	Live hard bottoms, low- and high-relief irregular bottoms	Subtidal hard bottom communities, usually submerged rocky outcroppings. Generally dominated by epifaunal organisms (e.g., sponges, corals, hydroids).	No
Oyster reefs	--	Aggregations of live and dead oysters with associated flora and fauna. Occur in intertidal and subtidal areas where salinities are relatively high. Estuaries with suitable substrate, calm and continuous water flow, and low sedimentation are ideal for development.	Inshore
Banks/shoals	--	Submerged ridges or bars of bottom sediment (such as sand) that rises from the water bottom to near the surface.	No
Reefs	Reefs, reef halos, patch reefs, deep reefs	Hermatypic (hard) and ahermatypic (soft) coral assemblages that dominate a habitat.	No
Shelf edge/slope	Shelf edge, shelf slope	The continental slop is a transitional environment influenced by processes of both the shelf, which ends at roughly the 200- m isobath, and the deep sea. The shelf/slope transition zone occurs between depths of 150 and 450 m.	No

Source: GMFMC 2016.

Figure 3: Bottom Substrates in the Project Area



Source: FFWCC 2019

Table 3: Resources and Substrates in Inshore Study Areas					
Resource	**Acreage**				
	Site A	**Site B**	**Site C**	**Site D**	**Total**
Algae Bed	0.0	0.2	7.3	0.0	7.5
Deep Water, 8 ft+	38.3	32.4	11.2	64.1	146.0
Firm, Moderately Firm, or Soft/Mud/Sand	18.2	45.3	0.4	13.6	77.5
Inland	16.6	3.2	3.2	0.0	23.0
Intertidal Marsh	4.9	10.1	0.8	0.1	15.9
Scattered Oyster Shell	0.1	<0.1	3.2	0.0	3.3
Seagrass	15.3	8.2	2.7	0.8	27.0
Shell Hash	1.0	2.2	0.4	5.2	8.8
Total	**94.4**	**101.5**	**29.1**	**83.8**	**308.8**

2.2.2 Sargassum

Sargassum is a genus of pelagic brown algae that forms dense floating mats in tropical Atlantic waters and is transported into the GOM on circumtropical currents. The floating mats provide habitat to a wide range of species in the water column and are an essential component of the water column habitat in the GOM. The floating mats include a diverse community of epibiota (algae, fungi, and invertebrates), more than 100 species of fish, and 4 species of sea turtle. About 10 percent of the invertebrate species and two fish species found using *Sargassum* mats are endemic (native or restricted to *Sargassum*) (GMFMC 2004).

Shrimp and crab come into contact with *Sargassum* as it drifts with the current through the GOM, comprising the bulk of the invertebrates that utilize *Sargassum* mats. *Sargassum* also acts as a vehicle for dispersal of some of its inhabitants and might be important in the life histories of many species of fish, providing them with a substrate, protection against predation, and concentration of food in the open GOM. Large predators associated with the *Sargassum* complex include amberjacks (*Seriola dumerili*), dolphin (*Coryphaena hippurus*), and almaco jacks (*Seriola rivoliana*) (GMFMC 2004). *Sargassum* habitat occurs in nearshore and offshore waters of the GOM in the Project area.

2.2.3 Emergent Marshes and Mangroves

Generally, coastal marshes, mangroves, beach/dune systems, and wet flats occur in the outer coastal plain region where the Project is located. Wetlands within the Project area consist of coastal lowlands, tidal marshes, flats, estuaries, islands, and river deltas, as well as black mangrove (*Avicennia germains*) wetlands. In addition, coastal fringe wetlands may be found within estuaries, bays, and along the shoreline of the region (U.S. Army Corps of Engineers [USACE] 2010). Wetland habitats, which are common along the coast, provide necessary habitat for many managed species, serving as nursery areas for larval and juvenile invertebrates and fish and providing organic material for detrital food webs (GMFMC 2004). Wetlands occur within the Project area and were identified during wetland delineation surveys along the proposed inland pipeline route including on San Jose Island, Stedman Island, Harbor Island, and on the mainland near the City of Aransas Pass (see Volume II).

2.2.4 Soft Bottom Habitat

Soft bottom benthic habitat refers to any seafloor habitats, except for hard bottom, which may include unconsolidated mud, clay, silt, sand, and shell fragments. A variety of species use these unconsolidated bottom habitats for spawning, burrowing, and feeding. Soft bottom habitats support both infauna (organisms that live in the substrate) and epifauna (organisms that live on the substrate), which provide an important trophic base for secondary consumers (Byrnes et al. 2017). Infaunal communities generally include polychaete worms (bristleworms), crustaceans, and mollusks whereas epifaunal communities may include crustaceans, echinoderms, mollusks, hydroids, sponges, and soft and hard corals (Bureau of Ocean Energy Management [BOEM] 2017, Darnell 2015).

Soft bottom habitats are the primary benthic habitat in the northern GOM. Throughout the northern GOM, densities of benthic macrofauna are typically higher at inshore locations and lowest at the outer shelf margin. In various studies, macrofauna were dominated by polychaete annelid worms, amphipods, and bivalve mollusks (Byrnes et al. 2017). As shown in Figure 3, the seafloor components of the Project will cross soft bottom habitats.

Sediment sampling conducted along the Project route indicates that the offshore sediments are primarily composed of silty sand and sandy silts containing small amounts of clay. Additionally, sampling points ranged from 0.0088 to 0.1242 mm. Table 4 provides the grain sizes of sediments within the Project area. Additionally, sediment chemistry data are provided in Appendix C. Sediment sampling stations are depicted in Figure 4. The benthos inhabiting soft bottom habitat are discussed in Section 8: Wildlife and Protected Resources, and the full list of identified species are provided in Appendix L.

Table 4: Sediment Characterization of Sediments within the Inshore Pipelines Route

Sample ID	latitude	longitude	Sand (%)	Silt (%)	Clay (%)	Gravel (%)	Phi Size	Physical Description
BWSPM-18-15	27.852330	-97.059572	97.0	2.8	0.2	0.0	0.5410	Sand
BWSPM-18-16	27.863864	-97.080982	90.4	6.0	3.6	0.0	0.4157	Sand
BWSPM-18-17	27.889593	-97.109506	29.5	58.4	12.1	0.0	-0.1189	Silt
BWSPM-18-18	27.898071	-97.135225	18.5	69.3	12.2	0.0	-0.0253	Silt

2.2.5 Oyster Reef

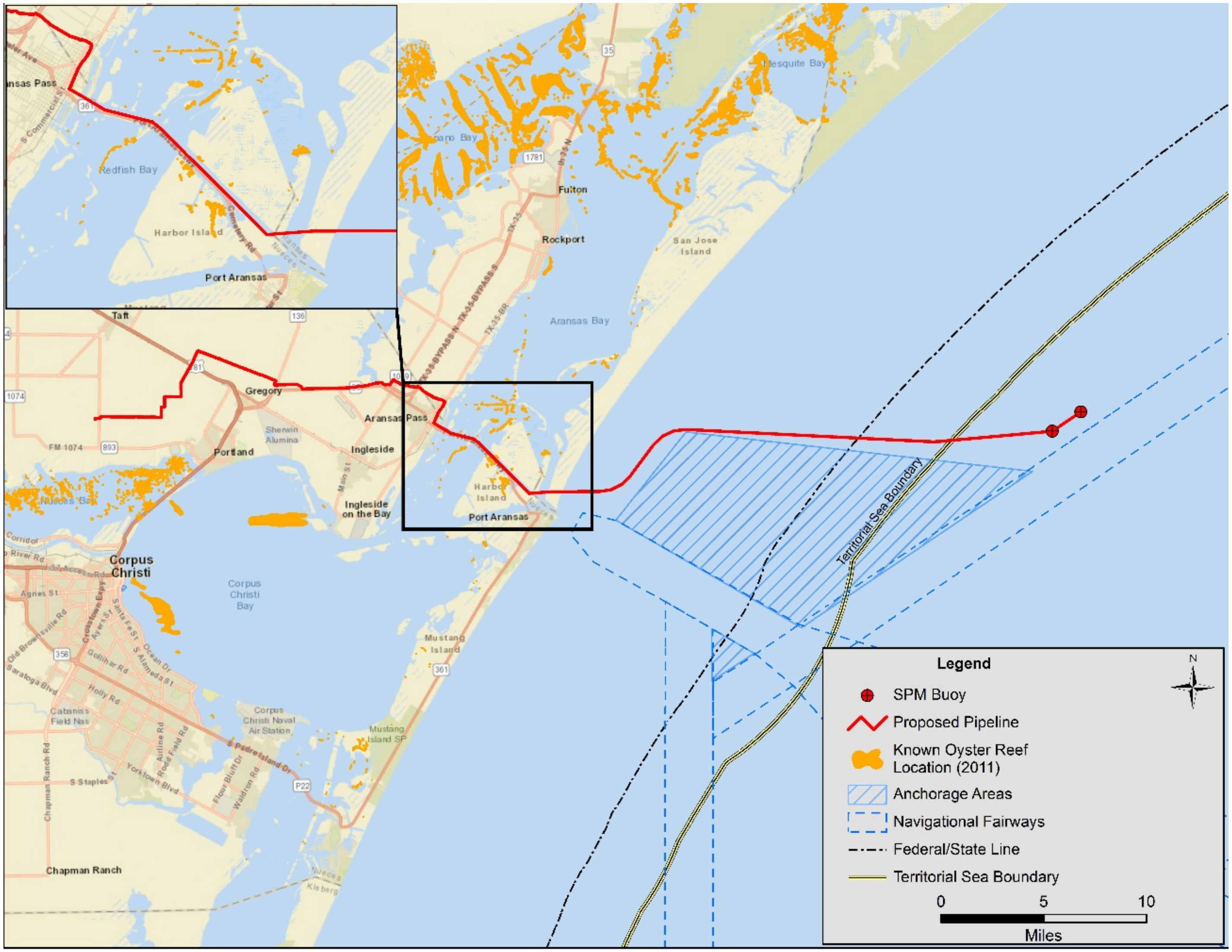
Generally, oyster reefs in the northern GOM are located in less than 9 ft (2.7 m) of water; however, they have been known to exist at depths as great as 15 ft (4.6 m) (Kilgen and Dugas 1989). Oyster reefs serve a large ecological role to fisheries, providing nursery habitat, food, and protection for adult and juvenile species(National Wildlife Federation [NWF 2013]). Oyster reefs are inhabited by a variety of aquatic species including forage fish, crabs (Brachyura), and amphipods which fill a multi-faceted roll for a variety of finfish, providing nutrient recycling; organic matter; and a food source. In the northern GOM, fish species including speckled trout (*Cynoscion nebulosus*), striped bass (*Morone saxatilis*), and sheepshead (*Archosargus probatocephalus*) are known to favor oyster reefs for foraging areas (NWF 2013, NOAA 2019a).

Oyster reef habitat is generally found near the mouths of estuaries in areas with low to moderate wave action but has also been recorded in small estuarine streams and bayous of intertidal or subtidal areas. Due to their location, which is generally subtidal, habitat associated with oyster reefs can significantly affect sedimentation rates. Historically, the majority of oyster reefs in Texas were located in Galveston Bay with some additional reefs in the Corpus Christi-Aransas Bay area (Kilgen and Dugas 1989).

NOAA's GOM Data Atlas identifies oyster reefs intermittently within Redfish Bay (Figure 5). The closest known reef area is approximately 220 ft (less than 0.067 km) from the Inshore Pipelines. About 0.4 ac (0.2 ha) of oyster bed was identified within the inshore survey polygons, as described above; scattered shell and shell hash were also present (see Table 3 and Appendix I). However, the pipelines will be installed through Redfish Bay using horizontal direction drill (HDD) construction methods, which do not result in impacts on the seafloor.

Figure 4: Sediment Sampling Locations within the Project Area

Figure 5: Oyster Reefs in the Project Vicinity



Source: BOEM 2019, NOAA 2019b

2.2.6 Water Column

The water column (habitat within the mass of water between the surface and the substrate but excluding benthic or structural features) provides EFH for many species. Waters occurring above the continental shelf within the in the neritic zone (656.2 ft [200 m]) of the ocean are included in the photic zone, where sunlight can penetrate and photosynthesis can occur. The Loop Current plays an important role in the nutrient balance of shelf waters, as well as the transport of larvae and floating *Sargassum* habitat (GMFMC 2004).

The base of the open-ocean food web is plankton, which includes small plants (phytoplankton) and animals (zooplankton) that are generally at the mercy of currents. Phytoplankton are photosynthetic organisms that produce the bulk of organic matter in aquatic ecosystems. Zooplankton include organisms that remain in the planktonic community throughout their lives (holoplankton), as well as planktonic life stages of larger organisms that will eventually leave the planktonic community (meroplankton). Zooplankton may exhibit some motility and/or diurnal migrations (Byrnes et al. 2017). A relatively small component of the zooplankton community in the upper 656.2 ft (200 m) of the water column are ichthyoplankton, which includes eggs, larvae, and juveniles (Southwest Fisheries Science Center 2019). The distribution of ichthyoplankton is a function of the location of spawning adults, currents, and sea-surface temperatures (Byrnes et al. 2017).

3 Managed Species in the Project Area

In addition to those habitat zones and types described in Section 1.2, the GMFMC divided the GOM into five ecoregions to further refine species distribution. The boundaries of each ecoregion represent ecological breaks (e.g., boundaries of biogeographic provinces, boundaries of heaviest influence by large rivers) and also coincide with NMFS' statistical grid for fishing efforts (GMFMC 2016). The Project is located in the estuarine, nearshore, and offshore areas of Ecoregion 5, which covers an area from Freeport, Texas to the U.S./Mexico border. Ecoregion 5 has increased subtropical influence with higher temperatures, but lower rainfall as compared to Ecoregions 1 through 4 (GMFMC 2016, NMFS 2015).

Of the 93 species listed in Table 1, a total of 35 are identified as occurring within the estuarine, nearshore, and offshore habitats of Ecoregion 5, including 4 shrimp species, the red drum, 15 reef fish species, 3 coastal migratory pelagic fish species, and 12 highly migratory species (see Tables 5 and 6). The following subsections provide detailed discussions for each managed species, based on the life histories provided by the GMFMC and NMFS in the relevant FMPs (GMFMC 2016; NMFS 2006 and 2010). Attachments 1-A and 1-B summarize the life history information for the 35 federally managed species which exhibit EFH within the Project area for all or part of their life cycles.

Table 5: GMFMC Managed Fishes Identified in Ecoregion 5 by Life Stage

Common Name	Scientific Name	Life Stage				
		Eggs	Larvae	Juveniles	Adults	Spawning Adults
Shrimp						
brown shrimp	*Farfantepenaeus aztecus*	x	x	x	x	x
pink shrimp	*Farfantepenaeus duorarum*	x	x	x	x	x
white shrimp	*Litopenaeus setiferus*	x	x	x	x	x
royal red shrimp	*Pleoticus robustus*	N/A	N/A	N/A	x	x
Red Drum						
red drum	*Sciaenops ocellatus*	x	x	x	x	x
Reef Fish						
queen snapper	*Etelis oculatus*	--	--	--	--	--
mutton snapper	*Lutjanus analis*	--	--	--	--	--
blackfin snapper	*Lutjanus bucanella*	--	--	--	--	--
red snapper	*Lutjanus campechanus*	x	x	x	x	x
cubera snapper	*Lutjanus cyanopterus*	--	--	--	--	--
gray (mangrove) snapper	*Lutjanus griseus*	--	--	--	x	x
lane snapper	*Lutjanus synagris*	x	x	x	x	x
silk snapper	*Lutjanus vivanus*	--	--	--	--	--
yellowtail snapper	*Ocyurus chrysurus*	--	--	--	--	--
wenchman	*Pristipomoides aquilonaris*	x	x	x	x	x
vermilion snapper	*Rhomboplites aurorubens*	x	x	x	x	x
speckled hind	*Epinephelus drummondhayi*	--	--	--	--	--
Goliath grouper	*Epinephelus itajara*	x	x	x	x	x
yellowedge grouper	*Hyporthodus flavolimbatus*	x	x	x	x	x
red grouper	*Epinephelus morio*	--	--	--	--	--
Warsaw grouper	*Epinephelus nigritus*	x	x	x	x	x
snowy grouper	*Epinephelus niveatus*	--	--	--	--	--
Nassau grouper	*Epinephelus striatus*	--	--	--	--	--
black grouper	*Mycteroperca bonaci*	--	--	--	--	--
yellowmouth grouper	*Mycteroperca interstitalis*	x	x	x	x	x
gag	*Mycteroperca microlepis*	--	--	--	x	x
yellowfin grouper	*Mycteroperca venenosa*	--	--	--	--	--
scamp grouper	*Mycteroperca phenax*	--	--	--	--	--
goldface tilefish	*Caulolatilus crysops*	--	--	--	--	--

Table 5: GMFMC Managed Fishes Identified in Ecoregion 5 by Life Stage

Common Name	Scientific Name	Life Stage				
		Eggs	**Larvae**	**Juveniles**	**Adults**	**Spawning Adults**
blueline tilefish	*Caulolatilus microps*	--	--	--	--	--
tilefish	*Lopholatilus chamaeleonticeps*	x	x	x	x	x
greater amberjack	*Seriola dumerili*	x	x	x	x	x
lesser amberjack	*Seriola fasciata*	x	x	x	x	x
almaco jack	*Seriola rivoliana*	x	x	x	x	x
banded rudderfish	*Seriola zonata*	--	--	--	--	--
gray triggerfish	*Balistes capriscus*	x	x	x	x	x
hogfish	*Lachnolaimus maximus*	--	--	--	--	--
Coastal Migratory Pelagic Fishes						
king mackerel	*Scomberomorus cavalla*	x	x	x	x	x
Spanish mackerel	*Scomberomorus maculatus*	--	x	--	--	--
cobia	*Rachycentron canadum*	x	x	x	x	x

Key:
"--" indicates that the species is not identified as occurring in Ecoregion 5 for the indicated life stage.
"X" indicates the species is identified as occurring in Ecoregion 5 for the indicated life stage.
"N/A" indicates that data is not available for the species at the indicated life stage.
Sources: GMFMC 2016, NMFS 2019

Table 6: Highly Migratory Species in the Project Area by Life Stage

Common Name	Scientific Name	Spawning/ Eggs/ Larvae[a]	Neonates[a]	Juveniles	Adults
sailfish	*Istiophorus platypterus*	-	N/A	x	x
scalloped hammerhead shark	*Sphyrna lewini*	N/A	x	--	--
blacktip shark	*Carcharhinus limbatus*	N/A	x	x	x
bull shark	*Carcharhinus leucas*	N/A	x	x	x
lemon shark	*Negaprion brevirostris*	N/A	x	x	--
sandbar shark	*Carcharhinus plumbeus*	N/A	--	--	x[b]
spinner shark	*Carcharhinus brevipinna*	N/A	x	x	x
whale shark	*Rhincodon typus*	N/A	x[b]	x[b]	x[b]
bonnethead shark	*Sphyrna tiburo*	N/A	x	x	x
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	N/A	x	x	x
blacknose shark	*Carcharhinus acronotus*	N/A	--	x	x
finetooth shark	*Carcharhinus isodon*	N/A	x	x	x

[a] The earliest life stages for billfishes are eggs and larvae; the earliest life stage for most sharks is the neonate.
[b] Although the Project does not cross EFH for this stage, it is located in the immediate vicinity of the Project
"--" indicates that the species is not identified as occurring in Ecoregion 5 for the indicated life stage.
"x" indicates that the species is identified as occurring in Ecoregion 5 for the indicated life stage.
"N/A" indicates that data is not available for the species at the indicated life stage.
Sources: NMFS 2019

3.1 Shrimp Fishery Management Plan

3.1.1 Brown Shrimp (*Farfantapenaeus aztecus*)

Brown shrimp have the greatest abundance in the central and western GOM. They are found in estuaries and offshore waters to depths of 360.9 ft (110 m), although they are most common in water depths of 88.6 to 180.4 ft (27 to 55 m; Louisiana Department of Wildlife and Fisheries 2015). Species abundance and habitat requirements for the brown shrimp are separated by life stage. Post larvae and juveniles typically occur within estuaries, while adults occur outside of bay areas. In estuaries, brown shrimp post larvae and juveniles are associated with shallow vegetated habitats, but they also are found over silty sand and non-vegetated mud bottoms. The density of post larvae and juveniles is highest in marsh edge habitat and submerged vegetation, followed by tidal creeks, inner marsh, shallow open water, and oyster reefs (GMFMC 2004, GMFMC 2016).

3.1.2 Pink Shrimp (*Farfantepanaeus duorarum*)

Pink shrimp are estuarine and offshore dwellers at depths as great as 360.9 ft (110 m), but most commonly at depths less than164 ft (50 m). It is the dominant shrimp species for the Florida coast, and spawns year-round in the Tortugas, with a peak from spring to fall. Pink shrimp eggs are found in offshore waters at depths from 29.5 to 157.5 ft (9 to 48 m) (GMFMC 2016). Post larval and juvenile pink shrimp are commonly found in seagrass habitat where they can burrow into the substrate during the day and emerge at night to feed (GMFMC 2004). Pink shrimp densities are highest in or near seagrasses, low in mangroves, and near absent in marshes. Adult pink shrimp are most abundant in GOM waters ranging from 29.5 to 157.5 ft (9 to 48 m) along coarse mixtures of sand and shell with less than 1 percent organic material (GMFMC 2004, GMFMC 2016).

3.1.3 White Shrimp (*Litopenaeus setiferus*)

White shrimp are offshore and estuarine dwellers and are pelagic or demersal, depending on life stage. They are found in depths as great as 131.2 ft (40 m) but are most commonly found at depths less than 88.6 ft (27 m). Spawning generally occurs at depths ranging from 29.5 to 111.5 ft (9 to 34 m); however, spawning is most common at depths less than 88.6 ft (27 m) from spring through fall in the GOM from Florida to Texas. Eggs and larvae are found in estuarine, nearshore, and offshore waters from spring through fall at depths ranging from 29.5 to 111.5 ft (9 to 34 m) and 0 to 269 ft (0 to 82 m), respectively (GMFMC 2016). Postlarvae migrate through passes mainly from May-November with peaks in June and September. Migration occurs in the upper 2 meters of the water column at night and at mid-depths during the day. Postlarval white shrimp become benthic upon reaching nursery areas in estuaries, where they seek shallow water with muddy-sand bottoms high in organic detritus or abundant marsh vegetation and develop into juveniles. Juveniles dwell within marsh edge microhabitats and feed on sand, detritus, organic matter, mollusk fragments, ostracods, copepods, insect larvae, and forams. Subadults migrate from estuaries in late August and September on ebb tides during the full and new moon. Adults occur in nearshore waters at depths less than 98.4 ft (30 m) with soft bottom sediments (GMFMC 2004, GMFMC 2016).

3.1.4 Royal Red Shrimp (*Pleoticus robustus*)

The species is known to occur from Martha's Vineyard (Massachusetts) through the GOM and the Caribbean Sea to French Guiana where they live on the upper continental shelf at depths between about 459.3 and 2,395 ft (140 and 730 m) (GMFMC 2016). Royal red shrimp are scarce in depths less than 820 ft (250 m) and are not abundant at depths greater than1,640.4 ft (500 m). The highest concentrations have been reported in the northeastern part of the GOM at depths between 820.2 and 1,558.4 ft (250 and 475 m; GMFMC 2004). Royal red eggs, larvae, and juveniles are in offshore waters ranging from 820.2 to 1,804.5 ft (250 to 550 m) year-round; although eggs are generally associated with shelf edge/slope habitats. Adults are found throughout the GOM along edge/slope, soft bottom, sand/shell, and reef habitats (in the southeast) at depths ranging from 459.3 to 2,395 ft (140 to 730 m) (GMFMC 2016). Commercial concentrations of royal red shrimp have been reported on the following types of bottoms: blue-black terrigenous silt and silty sand off the Mississippi River Delta; and whitish, gritty, calcareous mud off the Dry Tortugas (GMFMC 1996).

3.2 Red Drum Fishery Management Plan

3.2.1 Red Drum (*Sciaenops ocellatus*)

Red drum occur throughout the GOM in a variety of habitats. They are common in the majority of GOM estuaries, existing in a dynamic range of substrates including seagrass, sand, mud, and oyster reefs. This species can survive in waters ranging from freshwater to highly saline; no optimum salinity has been determined. Spawning occurs in August through January and peaks in September or October along deeper waters near the mouths of bays and inlets, and along the GOM-facing side of barrier islands (Pearson 1929, Matlock 1990, Simmons and Breuer 1962, and Perret et al. 1980). Spawning occurs from mid-August through October, with a peak from September to October, in nearshore regions of the central Texas coast (GMFMC 2016). Eggs hatch primarily in the GOM and larvae are transported to estuaries where fish mature before moving back into the GOM. Juvenile red drum have been reported within marshes and estuaries, near quiet, shallow, protected waters with grassy or slightly muddy bottoms (Perret et al. 1980, Simmons and Breuer 1962). Adult red drum use estuaries but tend to spend more time offshore as they age. Schools of red drum are common in GOM waters less than 229.7 ft (70 m) deep (GMFMC 2016).

3.3 Reef Fish Fishery Management Plan

3.3.1 Red Snapper (*Lutjanus campechanus*)

Red snapper are demersal and are found over sandy and rocky bottoms, around reefs, and around underwater objects in depths to 656.2 ft (200 m) and possibly beyond depths of 3,937 ft (1,200 m) (GMFMC 2016). Adults are found in nearshore and offshore waters in the northern GOM along reefs, hard bottom, and banks/shoal habitats at depths ranging from 23 to 479 ft (7 to 146 m). Spawning occurs in offshore waters from May to October, at depths of 59.1 to 121.4 ft (18 to 37 m) and over fine sand bottoms. Eggs are found offshore in summer and fall at depths ranging from 59.1 to 413.4 ft (18 to 126 m) (GMFMC 2016). Larvae, post larvae, and early juveniles are found from July through November in shelf waters, in depths ranging from 55.8 to 600.4 ft (17 to 183 m). Early and late juveniles are often associated with shell and low-relief structures but are also found over barren sand and mud bottom (GMFMC 2004, GMFMC 2016).

3.3.2 Gray (Mangrove) Snapper (*Lutjanus griseus*)

The gray (mangrove) snapper occurs in estuaries and shelf areas of the GOM to depths of 590.6 ft (180 m). This species is demersal to mid-water dwelling, occurring in marine, estuarine, and riverine habitats. The gray snapper occurs up to 20 mi (32 km) offshore and may be found in coastal plain freshwater creeks and rivers inshore. Adults are found among mangroves, sandy seagrass flats, and over sandy, muddy, rocky, bottoms. Spawning occurs in offshore shelf waters and near reefs or shoals from June through August; pelagic eggs are present from June to September. Larvae are planktonic and are most prevalent from June through August in offshore shelf areas and coral reefs from Florida to Texas. Postlarvae migrate into estuarine habitat and are commonly found over dense seagrass flats of Halodule and Syringodium. Juveniles are marine, estuarine, and riverine dwellers, often found in estuaries, channels, bayous, ponds, marshes, grass beds, and freshwater creeks. Juveniles also prefer seagrass flats containing Thalassia but can be found in marine, estuarine, and riverine environments. (GMFMC 2004, GMFMC 2016).

3.3.3 Lane Snapper (*Lutjanus synagris*)

The lane snapper occurs throughout estuaries and shelf areas of the GOM in depths ranging from 13.1 to 433.1 ft (4 to 132 m). This species is demersal, occurring over all bottom types, but it is most common in coral reef areas and sandy bottoms. Spawning occurs in offshore waters from May through August (peak spawning is during July and August) (GMFMC 2016). Eggs are found seasonally, from March through September with a peak from July to August, throughout offshore waters of the Gulf at depths ranging from 13.1 to 433.1 ft (4 to 132 m). Adults occur offshore at depths of 13.1 to 433.1 ft (4 to 132 m). Larvae are also found throughout the GOM at depths ranging from 0 to 164 ft (0 to 50 m), eventually settling on SAV from June through August. Juveniles are prevalent from late summer through early fall at depths ranging from 0 to 78.7 ft (0 to 24 m) in a variety of habitats including SAV, sand/shell reefs, soft bottom, and banks/shoals (GMFMC 2004, GMFMC 2016).

3.3.4 Wenchman (*Pristipomoides aquilonaris*)

Found throughout the GOM, wenchman occupy hard bottom habitats of the mid to outer shelf, where they primarily feed on small fish. They are found at depths ranging from 62.3 to 1,578.1 ft (19 to 481 m) but are most abundant between 262.5 and 656.2 ft (80 and 200 m) (GMFMC 2004). Eggs and larvae are found in offshore waters at depths ranging from 262.5 to 656.2 ft (80 to 200 m); however, juveniles and adults are found at depths ranging from 62.3 to 1,578.1 ft (19 to 481 m). Spawning adults generally occupy shelf/edge slope habitats during summer months at depths ranging from 262.5 to 656.2 ft (80 to 200m) (GMFMC 2016).

3.3.5 Vermilion Snapper (*Rhomboplites aurorubens*)

The vermilion snapper occurs in shelf areas of the GOM, but is more common to the eastern GOM, in west Florida. This snapper is demersal, preferring reefs and rocky bottom habitats at depths ranging from 59.1 to 656.2 ft (18 to 200 m). Spawning occurs in offshore waters from May to September. Eggs are found throughout the GOM in offshore waters ranging from 59.1 to 328.1 ft (18 to 100 m). Juveniles prefer hard bottom habitats, reefs, and submersed structures at depths of 59.1 to 328.1 ft (18 to 100 m) (GMFMC 2004). Adult vermilion snapper are also found throughout the GOM in nearshore and offshore waters ranging from 59.1 to 328.1 ft (18 to 100 m) along banks/shoal, reef, and hard bottom habitats. (GMFMC 2016).

3.3.6 Goliath Grouper (*Epinephelis itajara*)

The goliath grouper is typically found in shallow waters of the GOM and is most common in southwest Florida. This species is found as deep as 311.7 ft (95 m); however, it is most common at depths ranging from 6.6 to 180.4 ft (2 to 55 m). Juveniles prefer bays, estuaries, inshore seagrass flats, canals, and mangroves; however, larger juveniles are found near ledges, reefs, and holes within shallow waters. Younger adults are found inshore near docks, bridges, and jetties; whereas adults prefer offshore ledges and shipwrecks. Adult goliath groupers general feed on crustaceans, fish, and mollusks; however, the diet of juveniles is primarily blue crab and other crustaceans. Spawning occurs near offshore structures, wrecks, and other high-relief structures from July to December with peaks between July and September. Spawning aggregations may contain 10 to 150 individuals at depths ranging from 118.1 to 150.9 ft (36 to 46 m) (GMFMC 2004, GMFMC 2016).

3.3.7 Yellowedge Grouper (*Hyporthodus flavolimbatus*)

The yellowedge grouper is a deepwater species found throughout much of the GOM continental shelf with high populations near Texas and Florida. This species occupies high-relief hard bottoms and rock outcroppings on the outer continental shelf at depths ranging from 114.8 to 1,213.9 ft (35 to 370 m). Adults are most common at depths greater than 590.6 ft (180 m); however, juveniles occupy shallower depths ranging from 29.5 to 360.9 ft (9 to 110 m). Additionally, this species is generally associated with populations of snowy grouper (*Hyporthodus niveatus*) and tilefish (*Lopholatilus chamaeleonticeps*). Adults and juveniles are known to inhabit burrows and have a diet consisting of brachyuran crabs, fishes, and other invertebrates (GMFMC 2004, GMFMC 2016).

3.3.8 Warsaw Grouper (*Epinephelus nigritus*)

The Warsaw grouper is a deepwater species distributed throughout the GOM in association with hard bottoms. They occur from 131.2 to 1,722.4 ft (40 to 525 m) and prefer rough, rocky bottoms with high profiles such as steep cliffs and rocky ledges. Eggs, larvae, and adults are found in offshore waters throughout the GOM at depths ranging from 131.2 to 1,722.4 ft (40 to 525m); however, juveniles are found in shallow nearshore habitats ranging from 65.6 to 98.4 ft (20 to 30 m) and may enter bays, moving into deeper water as they grow (GMFMC 2004, GMFMC 2016).

3.3.9 Yellowmouth Grouper (*Mycteroperca interstitialis*)

The yellowmouth grouper generally occurs in the GOM off the west coast of Florida, in the Texas Flower Garden Banks, and along the northwest coast of Cuba. Individuals prefer rocky bottoms and coral reefs where they can feed on fishes, crustaceans, and other invertebrates. Spawning occurs primarily in spring and summer with peaks in April and May off the coast of Florida. Eggs and larvae are found in offshore waters at depths ranging from 65.6 to 620.1 ft (20 to 189 m) (GMFMC 2016). Juveniles generally occur in mangrove-lined lagoons and move to deeper waters later in life (GMFMC 2004).

3.3.10 Gag (*Mycteroperca microlepis*)

Gags are demersal and most commonly found in the eastern GOM, especially the west Florida shelf. Adults occupy hard bottom substrates such as offshore reefs and wrecks, coral and live bottoms, and depressions or ledges. Spawning adults form aggregations at depths of 164 to 393.7 ft (50 to 120 m), with the densest aggregations occurring near the Big Bend area of Florida. Spawning occurs near the shelf edge break from December to May with a peak in February or March along the Florida shelf. Eggs are pelagic, occurring in December to April, with areas of greatest abundance offshore on the west Florida shelf. Larvae are pelagic and most abundant in the early spring. Postlarvae and pelagic juveniles move through inlets into coastal lagoons and high salinity estuaries in April through May where they become benthic and settle into grass flats and oyster beds. Late juveniles move offshore in the fall to shallow reef habitat in depths of 3.3 to 164 ft (1 to 50 m) (GMFMC 2004). Adults occupy 42.7 to 328.1 ft (13 to 100 m) depths (large adults occur in greater depths), selecting hard bottoms, offshore reefs and wrecks, coral, and live bottom habitats (GMFMC 2016).

3.3.11 Tilefish (*Lopholatiuls chamaeleonticeps*)

The tilefish occurs throughout the deeper waters of the GOM. It is demersal, occurring from depths of 262.5 to 1,476.4 ft (80 to 450 m) but is most commonly found between depths of 820 and 1,148 ft (250 and 350 m). Preferred habitat is soft bottom, particularly malleable clay along the shelf edge. Eggs and larvae are pelagic, while early juveniles are pelagic to benthic. Late juveniles burrow and occupy shafts in the substrate. Adults also dig and occupy burrows along the outer continental shelf and on the flanks of submarine canyons (GMFMC 2004, GMFMC 2016).

3.3.12 Greater Amberjack (*Seriola dumerili*)

The greater amberjack occurs throughout the GOM to depths of 613.5 ft (187 m). Adults are found year-round in nearshore and offshore waters, occurring over reefs and wrecks and around buoys (GMFMC 2004, GMFMC 2016). Spawning occurs in offshore waters from February to through May in the northern GOM. Eggs are pelagic and larvae are found offshore, year-round using drifting algae for habitat. Juveniles are found in a variety of habitats in nearshore and offshore waters including drifting algae and often are attracted to floating plants and debris in offshore nursery areas from summer through fall (NOAA 1985, GMFMC 2004, GMFMC 2016).

3.3.13 Lesser Amberjack (*Seriola fasciata*)

The lesser amberjack can be found from the GOM to the northeast coast and Brazil. In the GOM, they are found in offshore waters and generally occupy drifting algae, hard bottom, or reef habitats at depths ranging from 180.4 to 1,141.7 ft (55 to 348 m). Eggs and larvae occur throughout the GOM (GMFMC 2004). Juveniles occur offshore in late summer and fall in the northern GOM. Small juveniles are associated with floating *Sargassum* (GMFMC 2016). Adults are found offshore year-round in the northern GOM, where they are associated with hard bottom, reefs, oil and gas platforms and irregular bottoms. Spawning occurs offshore September through December and February through March, likely in association with oil and gas structures and irregular bottoms (GMFMC 2004, GMFMC 2016).

3.3.14 Almaco Jack (*Seriola rivoliana*)

The almaco jack occurs throughout the GOM. Juveniles are known to use *Sargassum* as a refuge in open waters and off barrier islands. Eggs and larvae occur from the Florida Keys to Pensacola Bay and Texas to Mexico from spring through fall. Juveniles occur throughout the GOM at depths from 22 to 55.1 ft (6.7 to 16.8 m) from August through January and July through October along drifting algae and artificial reefs along nearshore and offshore areas. Adults are found far offshore at depths ranging from 69 to 587.3 ft (21 to 179 m), often associated with artificial reefs such as offshore platforms. Spawning is thought to occur from spring through mid-fall (GMFMC 2004, GMFMC 2016).

3.3.15 Gray Triggerfish (*Balistes capriscus*)

The gray triggerfish is found has a large range which extends throughout the northern GOM. In the GOM, this species is found at depths ranging from 32.8 to 328.1 ft (10 to 100 m), occurring in reefs, *Sargassum*, and mangroves. Eggs are benthic and occur throughout the GOM in late spring and summer, in nests prepared in sand near natural and artificial reefs (GMFMC 2004, GMFMC 2016). Eggs are guarded by the female and/or male. Larvae and post larvae are pelagic, occurring in the upper water column and usually associated with *Sargassum* and other flotsam. Early and late juveniles also are associated with *Sargassum* and may be found in mangrove estuaries. Adults are found offshore in waters ranging from 33 to 328 ft (10 to 100 m), where they are associated with natural and artificial reefs as well as hard bottom habitat (GMFMC 2004, GMFMC 2016). However, they may move away from structures to feed and have been observed hunting over soft bottoms (GMFMC 2004, GMFMC 2016).

3.4 Coastal Migratory Pelagic Fishery Management Plan

3.4.1 King Mackerel (*Scomberomorus cavalla*)

Within the GOM, king mackerel have centers of distribution in South Florida and Louisiana. Adults are found over reefs, in coastal waters, and over the shelf edge in depths of up to 656.2 ft (200 m)—although they generally occur in less than 262.5 ft (80 m) of water. Eggs are pelagic and found offshore between 114.8 and 590.6 ft (35 and 180 m) in spring and summer. Larvae occur over the middle and outer continental shelves, principally in the northcentral and northwestern GOM; juveniles are found closer inshore and out to the mid-shelf (GMFMC 2004, GMFMC 2016).

3.4.2 Spanish Mackerel (*Scomberomorus maculatus*)

Spanish mackerel are pelagic, occurring in the GOM with their center of distribution near Florida. This species generally occurs at depths as great as 246.1 ft (75 m) throughout the coastal zone of the GOM. Adults are usually found in neritic waters and along coastal areas. They inhabit estuarine areas, particularly higher salinity areas, during seasonal migrations, but are considered rare and infrequent in many GOM estuaries. Adult Spanish mackerel feed primarily on fishes and less often on crustaceans and mollusks with a diet that includes clupeids, engraulids, carangids, and squid. Adults spawn along the continental shelf from May to September. The northcentral and northeastern GOM are considered important spawning areas for this species. Pelagic eggs are found across the continental shelf at depths less than 164 ft (50 m) from spring to summer. Larvae are found across the continental shelf, primarily in the northern GOM where they have ample larval fishes such as carangids, clupeids, and engraulids for consumption. Juveniles are generally found in estuarine and coastal waters where they feed on engraulid and clupeid fishes, gastropods, and some squid (GMFMC 2004, GMFMC 2016).

3.4.3 Cobia (*Rachycentron canadum*)

Cobia are found throughout the coastal and offshore waters of the GOM from depths ranging from 3.3 to 229.7 ft (1 to 70 m). The species is large, pelagic, and epibenthic; it often inhabits areas near wrecks, reefs, pilings, buoys, and floating objects. Although adults occur year-round throughout the GOM, they display seasonal migrations and occur more abundantly in March–October in the northern GOM and in November–March in the southern GOM. Spawning occurs in spring and summer (from April through September) in the northern GOM throughout all adult areas, except in estuaries (NOAA 1985, GMFMC 2004). Eggs are pelagic, usually found in the top meter of the water column in the summer. Larvae are found in offshore shelf waters of the northern GOM, where they feed on zooplankton. Juveniles occur in coastal and offshore waters feeding on small fishes, squid, and shrimp (GMFMC 2004, GMFMC 2016).

3.5 Atlantic Highly Migratory Species Fishery Management Plan

3.5.1 Sailfish (*Istiophorus platypterus*)

Sailfish are distributed throughout much of the tropics, ranging from 40 degrees North to 40 degrees South latitude in the western Atlantic. Sailfish are an epipelagic species that occupy coastal to oceanic habitats. Generally, this species is found over the continental shelf edge, moving to inshore waters associated with landmasses. Spawning occurs in shallow waters ranging from 29.5 to 39.4 ft (9 to 12 m) in depth, primarily from April to October. Larvae, which feed on copepods, are found in offshore waters throughout the GOM from March to October (NMFS 2006).

EFH for spawning adults and eggs includes waters associated with the Gulf Stream and Florida Straits from 5 mi (8 km) offshore, extending to either 125 mi (201 km) offshore or the outer Exclusive Economic Zone (EEZ) boundary (whichever is closer). EFH for juveniles includes pelagic and coastal waters between 5 and 125 mi (8 and 201 km) offshore, or the EEZ boundary (whichever is closer) in warmer waters ranging from 21 ° to 28°C. Adult EFH includes pelagic coastal surface waters from Florida through the GOM ranging from 21 ° to 28°C in areas 5 mi (8 km) offshore southeast Texas, from Corpus Christi to the outer EEZ boundary, or the 2,000 m isobath (whichever is closer) (NMFS 2006, NOAA 2017).

3.5.2 Scalloped Hammerhead (*Sphyrna lewini*)

This is a very common, large, schooling hammerhead occurring in warm waters. It migrates seasonally north to south along the eastern United States. The scalloped hammerhead is considered vulnerable to overfishing because its schooling habits make it extremely vulnerable to gillnet fisheries (NMFS 2006). EFH for the neonate scalloped hammerheads in the GOM includes coastal areas of the GOM from Florida to Texas in and depths of 16.4 to 19.7 ft (5 to 6 m) in mud and seagrass substrate. EFH for juveniles and adults occurs in the northern GOM from eastern Louisiana to Pensacola, Florida (NOAA 2017).

3.5.3 Blacktip Shark (*Carcharhinus limbatus*)

The blacktip shark is circumtropical in shallow coastal waters and offshore surface waters of continental shelves. In the southeastern U.S., this species ranges from Virginia to Florida and the GOM (NOAA 2017). Young are born at 22 to 24 inches (55 to 60 centimeters) in length in late May to early June along shallow coastal nurseries and in bay systems of the GOM (Castro 1996). EFH for this species includes all major bay systems along the Gulf coast of Texas from Sabine Lake to the Lower Laguna Madre; however, only the juvenile stage of blacktip shark is present within the western GOM (NMFS 2006, NOAA 2017).

3.5.4 Bull Shark (*Carcharhinus leucas*)

The bull shark is a large, shallow water shark that is cosmopolitan in warm seas and estuaries. Along the Atlantic coast, they are found from Massachusetts to Florida and are common in southeast Florida and throughout the GOM (NMFS 2018a). This species is found predominantly in shallow coastal waters and is common in lagoons, bays, and the mouths of rivers. Young are born ranging approximately 20 to 26 inches (51 to 68 centimeters) tail length and live in nursery areas that are in low salinity estuaries within the GOM (NOAA 2017).

EFH for the bull shark includes shallow waters, inlets, and estuaries in waters less than 82 ft (25 m) deep along the Gulf coast (NMFS 2006). Neonate EFH includes the shallow coastal waters of Texas extending to the mouth of the Mississippi, particularly the inland bay and bayou systems of Lake Pontchartrain in Louisiana. Additionally, juvenile EFH in Texas is located within coastal waters along the Texas coast, especially Matagorda Bay and San Antonio Bay (NOAA 2017).

3.5.5 Lemon Shark (*Negaprion brevirostris*)

The lemon shark is common in the American tropics, inhabiting shallow coastal areas, especially around coral reefs. It is reported to use coastal mangroves as some of its nursery habitats, although this is not well documented in the literature. The primary population in continental U.S. waters is found off South Florida, although adults stray north to the Carolinas and Virginia in the summer.

EFH for this species includes shallow coastal waters, inlets, and estuaries as far offshore as the 82 ft (25 m) isobath across the GOM Coast. Neonate EFH in the GOM includes shallow coastal waters, inlets, and estuaries Galveston, Texas to the border of the U.S. and Mexico. Juvenile EFH includes shallow coastal areas along Texas in the GOM as well as shallow coastal waters off the coast of Puerto Rico and Florida, respectively; however, adult EFH for this species is not located within Texas (NOAA 2017).

3.5.6 Sandbar Shark (*Carcharhinus plumbeus*)

The sandbar shark is cosmopolitan in subtropical and warm, temperate waters and is common in coastal habitats. This bottom-dwelling species is commonly found in 65.6 to 180.4 ft (20 to 55 m) of water but has been found in waters as deep as 656.2 ft (200 m). Young are born from March to July. In the U.S., this species uses nurseries in shallow coastal waters along the Atlantic coast, from Cape Canaveral, Florida to Great Bay, New Jersey. In addition to EFH along the Atlantic coast, EFH for adult sandbar sharks occurs in the GOM in coastal areas from Florida to the Mississippi River, and habitats surrounding the continental shelf between Louisiana and Texas (NOAA 2017).

3.5.7 Spinner Shark (*Carcharhinus brevipinna*)

The spinner shark is a common, coastal pelagic, warm-temperate and tropical shark located on the continental and insular shelves. This species is migratory; however, patterns are poorly understood. Off eastern North America, the spinner shark ranges from Virginia to Florida and into the GOM. Young are born from late May to early June.

EFH for neonates and young-of-the-year for this species in the GOM includes coastal areas surrounding the Florida Keys and from the Big Bend Region of Florida to southern Texas. EFH for juveniles and adults in the GOM includes coastal areas from Apalachicola, Florida to southern Texas (NOAA 2017).

3.5.8 Whale Shark (*Rhincodon typus*)

The whale shark is a large, sluggish, pelagic filter feeder often seen swimming on the surface of the ocean. This species is the largest fish in the ocean and is found throughout all tropical seas, usually far offshore (Castro 1983). The location of whale shark nurseries is unknown as well as information associated with EFH for this species (NOAA 2017).

3.5.9 Bonnethead shark (*Sphyrna tiburo*)

The bonnethead shark is a small hammerhead that inhabits shallow coastal waters where it frequents sandy or muddy bottoms. This species is confined to the warm waters of the western hemisphere (Castro 1983). EFH for the GOM stock of neonates and juveniles are within shallow coastal waters, inlets, and estuaries less than 82 ft (25 m) deep from the Florida Keys to west of the Rio Grande in Texas, including all major bay systems from Sabine Lake to the Lower Laguna Madre (NMFS 2006, NOAA 2017). Additionally, EFH for adults is located in shallow coastal waters from Mobile Bay, Alabama to South Padre Island, Texas from inshore to the 25 m isobath (NMFS 2006).

3.5.10Atlantic Sharpnose Shark (*Rhizoprionodon terraenoae*)

The Atlantic sharpnose shark is a small coastal species, common year-round in the GOM and frequently found in schools of uniform size and sex. Although large numbers of Atlantic sharpnose shark are taken as catch during trawling, the species is fast-growing and reproduces yearly, allowing the population to maintain itself (NMFS 2006).

EFH for the Atlantic sharpnose shark near Texas includes shallow coastal areas, including bays and estuaries out to the 82 ft (25 m) isobath from Galveston Island, Texas south to the border of Texas and Mexico for juveniles and neonates. Additionally, EFH for adult Atlantic sharpnose sharks include waters from Galveston, Texas to Laguna Madre, Texas to the 50 m isobath (NOAA 2017).

3.5.11Blacknose Shark (*Carcharhinus acronotus*)

The blacknose shark is a common coastal species that abundant in the GOM during the summer and fall. EFH for this species includes shallow coastal waters to the 82 ft (25 m) isobath from North Carolina to Terrebonne Parrish, Louisiana. EFH for adults and juveniles in the GOM also extends from southeastern coastal Texas to Galveston Bay and offshore to southern Louisiana (roughly to areas offshore of Terrebonne Bay) within an average water depth 13.1 ft (4 m) in water temperatures ranging from 20.8 to 33.6 °C, with an average salinity of 32.1 ppt. EFH for neonates does not occur in the Project area (NOAA 2017).

3.5.12Finetooth Shark (*Carcharhinus isodon*)

The finetooth shark is a relatively common inshore species located in the west Atlantic and is abundant along the southeastern U.S. and GOM. This species is generally found at depths of 13.1 ft (4 m) and has important nursery habitat along the coast of South Carolina, Louisiana, and Texas. EFH for this species is located in North Carolina, Georgia, and Florida in the Atlantic, into the GOM as far west as Texas. In general, EFH for the finetooth shark is located in shallow coastal water, less than 5 m deep with muddy bottoms, on the seaward side of coastal islands from Apalachee Bay to St. Andrews Bay, Florida. Additionally, this EFH includes coastal waters out to the 82 ft (25 m) isobath from Mobile Bay to St. Louis, Mississippi and from near Sabine Pass, to Laguna Madre, Texas (NOAA 2017).

4 Impacts to Essential Fish Habitat from the Proposed Project

4.1 Summary of Anticipated Impacts

Most impacts associated with construction, operation, and decommissioning of the Project will be incurred by those habitats and species within a Region of Influence that includes the Project footprint as well as the area immediately surrounding Project Components. Impacts will be associated with physical habitat disruption during all phases of the Proposed Project (including increased turbidity and sedimentation), seawater intakes and discharges, increased vessel traffic, noise, and inadvertent spills. Impacts within the Region of Influence, but outside of the immediate Project area will be caused by support vessel traffic traveling between shore and the SPM buoy systems, as well as Very Large Crude Carrier (VLCC) traffic transiting through the GOM to call at the SPM buoy systems. Table 7 summarizes the impacts that will occur on EFH habitat and associated managed species during each phase of the Project. Each activity, and its impact on EFH and managed species, is further discussed below.

As discussed in Section 3: Project Description and Framework for Environmental Evaluation, the environmental consequences of the Proposed Project will vary in duration and significance. Four levels of impact duration were considered: temporary, short-term, long-term, and permanent. Temporary impacts generally occur during construction, with the resource returning to pre-construction conditions almost immediately afterward. Short-term impacts are considered to be those that may continue for up to 3 years following construction. Impacts are considered long-term if the resource will require more than 3 years to recover. A permanent impact could occur as a result of any activity that modified a resource to the extent that it will not return to pre-construction conditions during the life of the Proposed Project, such as within the footprint of Project. When determining the significance of an impact, we consider the duration of the impact, the geographic and biological context in which the impact will occur, and the magnitude and intensity of the impact. The duration, context, and magnitude of impacts vary by resource and therefore significance varies accordingly. Refer to Appendix A: Construction, Operation and Decommissioning Procedures, for a detailed description of techniques, procedures, and phases of the Propose Project that were used to evaluated environmental consequences in the following sections.

Most of the noted effects are temporary and will be offset by environmental protection guidelines or are negligible considering the localized effect of the Project actions compared to the habitat available in the GOM. Recovery of EFH is expected to occur quickly for majority of the affected environment.

Table 7: Summary of Essential Fish Habitat Impacts from Construction, Operation, and Decommissioning of the Project

Type of Habitat	Construction Impacts	Operational Impacts	Decommissioning Impacts
Submerged Aquatic Vegetation	Temporary and negligible impacts associated with potential disruption through inadvertent spills and by transiting vessels and turbidity and sedimentation associated with construction.	None anticipated during normal operations.	None. Onshore/Inshore Pipelines to be abandoned in place.
Sargassum	Temporary disturbance through noise and disruption from vessel traffic.	Permanent and minor impacts on water quality through regulated discharges. Short-term, localized, and negligible disruption through inadvertent spills. Moderate, temporary impacts by transiting vessels. Temporary disturbance through noise.	As discussed for construction.
Emergent Marshes	Temporary impacts associated with potential inadvertent releases and increased turbidity/sedimentation during installation of the Onshore and Inshore Pipelines through emergent marsh habitat.	None anticipated during normal operations.	None. Onshore/Inshore Pipelines to be abandoned in place.
Mangroves	Temporary impacts associated with potential inadvertent releases due to clearing for construction. Mangroves were identified during wetland delineation surveys of the Inshore Pipelines but will be avoided where possible by Project construction workspaces and best management practices.	None anticipated during normal operations.	None. Onshore/Inshore Pipelines to be abandoned in place.
Soft Bottom	Temporary and minor disturbance through turbidity/sedimentation; temporary and minor disturbance from pile-driving and noise-related impacts. Permanent loss of habitat and benthic faunal/infaunal mortality from installation of Project Components.	Permanent and negligible disturbance through turbidity/sedimentation by anchor chain sweep. Long- term creation of hard substrate.	Short-term and minor disturbance through turbidity/sedimentation. Permanent loss/removal of hard substrate (Project Components) that may have become colonized.
Oyster Reef	None. Inshore Waters crossed by HDD.	None anticipated during normal operations.	None.
Water Column	Short-term and negligible disturbance through increased turbidity/sedimentation and noise within the water column associated with HDDs. Permanent impacts associated with Impingement/entrainment of managed species in intake screens for hydrostatic test water withdrawals.	Permanent and minor impacts on water quality through regulated discharges. Permanent impacts associated with Impingement/entrainment of managed species in sea chests/intake screens. Temporary, localized disruption through inadvertent spills and by transiting vessels.	As discussed for construction. Also, permanent, but negligible impacts on ichthyoplankton from flooding of the abandoned pipelines with seawater, if applicable.

4.2 Construction Impacts

4.2.1 Inshore Pipelines Installation

The Inshore Pipelines will be constructed across the Redfish Bay and other inshore waters using the HDD method. HDD construction methods result in impacts at the entry and exit points of the drill, but typically avoid impacts between the two points. The Project will entail crossing both the mainland shoreline, Redfish Bay and other inshore waters, and the landward shoreline of San Jose Island) via HDD, thereby avoiding impacts on the shorelines and islands. As the floor of the Redfish Bay is generally covered in seagrass, direct impacts on seagrasses will be avoided by HDD construction. Approximately 0.4 ac (0.2 ha) of oyster reefs occur in Redfish Bay; however, they will also be avoided by HDD construction. No areas serpulid reefs have been identified within 30 mi (48.2 km) from the landfall location of the Inshore Pipelines.

Although HDD construction generally minimizes impacts on sensitive resources, there is the potential for an inadvertent return of drilling fluids, during which HDD drilling mud forces through fractures in the overlying material and discharges to the surface. As the drilling fluid will follow the path of least resistance, fluids may come to the surface over the Inshore Pipelines, or in a nearby area. Although an inadvertent return is possible, HDD drilling mud is a benign, non-toxic substance composed primarily of bentonite clay. The substance is denser than seawater and will settle on the seafloor after discharge, resulting in the smothering of benthic organisms that are within the affected area. In the case of any inadvertent return, BWTT will implement its Project-specific Inadvertent Return Contingency Plan which includes measures to prevent, detect, and mitigate for inadvertent releases of drilling fluid. Impacts on coastal wetlands (including mangroves) are discussed in Section 5: Wetlands and Waters of the U.S.

Turbidity refers to the insoluble, suspended particulates that impede the passage of light through water by scattering and absorbing light energy. The reduction of penetrating light reduces the depth of the photic zone which reduces the depth at which primary productivity occurs. Historic motorized vessels have been identified as a driver for seagrass loss in Redfish Bay through uprooting of seagrass species and subsequent turbidity (TPWD 2005). Turbidity, although temporary, reduces the light available to the seagrasses. The resultant sedimentation, however, can result in mounds of deposited sediment that are then prone to resuspension (Handley et al. 2007). Studies have shown that seagrasses take 3 to 5 years to recover, if buried by no more than 3 inches of sediment; however, shoalgrass could quickly invade buried sites and could outcompete other native species prior to their recovery (USACE and Interagency Coordination Team 2002). To minimize impacts on seagrasses from turbidity during pipeline construction, BWTT will utilize HDD construction methods across Redfish Bay. As BWTT has designed the Proposed Project to avoid in-water trenching, the potential for increased turbidity and sedimentation due to construction has been minimized to the extent practicable. Further, as previously indicated, the TPWD recommends the use of airboats, johnboats, shallow water boats, or trolling motors when traversing shallow waters through Redfish Bay to avoid impacts on seagrasses from propeller scars. BWTT will comply with these recommendations, where possible, which will also minimize the extent of localized turbidity from transiting vessels. Further, because no trenching is proposed, impacts on the benthic community (which is generally less motile, and therefore susceptible to sedimentation impacts) will be negligible. Construction of the Inshore Pipelines will take 18 months; each of the HDDs will take up to 9 weeks. HDD construction will temporarily increase noise, levels within the water column. Noise is discussed in Section 8: Wildlife and Protected Species and Section 13: Meteorology, Air Quality, and Noise.

BWTT conducted sediment quality testing along the Inshore Pipelines. Sediment samples were collected at four locations along the Inshore Pipelines. No exceedances of the Texas Commission on Environmental Quality's (TCEQ) guideline levels regarding sediment concentrations of contaminants were documented for sediment samples collected along the Inshore Pipelines; however, arsenic concentrations were detected to exceed NOAA's Effects Range Low (ERL) benchmark level at one sampling location in the Gulf Intracoastal Waterway (GIWW) near Aransas Pass. The ERL benchmark level is based upon a database of sediment chemistry and toxicity data and the ERL represents the 10th percentile of the effects database, and represents a concentration below which adverse effects rarely occur. The arsenic concentration at the sampling location that exceeds the ERL benchmark does not exceed the effects range median (ERM) value, representative of concentrations above which effects often occur (Buchman 2008, NOAA 1999). The location of this elevated concentration will be crossed via HDD, such that no disturbance of the surface sediments will occur.

4.2.2 Offshore Pipeline Installation

The most sensitive portion of the Offshore Pipelines route is near shore, where it passes through shallow water and makes landfall on San Jose Island. To avoid impacts on the coast of the barrier island, which includes marine/estuarine wetlands and sensitive coastal dune habitat, the Offshore Pipelines will be installed by HDD at this location.

At the seaward edge of the HDD (about 3,900 ft [1,188.7 m] from shore), the Offshore Pipelines will cross soft bottom habitats between the seaward boundary of San Jose Island to its interconnection with the SPM buoy systems about 17.0 mi (27.4 km) offshore. Offshore, trenching and backfilling for installation of the pipelines will be completed using a submersible pipeline jetting sled operated from an anchored pipe-laying barge. The pipelines will be buried a minimum of 3 ft (0.9 m) below the sediment surface. Operation of the sled will redeposit some material over the pipelines, but full backfilling will occur naturally. Based on a construction workspace width of 75 ft (22.9 m) and the 26.4 mi (42.5 km) of Offshore Pipeline length that will be installed by jetting, approximately 240.0 ac (97.1 ha) off soft bottom habitat will be directly disturbed during construction. Increased turbidity and sedimentation from trenching activities will also result in indirect impacts on the soft bottom and water column habitat that occurs immediately adjacent to construction workspaces, and the fauna that use them. Coarse sediments will fall out and resettle quickly while fine sediments remain suspended for a longer period of time; however, once installation is complete, local water turbidity should return to pre-construction levels without mitigation.

Installation of the proposed Offshore Pipelines in soft bottom habitat will produce a turbidity plume within the immediate vicinity of construction. As further described in Section 4: Water Quality and BWTT's TSS model results presented in Volume II, Appendix D, impacts will be temporary and minor, with suspended sediment levels along the trench generally returning to pre-construction levels within 1-2 days. TSS concentrations will be highest in the immediate area of the trench and will dissipate with distance from the trench, returning to ambient levels within a maximum distance of about 2.1 mi (3.5 km). The resultant suspended sediments have the potential to affect benthic infaunal or epifaunal organisms in its path. Because the marine soft bottom habitat is highly variable and experiences frequent natural disturbances, any disturbance to the seafloor environment will have an initial impact, but the affected habitat should recover rapidly by recruitment from the surrounding community (Brooks et al. 2006). Based on conservative model assumptions, sedimentation exceeding 0.04 inch thick will be limited to within 250 ft (76.2 km) of the Offshore Pipelines, and the layer of sediment deposited on the seafloor will decrease with distance. Over time, any difference in deposition thickness will be reduced by ongoing hydrodynamic forces; therefore, impacts will be temporary, localized and negligible (see Appendix D). It is expected that mobile nekton species will be displaced temporarily from the habitat but will return to the area almost immediately following construction. Similarly, the benthic community is expected to recolonize disturbed areas shortly after construction, such that no long-term effects on the community are expected. Increased turbidity and sedimentation could also result in the resuspension of contaminated materials, if present; however, Project-specific sediment sampling in offshore waters did not identify sediment chemistry concentrations exceeding the TCEQ's or NOAA's guidelines. Therefore, impacts are anticipated to be minimal and short-term.

Underwater noise may be generated by installation of the Offshore Pipelines in nearshore and offshore areas; however, underwater pipeline installation will progress along the route such that construction at any one location is of short duration. Therefore, impacts from pipeline installation noise will be temporary and negligible. Similarly, noise associated with increased vessel traffic will be transient as the vessel moves between Project areas, and will be mitigated through use of low speeds, which will be required for all construction and support vessels. Increases in ambient noise could decrease the quality of habitat provided by the water column and *Sargassum* mats. Overall, impacts associated with construction noise is anticipated to be negligible and temporary.

4.2.3 Deepwater Port Pile-Driving and Installation

The seafloor in the Offshore Project area is a soft- bottom environment, comprised of sand in areas closer to shore and under-consolidated mud in areas further offshore. No hard bottom habitat is present within the immediate Project area; the closest identified hard bottom areas to the SPM buoy systems are about 30 mi (48.2 km) east. To minimize impacts associated with offshore construction, the SPM buoy systems and associated components will be fabricated onshore and delivered to the site by barge. Similarly, 12 anchor piles for each SPM buoy system will be prefabricated on land prior to installation by industry acceptable practices at the offshore location. Once installed, the anchor chains will be attached to the piles, and subsequently to the SPM buoy. In addition, 10 piles will be installed for the pipeline end manifolds (PLEM). These construction activities will be of limited duration and are not anticipated to cause long-term adverse effects to the biological community.

Approximately 700 sq ft (0.02 ac; <0.01 ha) of soft bottom habitat will be permanently removed within the footprint of the SPM buoy systems components. Any non-motile biological resources in the footprint of the SPM buoy systems will be lost during installation and the habitat removed for the life of the Project (50 years). Mobile organisms that are displaced during construction are expected to quickly return following construction. With the exception of the benthic community underlying the Project's footprint, the benthos is expected to rapidly recover following construction (Brooks et al. 2006). Impacts beyond the permanent footprint of the Project are anticipated to be short-term. One potential benefit associated with installation of the SPM buoy systems is its potential to function as artificial hard bottom, providing a surface area for epifaunal colonization. As previously discussed, artificial reefs and manmade structures like jetties, pilings, groins and breakwaters provide a unique habitat for hard bottom taxa and associated nekton, particularly in areas previously void of hard substrate.

Construction and installation of the SPM buoy systems components will result in an increase in turbidity in the water column within and adjacent to the Project footprint; however, this effect is expected to be localized and limited to the time of placement. Deposition of suspended sediments in soft bottom habitats is expected to occur over a short distance from active construction and cover a small area relative to the total habitat available. TSS modeling was not conducted to quantify impacts from installation of the SPM buoy systems; however, sediment at the SPM buoy systems is predominantly silt and clay, and will remain suspended for longer durations than locations dominated by sand. However, all sediments are expected to settle within days or weeks of completion of construction. Overall, the increased turbidity and sedimentation is considered a temporary and negligible impact given the extent of locally available soft bottom and water column habitat.

Some installation activities will continue 24 hours a day and require continuous lighting. Lights in the form of navigational beacons will also be required. Lighting of vessels and workspaces will be limited to what is necessary to maintain safe working conditions. Although lighting may attract fishes, and their predators, to the construction area, resulting impacts are expected to be temporary and negligible.

4.2.3.1 Noise

The primary impacts on managed species from noise-producing activities will be avoidance of the area and stress. For species adjacent to pile-driving activities, injury is also possible due to the underwater sound pressure levels. Studies have shown that the sound waves from pile-driving may result in injury or trauma to fish, and other animals, with gas filled cavities, such as swim bladders, lungs, sinuses, and hearing structures (Popper and Hastings 2009). NMFS uses 150 decibels (dB) at a reference pressure of 1 micro Pascal (dB re 1 µPa) as the threshold for behavioral effects on fish species of particular concern, citing that noise levels in excess of 150 dB re 1 µPa root mean square (RMS) can cause temporary behavior changes (startle and stress) that could decrease a fish's ability to avoid predators (NMFS 2018b). The thresholds for the onset of injury to fish are summarized in Table 8.

Table 8: Estimated Sound Levels from Underwater Pile-Driving and Effects Levels for Fish

Pile-driving Activity or Effect Level	Cumulative Sound Exposure Level (SEL_{cum}) (dB re 1 µPa²s)[a]	Root Mean Square Sound Level (dB RMS) (dB re 1 µPA)[b]	Peak Sound Level (dB re 1 µPA)[c]
Estimated Sound Levels from Underwater Pile-Driving			
18-inch-diameter concrete piles at 33 ft (10 m) away	155[a]	166	185
72-inch-diameter CISS piles at 33 ft (10 m) away	182[a]	189	214
Effects Levels			
Injury Onset (all sizes)	--		206
Injury Onset, >2 grams (impulsive/non-impulsive noise)	187/234	--	--
Injury Onset, <2 grams (impulsive, non-impulsive noise)	183/191	--	--
Fish			
Injury Onset (all sizes)	--	--	112 (34)
Injury Onset (>2 grams)	1,172 (357)	--	--
Injury Onset (<2 grams)	2,165 (660)	--	--
Behavioral Effects		13,061 (3,981)	

[a] These measures are single strike sound exposure levels, rather than cumulative levels

[b] The RMS exposure level is the square root of the average squared pressures over the duration of a pulse and represents the effective pressure and intensity produced by a sound source.

[c] Peak sound pressure level is the largest absolute value of instantaneous sound pressure.

Sources: NMFS 2018b.

Pile-driving will be used for installation of 24 anchor piles for the SPM buoy systems and 10 PLEM foundation piles, and will occur in depths of approximately 88.5 to 89.5 ft (27.0 to 27.3 m). The intensity of sound produced during pile-driving is dependent on the material and size of the pile, depth of water, and method of pile- driving. A total of 10, 18-inch (0.5-meter)-diameter piles will be installed using an impact hydraulic hammer for the PLEM foundations and 24, 72-inch (1.8-meter)-diameter piles will be installed using an impact hydraulic hammer for the anchor piles of the SPM buoys. Pile-driving will occur over the 16-week installation timeframe for the SPM buoy systems, and only one pile will be driven at a time. A detailed description of pile-driving and installation required for the Project is included in Appendix A. The zones of influence were calculated using the estimated sound levels for the 72-inch (1.8 m)-diameter proxy piles, which will have a greater sound level impact than the smaller 18-inch (0.5-m)-diameter piles, and are therefore a conservative estimate of Project impacts.

The estimated underwater sound levels associated with pile-driving for the Project are provided in Table 8. If no mitigation is employed, pile-driving for the 72-inch-diameter piles will produce peak sounds above the injury peak threshold from up to 112 ft (34 m) from the source, although impacts may occur at further distances if fish remain in the exposure zone for longer periods of time. Noise-related disturbance resulting in behavioral effects could occur over much greater distances. This estimate represents a conservative, worst-case estimate since some of the piles that will be installed for the Project are of a smaller (18-inch) diameter than the 72-inch-diameter piles used in this analysis. Because pile-driving for the Project will be limited to the 16-week period required for construction of the SPM buoy systems and given the small radii in which the injury thresholds are exceeded for peak sound levels, impacts are expected to be temporary and minor, and will not result in population-level effects.

4.2.4 Hydrostatic Testing of the Pipelines

Once the pipelines are installed they will be cleaned using a cleaning pig and hydrostatically tested in accordance with the U.S. Department of Transportation (USDOT) safety standards at 49 CFR 192 and applicable permit conditions to verify their integrity and ensure their ability to withstand the maximum allowed operating pressure (MAOP). Hydrostatic testing will be conducted in segments and consists of capping the ends of a pipe section, filling the pipelines with water, pressurizing the pipelines, and maintaining that test pressure for a minimum of 8 hours.

Hydrostatic testing of the Proposed Onshore and Inshore Pipelines will use water from municipal sources and will not affect EFH. Hydrostatic testing of two 30-inch-diameter Offshore Pipelines will require approximately 5.0 million gallons (18,827 cubic meters [m^3]) of seawater. During hydrostatic testing, water will be pumped into the pipe and filtered through a mesh screen (typically a 100-micron mesh screen with an opening of 0.0059 inches [0.15 millimeters]) to prevent debris and foreign material from entering the pipelines. The mesh screening is likely to preclude impingement/entrainment of larger and more mobile fish that could withstand the water withdrawal rates; however, ichthyoplankton and some juvenile fish may become entrained on/impinged on the screens. Any organisms entrained into the pipelines during hydrostatic testing are anticipated to be lost prior to discharge. BWTT is investigating the use of biocides, corrosion inhibitors, and environmentally friendly oxygen scavengers for the hydrostatic testing of the Offshore Pipelines. Once more information is available, BWTT will provide supplemental information as required. All discharges will be made in accordance with the terms of the general discharge permit associated with hydrostatic testing operations of this type in the GOM. Hydrostatic testing procedures are further discussed in Volume I.

Ichthyoplankton abundance for the Project area was determined using data provided by NMFS from the summer/fall plankton collections. Data were available along the Texas coast from 1986 to 2014 (GSMFC 2018). Southeast Area Monitoring and Assessment Program (SEAMAP) Station B233 is in close proximity to the location of the Proposed Project and is the only station with a 30-by-30-nm (56-by-56-km) block centered on the Project; therefore, Station B233 was the only station assessed to determine local ichthyoplankton abundance (see Figure 8-6). Based on the bongo net data from the 26 samples taken over 24 years, the average abundance of eggs, multiplied by 3 to account for net extrusion, was 55,645 per million gallons (range 4,461 to 166,255) and the average abundance of larvae was 86,492 per million gallons (range 10,275 to 300,454)

Using the adjusted, conservative egg and larvae densities, the use of 5.0 million gallons (18,827 m^3) of seawater will result in the loss of approximately 278,225 eggs and 432,460 larvae (all taxa combined). The loss of planktonic organisms associated with hydrostatic testing is not believed to result in a reduction in fish or prey species at the population level; therefore, the food web and fisheries populations will incur a negligible adverse impact through water intakes during construction.

4.2.5 Vessel Traffic

Any *Sargassum* directly in the path of oncoming support and transport vessels may be submerged to depths under the vessel, and portions of the mat may be destroyed by passage under the propeller. Although certain species living within the mat breathe air (e.g. sea turtles), they are able to remain underwater for long periods and will not be affected by slightly prolonged submergence. It is likely that *Sargassum* mats in the path of vessels will be gently pushed away from the oncoming vessel due to the pressure of the bow waves and the buoyant nature of the mats. In the unlikely event of destruction of *Sargassum* by the propeller of a vessel, there is the potential to cause a moderate, temporary impact on organisms in that specific mat due to loss of habitat.

Potential spills of construction-related fuels and chemicals can result in adverse impacts to EFH and managed species; the small volume of these spills will be expected to have short-term, localized, negligible impacts similar to those described for an operational spill in Section 2.4.3.

4.3 Operational Impacts

Impacts on EFH and managed species during operation of the Project will generally be limited to presence of the SPM buoy systems, water usage by the VLCCs, port calls by the VLCCs (estimated at 16 per month for the two buoys combined), the sporadic transit of support vessels to and from the offshore port, and the presence of the restricted zones (see Section 14: Navigation, Safety, and Security). Once installed, the pipelines will be buried a minimum of 3 ft (0.9 m) below the seafloor; although the habitats disturbed during construction will take various amounts of time to recover to pre-construction levels, no additional impacts will be incurred during operations. Although not anticipated to occur, a release of petroleum products from the SPM buoy systems or pipelines will also impact EFH and managed species.

4.3.1 Deepwater Port Presence

Once constructed, the SPM buoy systems components will act as an artificial hard structure, allowing sessile invertebrates with a substrate on which to attach. Oil and gas platforms in the GOM have been found to be colonized by a diverse array of microorganisms, algae, and sessile invertebrates including barnacles, oysters, mussels, soft corals (bryozoans, hydroids, and octocorals), sponges, and hard corals (Gallaway and Lewbel 1982). In addition, the SPM buoy systems and components attaching it to the seafloor will likely cause fishes to congregate, creating a locally diverse fish assemblage.

The SPM buoy systems will require operational lighting for 24-hour operations, as well as navigational beacons. Project lighting may cause behavioral changes in nearby organisms, including attraction of predator and prey species, but will have no measurable effect on the quality of the aquatic environment. Because of the hard structure provided for managed species in an area of otherwise ubiquitous soft bottom habitat, the presence of the Project structures is considered a permanent, beneficial impact.

Artificial lighting has been shown to affect the vertical migration of zooplankton, resulting in a reduction in the total vertical movement of copepods (Moore 2000). In addition, lighting from marine structures has been shown to attract a variety of fish species, and offshore oil platforms may provide an enhanced foraging environment for larval, juvenile, and adult fish by attracting prey and providing enough light to locate and capture prey (Marchesan et al. 2005, Keenan et al. 2007).

Although lighting may influence the vertical distribution of zooplankton species in the immediate vicinity of the SPM buoy systems, attract fish species, and enhance predator success, this effect will be highly localized to the immediate vicinity of the platform. Keenan et al. (2007) found that light levels from a manned petroleum development platform in the northern GOM decreased with depth and distance, though light was visible at depths near 33 ft (10 m) and was greatest within about 365 ft of the platform (111 m) near the surface. The lighting and associated impacts from oil and gas platforms will be greater than impacts associated with the SPM buoy systems given the greater size and 24-hour operating workforce required for manned petroleum platforms. Because BWTT plans to shield lighting so that it is directed down from the proposed DWP, the horizontal spreading of light will be limited, and lighting impacts will be focused on the SPM buoy systems and immediately adjacent waters. At this location, light is only anticipated to affect water column EFH in a small radius immediately surrounding the SPM buoy systems. The area of lighting effects will be negligible compared with the total available suitable water column EFH for species in the GOM. Therefore, while lighting may cause behavioral changes, these impacts will be limited to the relatively small area of habitat surrounding the SPM buoy systems and will not result in measurable impacts on overall water column EFH in the GOM. Similarly, the BOEM found impacts due to offshore lighting from oil and gas development on fishes and invertebrates in the GOM to be insignificant due to the limited exposure and/or response expected (BOEM 2017). Given the limited amount of EFH potentially affected by lighting and the limited effects associated with lighting on offshore platforms, BWTT believes that there will be no measurable effects from Project lighting on managed species or their prey.

The primary impacts on managed species in the pelagic environment from noise-producing activities will be avoidance of the area and stress. As the pipelines and seafloor components of the Project will not result in significant noise, no impacts on fishes or invertebrates are anticipated. Noise produced at the SPM buoy systems and VLCCs may result in startle responses to fishes in the pelagic zone or in nearby *Sargassum* mats upon start-up of loading activities; however, this is anticipated to be a temporary impact and fishes making use of the structure will likely become use to the elevated ambient noise that will be present in the area during operations.

The SPM buoys will be attached to the seafloor via anchor chains attached to piles (12 of each per SPM buoy). As the buoys are floating and will move with the waves, currents, and VLCC activity, the anchor chains will also move, resulting in scour in areas where the anchor chains may drag on the seafloor. Although this chain sweep will occur throughout the life of the Project, resulting in continual disturbance of the soft bottom habitat and localized turbidity, the buoys will be limited to a swing circle with a radius of 150 ft (45.7 m). Given the small footprint of the swing circle, the impact to the affected soft bottom habitat is considered negligible.

4.3.2 VLCC Water Use

During operations, VLCCs will require the uptake of seawater in support of ballasting operations, for cooling of engines, pumps and other equipment, and in support of hoteling operations. The water column will be disturbed via the intake and discharge of water, as could any *Sargassum* present in the immediate area of these activities. Soft bottom habitats in the Project vicinity are not expected to be affected by operation of the Project due to the depth of the water in which it will be located. As VLCCs will remain offshore, no impacts on inshore habitats will occur.

The quantity of seawater withdrawals and discharges from the VLCCs will vary depending on the characteristics and size of each tanker. Based on 192 annual port calls (96 per SPM buoy system), the maximum annual seawater withdrawal from VLCCs in port would be 1.04 billion gallons per year. Each VLCC port call is estimated to last approximately 40 hours (6 hours mooring and connection, 28 hours loading, 6 hours disconnect). The withdrawal calculation includes continuous seawater usage for the inert gas deck seal (32 gallons per minute [gpm]; 14.8 million gallons per year) and main engine cooling (4,139 gpm; 811.6 million gallons per year while idling), as well as 12 hours (per port call) of firewater pump usage during mooring and unmooring to cool the hydraulic power pack that controls the mooring equipment (213.1 million gallons per year). The estimated usage is extremely conservative because the approximate loading time and time to connect and disconnect are conservative estimates, and because the use of the hydraulic power pack and associated cooling water is conservative as it is based on mooring at a jetty where six mooring winches are used, while at the DWP only the bow chain stopper will be used to connect the hawser. This volume represents only a small fraction of the amount of water available within the Proposed Project area. Typically, seawater will be drawn in through the lower sea chest, which is located towards the bottom of the vessel, approximately 66 ft (20.1 m) below the water surface for a VLCC based on fully loaded draft. A lesser portion of water withdrawal might occur through the upper sea chests, which are typically located approximately 6 ft (1.8 m) higher than the lower sea chests. The mesh openings, although relatively large (up to 1.4 inches; Coutts, Moore, and Hewitt 2003), will preclude entrainment of most adult pelagic species. Intake velocities typically remain below 0.5 ft/sec (0.2 m/s), which will be low enough to allow adult and juvenile fish to avoid being caught in the inflow of the screens, thus minimizing entrainment effects.

Planktonic organisms will likely be entrained and entrained eggs and larvae are assumed to experience 100 percent mortality. Factors that affect the numbers of individuals that are impinged or entrained include: the distance of the water intake from shore; depth of the water intake; through-screen intake velocity; screen size; pumping capacity; differences in life history; distribution patterns of organisms; quality and availability of habitat; and water quality at the intake (Galveston Bay National Estuary Program 1993, Saila et al. 1997). In addition, the number of eggs and larvae entrained depends on the distribution of eggs and larvae, which is highly variable and related to the distribution of spawning adults (Gledhill and Lyckowski-Shultz 2000).

Plankton surveys have been conducted in the GOM as part of the SEAMAP since 1982. Plankton are collected using both a neuston net and a bongo net. The neuston net has a 3.3- x 6.6-ft (1- x 2-m) mouth opening and a mesh size of 0.04 inch (0.950 millimeter [mm]). This net is fished at a depth of 1.6 ft (0.5 m) along the surface of the water. The bongo net has a 23.6-inch (60-centimeter [cm]) mouth opening and carries 0.01-inch (0.33-mm) mesh netting. The bongo net is fitted with a flowmeter that allows the volume of water filtered during the tow to be measured. This net is fished from approximately 3.28 to 16.4 ft (1 to 5 m) off the bottom to the water's surface and yields a sample from the water column that is integrated over depth.

Ichthyoplankton abundance for the Project area was determined using data provided by NMFS from the summer/fall plankton collections. Data were available along the Texas coast from 1986 to 2014 (GSMFC 2018). SEAMAP Station B233 is in close proximity to the location of the Proposed Project and is the only station with a 30- by 30-nm (56- by 56-km) block centered on the Project; therefore, Station B233 was the only station assessed to determine local ichthyoplankton abundance (see Figure 8-6). Based on the bongo net data from the 26 samples taken over 24 years, the average observed abundances in the sampling area are 7.6 larvae and 4.9 eggs per 3.3 ft^3 (1 m^3). The potential entrainment of fish eggs and larvae was obtained by multiplying densities observed during the SEAMAP studies by three to account for net extrusion. That adjusted density (22.9 larvae and 14.8 eggs per 3.3 ft3 [1 m^3], or 86,492 larvae and 55,911 eggs per million gallons) was multiplied by the estimated annual intake volume of seawater by VLCCs at the DWP (1.04 billion gallons). According to these calculations, approximately 90 million larval fish and 57.9 million fish eggs may be entrained through the VLCC systems or impinged on the intake screens each year. The predominant taxa will include Engraulidae (46.5 percent of the observed abundance), Gobiidae (13.8 percent), dusky flounder (9.4 percent), and Atlantic bumper (6.5 percent). However, these estimates assume that the abundance of larvae observed in the summer/fall will be present during all months of the year, that all larvae observed within the depth-integrated samples will be at the depth of the VLCC water intakes, and that the VLCCs will be present and operating year-round at the DWP. Although eggs are not identified to species/taxa, it is assumed that the eggs present in the Project area will be similar to those taxa identified in the larval dataset. The peak seasonality of most species is during the summer and fall months, and some larvae occur at different depths and/or exhibit vertical migrations throughout the water column, which may result in migration to waters deeper or shallower than the intake structures at various times throughout each 24-hour period (Sogard et al. 1987, Lyczkowski-Shultz and Steen 1991). Therefore, the impingement/entrainment estimates noted above likely overestimate the abundance of larvae that could become entrained within the VLCC systems at the DWP.

Discharges from the VLCC's cooling water systems and inert gas scrubber water are heated discharges, with the temperature of the discharge typically in the range of 18 to 51°F (10 to 28 °C) higher than the temperature of seawater initially withdrawn. These discharges will result in a heated plume that will return to ambient temperatures as it moves away from the tanker. The VLCCs will arrive at the DWP with fully loaded ballast tanks; although ballast water will be discharged during loading, no uptake of seawater for ballast operations will occur at port. Dilution and dispersion will limit the impacts from discharges to be minor and localized impacts. Further, the VLCCs and support vessels will be equipped with water and wastewater treatment systems that will ensure that discharges comply with applicable U.S. Coast Guard and the International Convention for the Prevention of Pollution from Ships requirements for marine vessel discharges, such that they will not result in any significant impacts on the quality of the water column habitat.

Operational intakes/discharges associated with ballasting and engine cooling will temporarily degrade the water column and any *Sargassum* mats in the vicinity of a discharge. Soft bottom habitats in the Project vicinity are not expected to be affected by operation of the SPM buoy systems due to the depth of the water in which it will be located. As discharges will quickly dilute, their overall effect is expected to be permanent but localized and minor.

4.3.3 Support Vessel Mooring and Ancillary Operations

Support vessels will regularly transit from shore to the SPM buoy systems and between the SPM buoy systems and incoming VLCCs. In addition, a minimum of two supply tugs will be onsite at the SPM buoy systems during mooring operations. Although regularly occurring, these vessel transits and tug operations are not anticipated to have any lasting effect on EFH or managed species as they are consistent with ongoing vessel activity in the GOM.

4.3.4 Restricted Operations Zone

The safety zone established for the SPM buoy systems and VLCCs will restrict non-Project related activities within approximately 939 ac (380 ha) of the marine environment which will otherwise be available for fishing opportunities. In addition, the hard structures associated with the SPM buoy systems will provide new structure for epifaunal colonization and fisheries recruitment over time; therefore, as the safety zone will prohibit fishing activities, this new habitat and faunal community will be protected from fishing pressures.

4.3.5 Inadvertent Product Releases

In the event of an oil spill, coastal wetland (including mangrove), water column, *Sargassum*, and other habitat used by fish in the Project area could become contaminated; however, the probability of a major crude oil spill is extremely low. The major elements of the Project that could leak crude oil include: the SPM buoy systems, the Offshore Pipelines from shore to the SPM buoy systems, and the flexible hoses connecting the pipelines to the SPM buoy systems and the SPM buoy systems to the loading tankers. Under the worst-case discharge scenario, a volume of 120,770 barrels of crude oil will be released. Trajectory models were completed for the Proposed Project, to evaluate the coastal impact (how much oil makes landfall), in the event of a worst-case discharge from all the Offshore Components. The trajectory and time that a worst-case scenario spill from either of the SPM buoy systems would remain on the surface varies between about 12 and 18 days seasonally; with the exception of subsurface oil during the fall seasonal trajectory model, oil is projected to remain offshore and not enter inshore areas behind GOM-facing barrier islands. Modeling scenarios were run for all seasons, and only during the fall scenario would any subsurface oil reach inshore areas; otherwise, oil released at the SPM buoy systems would remain offshore. Oil spilled from locations along the Offshore and Inshore Pipelines would be more likely to reach inshore waters and coastal habitats. The results of the trajectory models assume no response efforts were employed and therefore no oil was contained, recovered, or diverted. However, in the actual situation of an unanticipated discharge, BWTT would implement its Tactical Response Plan (see Volume I) and highly-trained tactical response teams would be mobilized immediately to initiate mitigation efforts. In addition, at the SPM connection point during connecting/disconnecting operations, the SPM hoses will connect directly to the manifold on the VLCC, thereby minimizing the potential for crude oil residue releases.

After oil is released into the environment, it undergoes a wide variety of physical, chemical, and biological processes that begin to transform the oil almost immediately. During the first 5 days post-spill, oil typically weathers through evaporation (particularly of the lighter hydrocarbon fractions of the oil); natural dispersion (the breakup of an oil slick into small droplets); dissolution (mixing of the water-soluble components of oil into the water); and emulsification (during which the oil forms a mousse; NOAA 2002). In addition, the formation of tarballs (small patches of oil that persist for long distances) occurs within the first days to weeks post-release (NOAA 2002).

Most seagrass beds in the Project area are protected from offshore spills by San Jose Island and other barrier islands; however, in the event of a nearshore or inland spill they could be damaged. Because seagrass beds remain submerged, they will not likely be fouled by a surface oil slick but could be damaged by the reduced light penetration and oxygen depletion if weather conditions resulted in oil remaining over seagrass beds for an extended period. Oil may also mix in the water column or with nearshore sediments, which are then transported to seagrass beds, resulting in contamination of seagrass tissues (Deepwater Horizon [DWH] Natural Resource Damage Assessment [NRDA] Trustees 2016). Contamination as well as light and oxygen depletion may reduce productivity, reduce tolerance to other stress factors, reduce reproductive success, and result in potential population-level impacts on seagrasses (Runcie et al. 2015, Martin et al. 2015). Because the worst-case-scenario spill will occur offshore and oil reaching nearshore environments will be weathered, significant adverse impacts on SAV are unlikely.

Sediment may become contaminated by oil in the event of a spill when oil mixes with nearshore sediments, and is then transported away from coastlines; via direct contact with oil droplets; or via transport of oil particles from the surface slick to the seafloor via marine snow (DWH NRDA Trustees 2016, Hastings et al. 2016). Hard bottom habitats within the GOM were exposed to oil and dispersants during the DWH oil spill when, during the response effort, impacts occurred after dispersants were applied to floating oil which resulted in oil and dispersants sinking from the surface to the seafloor (USGS 2018). Further, much of the offshore crude oil proximal to the Macondo well was deposited because of entrainment with the drilling mud for the well, which facilitated the oil sinking (NOAA 2016). During the DWH oil spill, it is estimated that more than 770 sq mi (2,000 sq km) of deep-sea benthic hard- and soft bottom habitats were injured (DWH NRDA Trustees 2016); however, the Bluewater SPM Project's worst-case scenario spill will be much less by comparison. Adverse impacts on soft bottom habitat in the event of the worst-case scenario spill will be localized, and over time toxic particles will be weathered and removed from affected habitats. Because offshore hard bottom habitats and artificial reefs are located at depths greater than 5 m, oil concentrations in the water column will be diluted below acute toxicity levels and any impacts will be recovered quickly (NOAA 1992). Therefore, the risk of impacts on these habitats in the event of a spill is low.

Sargassum floating in areas of surface oiling may become fouled. Floating oil tends to collect and drift in drift lines along the same convergent currents that transport *Sargassum*; therefore, oil may become concentrated in the same areas as *Sargassum*, resulting in greater exposure (DWH NRDA Trustees 2016). Following the DWH oil spill, the surface area of *Sargassum* habitat was shown to be reduced, resulting in a loss of *Sargassum* habitat (DWH NRDA Trustees 2016). Oiling of *Sargassum* also exposes the organisms using that habitat to higher concentrations of contaminants and (Powers et al. 2013).

Further, *Sargassum* impacted by oil and dispersants will sink from the surface to the seafloor within 24 to 48 hours (Powers et al. 2013). This leaves organisms dependent upon these floating mats vulnerable to predators and without a source of food. In addition, this sinking allows oil to migrate to mesopelagic and benthic communities (NOAA 2018, Powers et al. 2013). As the *Sargassum* begins to sink through the water column, oil and dispersants are dissolved and significantly reduce the amount of oxygen within the water column. This leads to indirect injury and mortality to aquatic organisms as well as benthic organisms due to hypoxic conditions within the water column and on the seafloor as the mats decompose (Powers et al 2013, Fisher et al. 2016). Although the impacts of a crude oil spill will be adverse, they will be localized and temporary and will not significantly impact EFH.

Oil spills in shallow or confined water (such as enclosed freshwater or brackish ponds) may result in the mortality of large numbers of juvenile and adult fish; however, in open water impacts on fish are typically limited and juvenile and adult fish are mobile and able to minimize exposure to oil (NOAA-ORR 2019). Early life stages of fish are typically more sensitive to oil toxicity than adults (DWH NRDA Trustees 2016, National Research Council 2003). Contact with surface oil or with dissolved hydrocarbons can result in the mortality of fish embryos and larvae (Carls and Rice 1990). As summarized by the DWH NRDA Trustees, toxicity studies conducted after the DWH spill found that the surface mixture of water and oil is toxic to early life stages of fish and invertebrates in the GOM, and that exposure to ultraviolet light increases toxicity (2016).

Sub-lethal exposure of eggs is associated with decreased larval size and yolk reserves, which may reduce larval survival (Carls and Rice 1990). Other sub-lethal effects on fish may include reduced growth, immune suppression, developmental effects (including impaired cardiovascular development), and reduced swim performance (see summaries in DWH NRDA Trustees 2016 and National Research Council 2003). These impacts can reduce an individual's survivorship and reproduction.

In the event of an operational spill resulting from the Project, eggs and larvae in the immediate vicinity of the spill will likely be subject to oil-induced mortality. Mortality rates for ichthyoplankton are naturally high, and therefore the localized mortality associated with a spill is not expected to have population-level effects. Following the DWH oil spill, analysis of long-term population data did not identify significant changes in fishery populations (DWH NRDA Trustees 2016). Given the scale of the worst-case scenario spill associated with the Project will be small in comparison with the DWH spill, significant, population- level effects are not anticipated. Pelagic and demersal fish are unlikely to be exposed to concentrations sufficient to result in mortality, although fish within contaminated habitats could be subject to sub-lethal, toxic effects. Therefore, the localized, short-term, adverse impact of the worst-case scenario oil spill on managed species will not be significant.

4.4 Decommissioning Impacts

At the end of its useful life (50 years), the Project will be decommissioned. Decommissioning of the proposed Onshore and Inshore Pipelines will consist of purging the pipe of crude oil liquids and filling them with water. Similar to hydrostatic testing, as described in 3.4.2.4, ichthyoplankton present within any seawater used for flooding will be lost, but this loss is not believed to result in a reduction in fish or prey species at the population level and the impact will therefore be negligible. The abandonment of the Inshore Pipelines will avoid the EFH impacts that will be associated with their removal.

The Offshore Pipelines (from a point about 3,900 ft [1,188.7 m] offshore) will be removed, as will the SPM buoy systems. Decommissioning of the Offshore Pipelines will consist of divers to cut sections of the pipe and a heavy lift vessel to retrieve the cut segments from the seafloor for offsite disposal. The SPM buoy systems will be removed using divers and offshore cranes. The Offshore Components will be generally be disconnected and hauled to shore for proper disposal. The anchor piles will either be removed by vibration or cutting the piles 15 ft (4.6 m) below the mudline. The removal by vibration involves utilizing a vibrating hammer to loosen and remove the pile, as opposed to the impact hammer that will drive in piles during construction. A crane will be attached to the top of the pile and will apply tension to retrieve the piling at the surface. Removal by cutting, which is standard practice in the GOM, involves the jetting and removal of the seafloor materials around each pile to facilitate the cut; deeper portions of the pile are left in place, buried below the seafloor. Either removal option will result in increased turbidity and sedimentation adjacent to the activity; however, given the small amount of area impacted and the duration of impacts (approximately 25 days for removal of the anchor piles), these impacts will be minor and temporary.

Decommissioning of the SPM buoy systems and Offshore Pipelines is expected to disturb both open water and soft bottom EFH, as well as transient areas of *Sargassum*. The removal of these Project Components will cause a temporary increase in turbidity to both the lower water column and the seafloor. Further, removal of the hardbottom components in the offshore environment will result in loss of the epifaunal community that had likely colonized the structures. Once removed, the decrease in this prey base and the loss of structure will likely result in any congregated mobile species dispersing from the area as it returns to its pre-construction state, resulting in a permanent and adverse, but minor impact.

Regulated intakes/discharges from vessels and vessel traffic may affect the upper water column and nearby *Sargassum* mats and assemblages. Noise will be localized where Project Components are removed; no explosives will be used. Adverse impacts on the aquatic environment from removal of the Project Components will be similar to those discussed for construction and are considered minor and temporary.

5 Cumulative Impacts

Cumulative effects generally refer to impacts that are additive or synergistic in nature and result from the construction of multiple actions in the same vicinity and time frame. Cumulative impacts can result from individually minor, but collectively significant actions, taking place over a period of time. In general, small-scale projects with minimal impacts of short duration do not significantly contribute to cumulative impacts.

Activities that could impact EFH in the western GOM include offshore oil and gas terminals and exploration and production; onshore gas and oil terminals, waterway improvement projects, the two Desalination Projects, and marine traffic associated with the oil and gas industry, as well as recreation. A detailed list of projects that could contribute to cumulative impacts on EFH in Table 9. Onshore activities are not included, since, although discharges and runoff from coastal facilities could affect managed species, it is anticipated that these activities will be conducted in accordance with applicable permits, such that impacts are adequately minimized. Impacts on EFH associated with these activities will be associated with direct modification, disturbance, or loss of EFH within the Project footprints, degradation of water quality from turbidity and sediment, inadvertent spills and marine debris, as well as reduction of habitat, vessel traffic, and noise.

Channel maintenance and dredging activities, as well as the minor coastal improvement projects, have the potential to affect water and habitat quality in the immediate vicinity of the projects. These projects are generally short-term and their effects (turbidity and sedimentation, with the potential for limited habitat loss for new construction) will typically be limited to the area where dredging/construction takes place. As a result, the cumulative effects of construction of the Project, when considered with these projects will be negligible.

Installation of the Proposed Project will avoid impacts on SAV, but will temporarily impact 29.24 ac (11.83 ha) of wetland habitat; other nearshore projects could result in similar impacts, or could result in additional impacts on SAV and wetlands. The project will also permanently impact 4.81 ac (1.95 ha) of wetlands and WOUS, which will be mitigated for according to USACE permit requirements. However, any impacts on these habitats will be mitigated in accordance with applicable USACE and NMFS requirements. As a result, the cumulative effects on the total available area of SAV and wetland habitat, when considered with other projects, will not be significant.

Offshore oil and gas terminals and exploration activities can include installation/removal of mooring platforms and laying of pipelines and associated anchoring activities, service vessel operations, supporting infrastructure discharges, and oil spills. The primary cumulative effect from these activities will be the installation of platforms and other permanent structures within the GOM; these structures provide create vertical substrate within previously soft bottom habitat that will function as hard bottom EFH, similar to the impact expected from placement of the structures associated with the proposed SPM buoy systems. Overall design of the SPM buoy systems will impact a similar area of soft bottom EFH as other types of offshore oil and gas infrastructure, possibly less given the nominal seafloor footprint of the Proposed Project. Further, in addition to improvements to the Corpus Christi Ship Channel, the Port of Corpus Christi Authority is also proposing to conduct ecosystem restoration to protected endangered species, wetlands, and seagrasses, which will result in the creation of EFH. These impacts are considered to have permanent beneficial impacts on managed species, but given the size of the Western Planning Area, the overall benefit of habitat creation from these projects is anticipated to be minor.

Table 9: Projects Potentially Contributing to Impacts on EFH

Project (Owner)	Location within Project Area	Estimated Timeframe (Construction / Operation)	Potential Impact Area	Closest Known Distance to Project (mi/km)	Vessel Transits[a] (Construction / Operation)	Description
Annova LNG Brownsville	Brownsville, TX	2020 / 2024	550ac	127 / 205	288 / 250	The applicants are proposing to construct and operate a liquefaction and liquefied natural gas (LNG) export terminal to include six LNG trains, two 160,000 m^3 LNG storage tanks, and a marine berth. The project will be located along the Brownsville Ship Channel in Cameron County, Texas.
Corpus Christi LNG (Cheniere)	Corpus Christi, TX	Under construction / 2021	2,000 ac	3 / 5	Unknown / 500	Corpus Christi LNG, LLC is currently constructing an LNG export terminal in San Patricio County, Texas, along the northeast side of Corpus Christi Bay. Upon completion the terminal will include three LNG trains, three 160,000-m^3 LNG storage tanks, and two LNG berthing docks (CP12-507). Also, currently under Federal Energy Regulatory Commission (FERC) review is a proposal for two additional LNG trains, one additional LNG storage tank, an about 22-mile-long natural gas pipeline with one compressor station (PF15-26).
Freeport LNG Dev. (Cheniere)	Freeport, TX	Under construction / 2020	661.4 ac	107 / 172	Between 600 and 940 / an additional 150 (incremental increase for anticipated upgrades)	FLNG Expansion and FLNG LNG, LLC are currently constructing LNG, storage, and export facilities at the existing Freeport LNG Terminal on Quintana Island in Brazoria County, Texas. The terminal was originally approved as an import facility. Also, currently under FERC review is a proposal for one additional LNG train and additional supporting infrastructure, utility, and auxiliary facilities, as well as an increase in the total LNG production from the previously authorized 13 MTPA to 15.3 MTPA.
Golden Pass (ExxonMobile)	Sabine Pass, TX	2019 / 2024	919 ac	208 / 335	7,300 / 200[b]	Expansion of the existing terminal (located on 447 ac) near Sabine Pass, Jefferson County, Texas, on the western shore of the Sabine Pass Channel. Upon completion the terminal will include three LNG trains; a 2.6-mile-long, 24- inch diameter pipeline; three compressor stations; and modifications to existing facilities to allow for bi-directional flow (CP14-517).
Port Arthur LNG (Port Arthur LNG, LLC and PALNG Common Facilities Company, LLC)	Port Arthur, TX	2019 / 2023	890 ac	208 / 335	2,920 / 360	The applicants are proposing to construct an LNG export terminal to include two LNG trains, three 160,000-m^3 LNG storage tanks, a natural gas liquids (NGL) and refrigerant storage area, truck loading/unloading facility, and two LNG vessel berths. The project will be on the west side of the Sabine-Neches Waterway in Jefferson County, Texas.
Rio Grande LNG (Rio Grande LNG and Rio Bravo Pipeline)	Brownsville, TX	2019 / 2023	1,137 ac	126 / 203	1,760 / 624	The applicant is proposing to construct an LNG export terminal to include six liquefaction trains, a marine berth capable of receiving two LNG carriers at a time, and four 180,000 m^3 LNG storage tanks. The project will be located along the Brownsville Ship Channel in Cameron County, Texas.
Texas LNG Brownsville (Texas LNG)	Brownsville, TX	2020 / 2024	311.5 ac	125 / 200	218 / 150	The applicant is proposing to construct an LNG export terminal to include two LNG trains, two 210,000 m^3 LNG storage tanks, and a marine berth to accommodate one LNG vessel. The project will be located along the Brownsville Ship Channel in Cameron County, Texas.

Table 9: Projects Potentially Contributing to Impacts on EFH

Project (Owner)	Location within Project Area	Estimated Timeframe (Construction / Operation)	Potential Impact Area	Closest Known Distance to Project (mi/km)	Vessel Transits[a] (Construction / Operation)	Description
Improvement of the confluence of Corpus Christi Ship Channel and the Aransas Pass Channel (Port Aransas Marina Association)	Port Aransas, TX	Unknown	70 linear foot extension; 0.26 ac (of fill)	0.3 / 0.5	Unknown	The Port Aransas Marina Association is seeking authorization to install a sheetpile breakwater extension at the confluence of the Corpus Christi Ship Channel (CCSC) and the Aransas Pass Channel (SWG-1998-02486).
Corpus Christi Ship Channel Improvement Project (Port of Corpus Christi Authority)	Corpus Christi area of Texas	Under construction / Unknown	widen 530 ft up to 33-ft increase in depth	4 / 6	Unknown	The Port of Corpus Christi Authority (POCC) is constructing ecosystem restoration features along the CCSC. The POCC is also seeking authorization to widen and deepen the channel and add Barge Shelves across the bay.
Lake Padre Development (Unknown)	Padre Island (north), TX	Under construction / Unknown	100 ac	19 /30	Unknown	Expansion of Lake Padre and development of a 100-ac stretch.
Padre Isles (water oriented, recreational community) (Padre Isles Property Owners Association)	Padre Island (north), TX	Under construction / Unknown	3,700 ac[c]	21 / 34	None expected	Ongoing development of a water oriented, recreational community on North Padre Island. About 3,550 lots have not been developed.
Desalination Plant (Port of Corpus Christi Authority and City of Corpus Christi)	Port Aransas, TX	Unknown	33 ac	0.0 / 0.0	Unknown	The Port of Corpus Christi Authority filed a permit in June 2018 on behalf of the City of Corpus Christi seeking approval to construct and operate a desalination plant on Harbor Island. The plant would have the capacity to process 50-million gallons of water per day.
Texas Gulf Terminals Project (Texas Gulf Terminals, Inc.)	Gulf of Mexico, Nueces and Kleberg Counties, TX	Unknown[d]	316.5 ac	26 / 42	1,039	Texas Gulf Terminals, Inc. is proposing to construct and operate and offshore crude oil facility in the GOM. The facility would include an offshore mooring point off the coast of North Padre Island and an onshore storage facility which would be connected via 26.7 mi (43.0 km) of offshore and onshore pipelines.
Improvements to Holly Road (Texas Department of Transportation [TxDOT])	Nueces County, TX	2019	0.75 mi	12 / 20	None expected	TxDOT is planning to make improvements to Holly Road between State Highway 286 and Greenwood Drive. The improvements would include two additional travel lanes, a four-lane curb and gutter facility with a raised median, sidewalks, and a bicycle lane.
State Highway 200 (TxDOT)	San Patricio County, TX	2019	1.98 mi	3 / 5	None expected	TxDOT is planning to build a new highway to address traffic problems in the City of Ingleside. Upon completion State Highway 200 would include four 12-ft wide travel lanes and two 10-ft wide shoulders.

Table 9: Projects Potentially Contributing to Impacts on EFH

Project (Owner)	Location within Project Area	Estimated Timeframe (Construction / Operation)	Potential Impact Area	Closest Known Distance to Project (mi/km)	Vessel Transits[a] (Construction / Operation)	Description
Plastics Plant (Gulf Coast Growth Ventures)	San Patricio County, TX	Unknown	1,300 ac	0.8 / 0.1	Unknown	Gulf Coast Growth Ventures is proposing to construct and operate a plastics plant on 1,300 ac near Gregory, TX.
Desalination Plant (Seven Seas Water)	Port Aransas, TX	Unknown	10 ac	0.0 / 0.0	Unknown	Seven Seas Water is proposing to construct and operate a desalination plant on a 10-ac site on Harbor Island. The plant would have the capacity to process 10-million gallons of water per day.
SPOT Terminal Services Project (SPOT Terminal Services LLC)	Gulf of Mexico, Brazoria and Harris Counties, TX	2020 / 2022	1,130 ac	100 / 161	Unknown / 1,195	SPOT Terminal Services is proposing to construct and operate and offshore crude oil facility in the GOM. The facility would include one platform and two offshore mooring points off the coast of Brazoria County and an onshore storage facility which would be connected via 40.8 nautical mi (75.6 m) of the Offshore Pipelines.
Texas COLT Project (Texas COLT LLC)	Gulf of Mexico, Brazoria, Harris, and Galveston Counties, TX	2020 / 2022	Unknown	88 / 142	Unknown / 828	Texas COLT is proposing to construct and operate and offshore crude oil facility in the GOM. The facility would include a manned platform and a single offshore mooring buoy off the coast of Brazoria County and an onshore storage facility which would be connected via 27.8 nautical mi (51.5 m) of the Offshore Pipelines.
Oil and Gas Exploration & Production (Various)	Western Planning Area	2017 / 2022	75,400,000 ac[e]	0.0[f] / 0.0	Between 1,720 and 21,640[g]	BOEM's lease program proposes 10 lease sales over a five-year period. Activities associated with these leases could include seismic surveys, drilling oil, and natural gas exploration and installation of infrastructure such as on and offshore platforms and pipelines, as well as marine traffic to transportation of equipment and people and associated with support services.
Recreation, cruise ships, etc. (Various)	Various Ports in TX	ongoing	unknown	0.9[h] / 1.4	Unknown	Nearby ports provide access to the GOM associated with mineral exploration, cruises, recreational fishing, diving, and military training. Established shipping lanes govern the movement of these vessels (33 CFR 166), the closest of which is the Brazos Santiago Pass to Aransas Pass Safety Fairway.

Table 9: Projects Potentially Contributing to Impacts on EFH

Project (Owner)	Location within Project Area	Estimated Timeframe (Construction / Operation)	Potential Impact Area	Closest Known Distance to Project (mi/km)	Vessel Transits[a] (Construction / Operation)	Description

Note: Sources for tabular information are provided in Section 16: Cumulative Impacts.

a. Construction transits are based on the total number of vessel transits (one-way) required for the entire construction period. Operation transits are the expected number of vessel transits each year the project is in operation, including support vessels where known.

b. These vessel transits were authorized under the initial import terminal order (FERC docket CP04-386-000), the currently approved but not yet constructed project (FERC docket CP14-517) will not result in an increase in transits during operation.

c. Approximate size of the community, which includes previously and yet to be developed areas.

d. Texas Gulf Terminal, Inc. submitted its application to the MARAD in July of 2018 and anticipates construction would commence 18-months after receiving a permit.

e. BOEM's preferred alternative is a lease program for any inactive lease block, as depicted in Figure 16-1, such that future activity associated with oil and gas exploration and production could occur throughout the Western, Central, and Eastern Planning Areas, with exception of those blocks within the marine sanctuaries and as noted in BOEM 2017.

f. This is the total area available for lease as of March 2019 (DOI 2019).

g. This estimate is for transits throughout the GOM, so is not representative of activities exclusively within the Western Planning Area. In total this increase in transits represents a less than 2 percent increase in traffic in the GOM.

h. Recreational activities, in particular diving, occur with the marine sanctuaries depicted in Figure 16-1. Recreational activities including fishing, boating, and diving also occur throughout the near and offshore waters within the Project area.

Ongoing marine traffic and offshore oil and gas terminals and exploration activities produce noise in the Project area. Pile-driving will be the greatest source of noise associated with the Project; given the temporary nature of pile-driving impacts, and the distance from other projects, construction is not expected to contribute to a significant cumulative impact on noise with other activities in the GOM. Further, the contribution of the Project to cumulative vessel traffic is consistent with existing uses of the GOM and the incremental contribution of the Project during operations to the noise environment will be negligible.

Oil and gas terminals and exploration activities in the Western Planning Area have the potential for inadvertent releases of petroleum products, which could result in impacts on EFH similar to those described above for the Project. In the event of a spill, operators will be required to implement oil spill response procedures in accordance with applicable federal regulations to remove oil from the environment and mitigate impacts. Given the low probability of a spill associated with the Proposed Project, and the implementation of federal regulations, the potential for cumulative impacts due to inadvertent releases of petroleum is unlikely and will be minor.

Given the distance between the Proposed Project and other projects identified in Table 9, and the impact avoidance and minimization measures described above, there is little potential for overlap of impacts between these projects. Further, the localized nature of impacts on EFH suggests that the incremental contribution of the Proposed Project to cumulative impacts on EFH will be permanent but negligible.

6 Mitigation of Proposed Project Impacts

BWTT has developed the Proposed Project in a manner that minimizes impacts on all habitat and species to the extent possible. In addition to siting the SPM buoy systems and pipelines in soft bottom habitats which, although designated as EFH, are the most prevalent and least sensitive habitat in the GOM, BWTT is integrating the following best management practices into its Proposed Project:

BWTT will use HDD construction methods for the coastal landfall approach of the pipelines to San Jose Island and at all crossings of inshore waters, which will avoid sensitive wetland communities along the shoreline, SAV, and oyster beds.

- The SPM buoy systems and associated pipelines are sited well away from sensitive live/hard bottom habitat.
- BWTT has designed the Project to have the smallest footprint practicable to minimize impacts on marine resources.
- Construction and support vessels under the purview of BWTT will be required to Notices to Lessees No. 2015-BSEE-G03, *Marine Trash and Debris Awareness and Elimination*, which will minimize the potential for lost debris to degrade EFH.
- Land-based fabrication of the offshore SPM buoy systems, to minimize the timing and disturbance associated with offshore installation.
- A Project-specific spill response plan will be developed prior to construction, which will identify measures to prevent, contain, and clean up any inadvertent spills from construction and support vessels.

In addition, pile-driving associated with installation of the SPM buoy systems could result in behavioral effects on fish. BWTT will consult with NMFS to determine if any mitigation is required to protect offshore fishes from underwater pile-driving noise. While identification of mitigation is not final, measures may include:

- Use of the lowest energy hammer feasible for installation of the piles.
- The use of “soft starts,” using a lower hammer energy level to begin pile-driving, which allows sensitive species to avoid the vicinity prior to peak pile-driving noise.
- The use of a bubble curtain or other sound damping system to minimize propagation of pile- driving noise.

7 References

Brooks, Allen R.; Purgy, Carla N.; Bell, Susan S.; Sulak, Kenneth J. 2006. The Benthic Community of the Eastern U.S. Continental Shelf: A literature Synopsis of Benthic Faunal Resources. Continental Shelf Research. Volume 26, Issue 6. Pages 681-824. Available online at: https://www.sciencedirect.com/science/article/pii/S0278434306000409. Accessed February 2019.

Buchman, Michael F. 2008. Screening Quick Reference Tables (SQuiRTs). National Oceanic and Atmospheric Administration. Available at: https://repository.library.noaa.gov/view/noaa/9327. Accessed April 2019.

Bureau of Ocean Energy Management (BOEM). 2017. Gulf of Mexico OCS Region. Volume 1. Oil and Gas Leasing Program: 2017-2022. Final Programmatic Environmental Impact Statement. U.S. Department of the Interior. Available online at: https://www.boem.gov/BOEM-EIS-2017-009-v1/. Accessed February 2019.

Bureau of Ocean Energy Management (BOEM). 2019. Geographic Mapping Data in Digital Format. Available online: https://www.data.boem.gov/Main/Mapping.aspx. Accessed March 2019.

Byrnes et. Al. 2017. Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill. Volume 1. Water Quality, Sediments, Sediment Contaminants, Oil and Gas Seeps, Coastal Habitats, Offshore Plankton and Benthos, and Shellfish. Edited by C. Herb Ward.

Carls, M.G. and S. D. Rice. 1990. Abnormal Development and Growth Reductions of Pollock Theragra chalcogramma Embryos Exposed to Water-Soluble Fractions of Oil. Fishery Bulletin 88(1). Available at: https://spo.nmfs.noaa.gov/content/abnormal-development-and-growth-reductions-pollock-theragra-chalcogramma-embryos-exposed. Accessed March 2019.

Castro, Jose I. 1983. The sharks of North American waters. Texas A&M University Press, College Station, Texas 180 pp/

Castro, Jose I. 1996. Biology of the Blacktip Shark *Carcharhinus Limbatus* Off the Southeastern United States. Bulletin of Marine Science 59(3) 508-522. Available at: http://docserver.ingentaconnect.com/deliver/connect/umrsmas/00074977/v59n3/s5.pdf?expires=1552061180&id=0000&titleid=10983&checksum=028C7E6A6211D78ED1D10E778F9AE26F. Accessed February 2019.

Coutts, A, K. Moore, C. Hewitt. 2003. Ships' sea-chests: an overlooked transfer mechanism for non-indigenous marine species? Baseline/Marine Pollution Bulletin. Vol 46, 1504-1515.

Darnell, Rezneat. 2015. The American Sea. A Natural History of the Gulf of Mexico. Harte Research Institute for Gulf of Mexico Studies Series. Sponsored by the Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi.

Deepwater Horizon Natural Resource Damage Assessment Trustees (DWH NRDA Trustees). 2016. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan (PDARP) and Final Programmatic Environmental Impact Statement. Online at: http://www.gulfspillrestoration.noaa.gov/sites/default/files/wp-content/uploads/Front-Matter-and-Chapter-1_Introduction-and-Executive-Summary_508.pdf. Accessed February 2019.

Fisher, C.R., P.A. Montagna, and T.T. Sutton. 2016. How did the Deepwater Horizon oil spill impact deep-sea ecosystems? Oceanography 29(3):182–195, http://dx.doi.org/10.5670/oceanog.2016.82. Available at: https://tos.org/oceanography/assets/docs/29-3_fisher.pdf. Accessed March 2019.

Florida Fish and Wildlife Conservation Commission (FFWCC). 2019. GIS and Mapping Data: Available at: http://geodata.myfwc.com/pages/downloads. Accessed February 2019.

Gallaway, B. and G. Lewbel. 1982. The Ecology of Petroleum Platforms in the Northwestern Gulf of Mexico: A Community Profile. Bureau of Land Management Gulf of Mexico OCS Regional Office– Open File Report 82-03. Available online at: https://www.nwrc.usgs.gov/techrpt/82-27text.pdf. Accessed March 2019.

Galveston Bay National Estuary Program. 1993. Non-Fishing Human Induced Mortality of Fisheries Resources in Galveston Bay. Publication GBNEP-29, May.

Gledhill, Christopher T., & Lyczkowski-Shultz, Joanne. 2000. Indices of larval king mackerel (Scomberomorus cavalla) abundance in the Gulf of Mexico for use in population assessments. Southeast Fisheries Science Center. National Marine Fisheries Service, NOAA. Pages 684- 691Geraci, J. R. 1990. Physiologic and toxic effects on cetaceans. In: Sea Mammals and Oil: Confronting the Risks. J. R. Geraci, and D. J. St. Aubin [eds.]. Academic Press. San Diego, CA, pp. 167-197.

Gulf of Mexico Fishery Management Council (GMFMC). 1996. Amendment 8 to the Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico United States Waters. National Oceanic and Atmospheric Administration Document NA57FC0004. Available online at: http://sero.nmfs.noaa.gov/sustainable_fisheries/gulf_fisheries/reef_fish/archives/reef_fish_amend_8_june_1995.pdf. Accessed February 2019

Gulf of Mexico Fishery Management Council (GMFMC). 2004. Final Environmental Impact Statement for the Generic Essential Fish HabitatAmendment to the following fishery management plans of the Gulf of Mexico (GOM): Shrimp Fishery of the Gulf of Mexico, Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf of Mexico, Stone Crab Fishery of the Gulf of Mexico, Coral and Coral Reef Fishery of the Gulf of Mexico, Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic. March 2004. National Oceanic and Atmospheric Document NA17FC1052. Available online at: https://gulfcouncil.org/wp-content/uploads/March-2004-Final-EFH-EIS.pdf. Accessed January 2019.

Gulf of Mexico Fishery Management Council (GMFMC). 2016. Final Report 5-Year Review of Essential Fish Habitat Requirements. December 2016. Available online at: http://gulfcouncil.org/wp-content/uploads/EFH-5-Year-Revew-plus-App-A-and- B_Final_12-2016.pdf. Accessed January 2019.

Gulf States Marine Fisheries Commission (GSMFC). 2018. Southeast Area Monitoring and Assessment Program. Dataset provide by Glenn Zapfe (NOAA) to Jennifer McCoy (EDGE Engineering and Science) on April 29, 2018.

Handley, L., Altsman, D., and DeMay, R. 2007. Seagrass Status and Trends in the Northern Gulf of Mexico: 1940-2002. U.S. Geological Survey. Scientific Investigations Report 2006-5287. Available online at: https://pubs.usgs.gov/sir/2006/5287/. Accessed February 2019.

Hastings, D., P. Schwing, G. Brooks, R. Larson, J. Moford, T. Roeder, K. Quinn, T. Bartlett, I. Romero, D. Hollander. 2016. Changes in sediment redox conditions following the BP DWH blowout event. Deep Sea Research Part II: Topical Studies in Oceanography. 129 (167-178). Available at: https://www.researchgate.net/publication/270007198_Changes_in_sediment_redox_conditions_following_the_BP_DWH_blowout_event/download. Accessed February 2019.

Keenan, S., M. Benfield, and J. Blackburn. 2007. Importance of the artificial light field around offshore petroleum platforms for the associated fish community. Marine Ecology Progress Series. 331: 219-231. Available at: https://www.researchgate.net/publication/250218934_Importance_of_the_artificial_light_field_around_offshore_petroleum_platforms_for_the_associated_fish_community/download. Accessed March 2019.

Kilgen, Ronald H. and Dugas, Ronald J. 1989. The Ecology of Oyster Reefs on the Northern Gulf of Mexico: An Open File Report. U.S. Department of the Interior. Fish and Wildlife Service. Minerals Management Service. NWRC Open File Report 89-03. Available at: https://www.boem.gov/ESPIS/3/3757.pdf. Accessed February 2019.

Louisiana Department of Wildlife and Fisheries. 2015. Louisiana Shrimp Fishery Management Plan. Available online at: http://www.wlf.louisiana.gov/sites/default/files/pdf/page/37762-fishery- management-plans-marine/shrimpfmp7-27-15.pdf. Accessed February 2019.

Lyczkowski-Shultz, J., and J. Steen Jr., 1991. Diel Vertical Distribution of Red Drum Sciaenops ocellatus Larvae in the Northcentral Gulf of Mexico. Fishery Bulletin: Vol 89 (631-641).

Marchesan, M., S. Maurizio, L. Verginella, E. Ferrero 2005. Behavioral effects of artificial light on fish species of commercial interest. Fisheries Research 73 (1-2). P. 171-185. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.620.2272&rep=rep1&type=pdf. Accessed March 2019.

Martin, C. W., Hollis, L. O., and Turner, R. E. 2015. Effects of Oil-Contaminated Sediments on Submerged Vegetation: An Experimental Assessment of Ruppia maritima, PLoS ONE, 10(10). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0138797. Accessed March 2019.

Matlock, Gary C. 1990. The Life History of Red Drum. Texas Parks and Wildlife Department, Texas A&M University, College Station, Texas. 29 Pages. Available at: https://www.researchgate.net/publication/252321167_The_life_history_of_red_drum/download. Accessed February 2019.

Moore, M.V., S.M. Pierce, H.M. Walsh, SK.K. Kavalvik, J.D. Lim. 2000. Urban light pollution alters the diel vertical migration of Daphnia. Verhandlungen des Internationalen Verein Limnologie. 27: 779–82. Available at: http://academics.wellesley.edu/Biology/Faculty/Mmoore/Content/Moore_2000.pdf. Accessed March 2019.

National Marine Fisheries Service (NMFS). 2006. Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, NMFS, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Available online at: https://www.fisheries.noaa.gov/management-plan/consolidated-atlantic- highly-migratory-species-management-plan. Accessed February 2019.

National Marine Fisheries Service (NMFS). 2010. Amendment 3 to the 2006 Consolidated HMS Fishery Management Plan:Atlantic Shark Management Measures. National Oceanic and Atmospheric Administration, NMFS Office of Sustainable Fisheries Highly Migratory Species Management Division. Available online at: https://www.fisheries.noaa.gov/action/amendment-3-2006-consolidated-hms-fishery- management-plan-atlantic-shark-management-measures. Accessed February 2019.

National Marine Fisheries Service (NMFS). 2015. Essential Fish Habitat – Gulf of Mexico. National Oceanicand Atmospheric Administration, NMFS Southeast Region, Habitat Conservation Division. Availableonline: http://sero.nmfs.noaa.gov/habitat_conservation/documents/efh_gmfmc_ver082015.pdf. Accessed January 2019.

National Marine Fisheries Service (NMFS). 2016. 5-Years Review of Essential Fish Habitat Requirements. 2010 through 2015. Available T: https://www.fisheries.noaa.gov/resource/document/essential-fish-habitat-5-year-review-summary-report-2010-through-2015. Accessed May 2019.

National Marine Fisheries Service (NMFS). 2017. Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan: Essential Fish Habitat and Environmental Assessment. National Oceanic and Atmospheric Administration. Office of Sustainable Fisheries. Atlantic Highly Migratory Species Management Division. Available online at: https://www.fisheries.noaa.gov/action/amendment-10-2006-consolidated-hms-fishery-management-plan-essential-fish-habitat.

National Marine Fisheries Service (NMFS). 2018a. NOAA Fisheries Fact Sheet. Bull Shark. National Oceanicand Atmospheric Administration NMFS Northeast Fisheries Science Center. Accessed online at https://www.nefsc.noaa.gov/nefsc/Narragansett/sharks/bull-shark.html. Accessed February 2019.

National Marine Fisheries Service (NMFS). 2018b. Greater Atlantic Regional Fisheries Office: Effects Analysis – Acoustic Impacts. https://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/index.html. Accessed March 2019.

National Marine Fisheries Service (NMFS). 2019. EFH Mapper. Available at: https://www.habitat.noaa.gov/protection/efh/efhmapper/. Accessed February 2019.

National Oceanic and Atmospheric Administration – Office of Response and Restoration (NOAA-ORR). 2019. How Oil Spills Affect Fish and Whales. Available online at: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/how-oil-spills-affect-fish- and-whales.html. Accessed February 2019.

National Oceanic and Atmospheric Administration (NOAA). 1985. Gulf of Mexico coastal and ocean zones strategic assessment: Data Atlas. U.S. Department of Commerce. NOAA, NOS. Available online at: https://catalog.data.gov/dataset/gulf-of-mexico-coastal-and-ocean-zones- strategic-assessment-data-atlas-1985-nodc-accession-0126. Accessed January 2019.

National Oceanic and Atmospheric Administration (NOAA). 1992. Introduction to Coastal Habitats and Biological Resources for Spill Response. Available at: https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/coastal-habitats-biological-resources-job-aid.html. Accessed April 2019.

National Oceanic and Atmospheric Administration (NOAA). 1999. Sediment Quality Guidelines developed for National Status and Trends Program. Available at: *www.coastalscience.noaa.gov/publications/handler.aspx?key=1527*. Accessed April 2019.

National Oceanic and Atmospheric Administration (NOAA). 2002. Trajectory Analysis Handbook. Available at: https://response.restoration.noaa.gov/sites/default/files/Trajectory_Analysis_Handbook.pdf.

National Oceanic and Atmospheric Administration (NOAA). 2016. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. Available at: http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/. Accessed September 27, 2018.

National Oceanic and Atmospheric Administration (NOAA). 2017. Final Amendment 10 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan. Essential Fish Habitat and Environmental Assessment. National Oceanic and Atmospheric Administration. Atlantic Highly Migratory Species Management Division. Available online: https://www.fisheries.noaa.gov/action/amendment-10- 2006-consolidated-hms-fishery-management-plan-essential-fish-habitat. Accessed February 2019.

National Oceanic and Atmospheric Administration (NOAA). 2018. Office of Response and Restoration. 2018. What Happens when Oils Spills Meet Massive Islands of Seaweed? Available at:

https://response.restoration.noaa.gov/about/media/what-happens-when-oil-spills-meet-massive-islands-seaweed.html. Accessed March 2019.

National Oceanic and Atmospheric Administration (NOAA). 2019a. Oyster Reef Habitat. Available at: https://www.fisheries.noaa.gov/national/habitat-conservation/oyster-reef-habitat. Accessed February 2019.

National Oceanic and Atmospheric Administration (NOAA). 2019b. Gulf of Mexico Data Atlas. Available online at: https://www.ncei.noaa.gov/maps/gulf-data-atlas/atlas.htm. Accessed February 2019.

National Research Council. 2003. Ocean Noise and Marine Mammals. Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. Oceans Studies Board. Division on Earth and Life Sciences. The National Academic Press, Washington D.C. 221 pages.

National Wildlife Federation (NWF). 2013. Artificial Reefs of the Gulf of Mexico: A Review of Gulf State Programs & Key Considerations. Available at: https://www.nwf.org/~/media/PDFs/Water/Review-of-GoM-Artificial-Reefs-Report.pdf. Accessed February 2019.

Pearson, John C. 1929. Natural History and Conservation of Redfish and Other Commercial Sciaenids on the Texas Coast. Available at: https://tamug-ir.tdl.org/handle/1969.3/23948. Accessed February 2019.

Perret, William S., Weaver, James E., Williams, Roy O., Johansen, Patricia L. McIiwain, Thomas D., Raulerson, Richard C., and Tatum, Walter M. 1980. Fishery Profiles of Red Drum and Spotted Seatrout. Gulf States Marine Fisheries Commission. 70 Pages. Available online at: https://www.gsmfc.org/publications/GSMFC%20Number%20006.pdf. Accessed February 2019.

Popper, A.N. and Hastings M.C. 2009. The effects of anthropogenic sources of sound on fishes. Available at: https://www.nrc.gov/docs/ML1434/ML14345A572.pdf. Accessed March 2019.

Powers, Sean P.; Hernandez Frank J.; Condon, Robert H.; Drymon J. Marcus; and Free, Christopher M. 2013. Novel Pathways for Injury from Offshore Oil Spills: Direct, Sublethal and Indirect Effects of the Deepwater Horizon Oil Spill on Pelagic Sargassum Communities. Available at: https://pdfs.semanticscholar.org/177b/e16fba6c28db3ce26ec3d754c5e4a8b7b541.pdf?_ga=2.212522132.1815945480.1552060966-676976920.1552060966. Accessed March 2019.

Runcie, John; Macinnis-NG, Cate; and Ralph, Peter. 2015. The toxic effects of petrochemicals on seagrasses. Literature review. Institute for Water and Environmental Resource Management and Department of Environmental Sciences. University of Technology, Sydney. Australian Maritime Safety Authority. Available online at: https://www.researchgate.net/publication/252133825_The_toxic_effects_of_petrochemicals_on_seagrasses_Literature_review. Accessed March 2019.

Saila, S.B., E. Lorda, J.D. Miller. R.A. Sher, and W.H. Howell. 1997. Equivalent Adult Estimates for Losses of Fish Eggs, Larvae, and Juveniles at Seabrook Station with Use of Fuzzy Logic to Represent Parametric Uncertainty. North American Journal of Fisheries Management 17:811- 825. Available online at: https://onlinelibrary.wiley.com/doi/abs/10.1577/1548- 8675(1997)017%3C0811:EAEFLO%3E2.3.CO;2. Accessed April 2019.

Simmons, Ernest G. and Breuer, Joseph P. 1962. A study of Redfish *Sciaenops ocellata* Linnaeus and Black Drum. Publications of the Institute of Marine Science. Volume 8. Institute of Marine Science.

Sogard, S., D. Hoss, and J. Govoni. 1987. Density and Depth Distribution of Larval gulf Menhade, Brevoortia Patronus, Atlantic Croaker, Micropogonias Undulatus, and Spot, Leiostomus Xanthurus, in the Northern Gulf of Mexico. Fisheries Bulletin: Vol. 85, No. 3.

Southwest Fisheries Science Center (SWFC). 2019. What are Ichthyoplankton? Available at: https://swfsc.noaa.gov/textblock.aspx?division=frd&id=6210. Accessed February 2019.

Texas Parks and Wildlife Department (TPWD). 2005. Redfish Bay Seagrass Protection Rules Proposed. Available at: https://tpwd.texas.gov/newsmedia/releases/?req=20051003b. Accessed March 2019.

Texas Parks and Wildlife Department (TPWD). 2019a. Seagrass Protection. Available at: https://tpwd.texas.gov/landwater/water/habitats/seagrass/redfish-bay. Accessed February 2019.

Texas Parks and Wildlife Department (TPWD). 2019b. Seagrass Types. Available at: https://tpwd.texas.gov/landwater/water/habitats/seagrass/seagrass-types. Accessed February 2019.

U.S. Army Corps of Engineers (USACE). 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coast Plain Region (Version 2.0). Available online at: http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/reg_supp/AGCP_regsupV2.pdf. Accessed February 2019

U.S. Army Corps of Engineers and Interagency Coordination Team. 2002. Laguna Madre GIWW Dredge Material Management Plan. Available online at: http://www.swg.usace.army.mil/Portals/26/docs/Navigation/GIWW-N- ICT/LagunaMadreDMMP.pdf. Accessed March 2019.

U.S. Geological Survey (USGS). 2010. Texas Coastal Bend. Available at: https://pubs.usgs.gov/sir/2006/5287/pdf/TexasCoastalBend.pdf. Accessed February 2019.

United States Geological Survey (USGS). 2018. Deepwater ROV Sampling to Assess Potential Impacts to Hardbottom Coral Communities and Associates from the Deepawater Horizon Oil Spill. Available at: https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/nrda-deepwater-rov-sampling-assess?qt-science_center_objects=0#qt-science_center_objects. Accessed March 2019.

Williams, Susan L. and Heck, Kenneth L. Jr. 2001. Seagrass Community Ecology. Ecology Available at: https://www.researchgate.net/publication/240777413_Marine_Community_Ecology/download. Accessed March 2019.

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
SHRIMP									
Brown Shrimp (*Crangon crangon*)									
fertilized eggs (0.26 mm diameter)	3,4,5	offshore	soft bottom, sand/shell	fall and spring	>24	18-110	N/A	N/A	Hatch 24 hours after spawning
Larvae, pre-settlement postlarvae (<14 mm)	3,4,5	estuarine, nearshore, offshore	WCA	year-round, peak: spring	28-30	0-82	phytoplankton and zooplankton	N/A	N/A
late post larvae juveniles (14 – 80 mm)	3,4,5	estuarine	SAV, emergent marsh, oyster reef, soft bottom, sand/shell	spring – fall	7–35	< 1	benthic algae, polychaete worms, peracarid crustaceans	predation is the major cause of mortality, cold temperatures in shallow water	higher growth rates in salt marsh than soft bottom and with carnivorous feeding; reduced growth in low salinity due to increased metabolic costs and decreased food resources; 0.9 mm/day
sub – adults	3,4,5	estuarine, nearshore	soft bottom, sand/shell	spring – fall	18–28	1–18	polychaetes, amphipods, other benthic invertebrates	cold fronts, hypoxia	N/A
non-spawning adults (females > 140 mm TL)	3,4,5	offshore	soft bottom, sand/shell	summer and fall	10–37	14-110	omnivorous, feed at night	N/A	N/A
spawning adults	3,4,5	offshore	soft bottom, sand/shell	fall and spring, year-round in depths >64m	N/A	18–110	omnivorous, feed at night	N/A	N/A
Pink Shrimp (*Penaeus duorarum*)									
fertilized eggs (0.31 – 0.33 mm diameter)	1,2,3,5	offshore	sand/shell	year - round	> 27	9–48	N/A	N/A	N/A
larvae, pre-settlement postlarvae (< 15 mm)	1,2,3,5	estuarine, nearshore, offshore	WCA	year - round	15-35	1-50	phytoplankton, zooplankton	Mortality is higher at 35°C	N/A
late postlarvae juveniles (>15 mm)	1,2,3,5	estuarine, nearshore,	SAV, soft bottom, sand/shell, mangroves (low densities)	year– round (W. FL); fall – spring (TX)	6–38	0–3	seagrass, annelids, small crustaceans, shrimp, bivalves	no recorded kills from cold fronts	0.05 – 2.08 mm CL/week

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico									
Life stage[a]	**Eco-region**	**Habitat Zone**	**Habitat Type[b]**	**Season**	**Temp (°C)[c]**	**Depth (m)[d]**	**Prey**	**Mortality[e]**	**Growth[f]**
sub - adults	1,2,3,5	estuarine, nearshore, offshore	SAV, soft bottom, sand/shell, mangroves (low densities), oyster reefs	year-round (W. FL); fall – spring (TX)	6-38	1-65	annelids, small crustaceans, shrimp, bivalves	avoid cold by migrating to deeper water; low predation offshore	0.05-2.08 mm CL/week
non-spawning adults (>75 mm TL)	1,2,3,5	nearshore, offshore	sand/shell	year-round	16-31	1–110	carnivores	low predation offshore	N/A
spawning adults (capable at 65 – 75 mm TL)	1,2,3,5	nearshore, offshore	sand/shell	year-round (W. FL); fall – spring (TX)	16-31	9-48	carnivores	low predation offshore	N/A
White Shrimp (*Panaeus setiferus*)									
fertilized eggs	2,3,4,5	estuarine, nearshore, offshore	N/A	spring - fall	N/A	9–34	N/A	daily Z =0.373	demersal eggs, hatch 10 – 12 hours after spawning; egg/larval stage lasts 16 days
larvae/ Pre-settlement postlarvae	2,3,4,5	estuarine, nearshore, offshore	N/A	spring – fall	17–28.5	0–82	phytoplankton and zooplankton	N/A	egg/larval stage lasts 16 days
late postlarvae/ juveniles	2,3,4,5	estuarine, nearshore	emergent marsh	late spring - fall	postlarvae 13–31; juveniles 9 - 33	< 1	omnivorous; detritus, annelid worms, peracarid crustaceans, caridean shrimp diatoms	predation; daily Z =0.014–0.126	growth rates increase with temperatures 18–32.5°C, but decrease at 35°C; grow slowly at < 18°C; 0.3–1.2 mm/day; stage duration = 79 days
sub - adults	2,3,4,5	estuarine, nearshore, offshore	soft bottom, sand/shell	summer - fall	> 6	1 – 30	omnivorous, scavengers; annelids, insects, detritus, gastropods, copepods, bryozoans, sponges, corals, fish, filamentous algae, vascular stems and roots	daily Z = 0.023–0.048	stage duration = 33 days; 0.4–1.5 mm/day
adults	2,3,4,5	estuarine, nearshore, offshore	soft bottom	late summer and fall	7 – 38	< 27	omnivorous	daily Z = 0.004–0.034	adult/spawning stage duration is about 237 days; 0.4–1.0 mm/day

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico									
Life stage[a]	**Eco-region**	**Habitat Zone**	**Habitat Type[b]**	**Season**	**Temp (°C)[c]**	**Depth (m)[d]**	**Prey**	**Mortality[e]**	**Growth[f]**
spawning adults	2,3,4,5	estuarine, nearshore, offshore	N/A	spring – late fall; peak: Jun - Jul	N/A	9 – 34	omnivorous	N/A	adult/spawning stage duration is about 237 days; 0.4–1.0 mm/day
Royal Red Shrimp (*Pleoticus robustus*)									
eggs	N/A	offshore	shelf edge/slope	year – round	9-12	250-550	N/A	N/A	N/A
larvae	N/A	N/A	N/A	N/A	N/A	250-550	N/A	larvae	N/A
postlarvae	N/A	N/A	N/A	N/A	N/A	250-550	N/A	N/A	N/A
early juveniles	N/A	N/A	N/A	N/A	N/A	250-550	N/A	N/A	N/A
late juveniles	N/A	N/A	N/A	N/A	N/A	250-550	N/A	N/A	N/A
adults	1,2,3, 4,5	offshore	shelf edge/slope, soft bottom, sand/shell *reefs	year – round	N/A	140–730	small benthic organisms	N/A	Max length = 184 mm (male); 229 mm (female); can live up to 5 years
spawning adults	1,2,3, 4,5	Offshore	shelf edge/slope	year - round	N/A	250-550	N/A	N/A	Maturity – 235mm TL (male); 155 mm TL (female)

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
RED DRUM									
Red Drum (*Sciaenops ocellatus*)									
eggs	1,2,3, 4,5	N/A	WCA	summer, fall	20–30	20–30	N/A	high early in spawning	N/A
larvae	1,2,3, 4,5	estuarine	SAV, soft bottom, WCA	late summer, fall	18.3–31	N/A	copepods	higher at 20–24°C than 25–30°C	0.5 mm/day. Faster at 25-30°C. 3-6 mm at 2 weeks. peak settlement from 6–8 mm TL
postlarvae	1,2,3, 4,5	estuarine	SAV, emergent marsh, soft bottom, sand/shell	late summer, fall	18.3–31	N/A	copepods	N/A	increased with increasing salinity (up to 30 ppt)
early juveniles	1,2,3, 4,5	estuarine, nearshore	SAV, soft bottom, emergent marsh	Sep – Dec	> 5–32.2	0–3	copepods, mysids, amphipods, shrimp, polychaetes, insects, fish, isopods, bivalves, decapods, crabs	rapid decline in water temperature can cause mortality	higher in backwater than seagrass beds. 15 – 20 mm/month
late juveniles	1,2,3, 4,5	estuarine, nearshore	SAV, soft bottom, hard bottom, sand/shell	fall	> 5–30	0–5	mysids, amphipods, shrimp, polychaetes, insects, crabs, fish	changes in environment, disease, parasites, rapid decline in water temperature	15–20 mm/ month
adults	1,2,3, 4,5	estuarine, nearshore, offshore	SAV, emergent marsh, soft bottom, hard bottom, sand/shell, WCA	N/A	2–33	1-70	crabs, shrimp, fish	*M* (age constant) = 0.07–0.13	L_{inf} = 881 mm FL, *k* = 0.32, t_0= -1.29, max age =42 years
spawning adults	1,2,3, 4,5	offshore	SAV, soft bottom, hard bottom, sand/shell	Mid-Aug – Oct.	20–30	40–70	N/A	N/A	L_{50} (male)= 529 mm FL, L_{50} (female) = 825-900(male) mm FL

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
REEF FISH									
Red Snapper (*Lutjanus campechanus*)									
eggs	1,2,3, 4,5	offshore	WCA	Apr – Oct.	N/A	18-126	N/A	N/A	
larvae	1,2,3, 4,5	offshore	WCA	Jul – Nov.	17.3–29.7	18-126	alga, rotifers (in laboratory)	N/A	
postlarvae	1,2,3, 4,5	offshore	WCA	Jul – Nov.	17.3–29.7	18-126	N/A	N/A	
early juveniles	1,2,3, 4,5	nearshore, offshore	reefs, hard bottom, banks/shoals, soft bottom, sand/shell	Jul – Nov.	17.3–29.7	17-183	zooplankton, shrimp, chaetognaths, squid, copepods	shrimp trawl bycatch; *M* (age 0) = 2.0/year	
late juveniles	1,2,3, 4,5	nearshore, offshore	reefs, hard bottom, banks/shoals, soft bottom, sand/shell	year-round	20-28	18-55	fish, squid, crabs, shrimp	shrimp trawl bycatch; *M* (age 1) = 1.2/year	
adults	1,2,3, 4,5	nearshore, offshore	reefs, hard bottom, banks/shoals	year-round	14-30	7-146	fish, shrimp, squid, octopus, crabs	Enter fishery at age 2; *M=0.094/ year*	
spawning adults	1,2,3 4,5	offshore	sand/shell, banks/shoals	Apr-Oct.	16-29	18-126	N/A	N/A	50% mature (female) at age 4-5, 400-450 mm TL; 100% mature (female) at age 8, 700 mm TL
Gray (mangrove) snapper (*Lutjanus griseus*)									
eggs	1,2	offshore	WCA	Jun-Sep	N/A	*0-180*	N/A	N/A	pre-settlement duration: 25- 33d
larvae	1,2	offshore	WCA	Apr-Nov peak: Jun- Aug	15.6-27.2	*0-180*	lab: zooplankton	N/A	pre-settlement duration: 25- 33d
postlarvae	1,2	estuarine	SAV	N/A	N/A	N/A	copepods, amphipods	N/A	pre-settlement duration: 25-33d
early juveniles	1,2	estuarine	SAV, mangrove, emergent marsh	N/A	12.8-36.0	1-3	amphipods	N/A	growth rate = 0.60-1.02 mm/d; SAV residents ~ 8 months; settle Sep-Oct (at 78 mm TL)

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
late juveniles	1,2	estuarine, nearshore	SAV, mangrove, emergent marsh	N/A	12.8-36.0	*0-180*	penaeid shrimp, crabs, fish, mollusks, polychaetes	N/A	growth rate = 0.60-1.02 mm/d; *SAV residents ~ 8 months; occupy mangroves from 100-120+ mm TL*
adults	1,2,3, 4,5	estuarine, nearshore, offshore	hard bottom, soft bottom, reef, sand/shell, banks/shoals, emergent marsh	N/A	13.4-32.5	0-180	fish, shrimp, crabs	*Z*=0.17- 0.22, *M*=0.15	recruit to fishery @ age 4; max. age = 28 years; L_{inf}=656.4 mm TL, *k* = 0.22, t_o = 0
spawning adults	1,2,3, 4,5	estuarine, nearshore, offshore	reef, hard bottom	year-round (S. FL), summer elsewhere	N/A	0-180	N/A	N/A	maturation at 185 mm TL for males and 200 mm TL for females
Lane snapper (*Lutjanus synagris*)									
eggs	1,2,3, 4,5	offshore	WCA	Mar-Sep, peak: Jul- Aug	N/A	*4-132*	N/A	N/A	N/A
larvae	1,2,3, 4,5	*estuarine, nearshore, offshore*	*WCA*	*Jun- Aug*	28 (in lab); *28.4- 30.4*	*0-50*	plankton and rotifers (in laboratory)	death by day 10 at 25°C in lab; * *Z*= - 0.429± 0.053(SE), subject to size-selective mortality*	*SL-age curve = 0.032, *K*=0.047 ±0.008 (SE; W. Straits of FL), *K* = 0.042 ±0.008 (SE; E. Straits of FL), PLD=25.6 d*
postlarvae	1,2,3, 4,5	*estuarine, nearshore, offshore*	*WCA*, SAV	*Jun- Aug*	*28.4- 30.4*	*0-50*	N/A	death by day 10 at 25°C in lab; * *Z*= - 0.429± 0.053(SE), subject to size- selective mortality*	*SL-age curve = 0.032, *K* =0.047 ±0.008 (SE; W. Straits of FL), *K*= 0.042 ±0.008 (SE; E. Straits of FL), PLD =25.6 d*
early juveniles	1,2,3, 4,5	estuarine, nearshore, offshore	SAV, sand/shell, reefs, soft bottom, banks/shoal, *mangrove*	late summer-early fall	28-29.5	0-24	copepods, grass shrimp, small inverts	*subject to growth-selective mortality*, daily *Z*= 0.097-0.165	settle Jul- Aug, min. settle length =15.1 mm SL, min. settle age= 25 d, growth rate = 0.9-1.3 mm/d
late juveniles	1,2,3, 4,5	estuarine, nearshore, offshore	SAV, sand/shell, reefs, soft bottom, banks/shoals, mangrove	late summer-early fall	28-29.5	0-24	copepods, grass shrimp, small inverts	*subject to growth-selective mortality*, daily *Z* = 0.097-0.165	growth rate = 0.9-1.3 mm/d

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico									
Life stage[a]	**Eco-region**	**Habitat Zone**	**Habitat Type[b]**	**Season**	**Temp (°C)[c]**	**Depth (m)[d]**	**Prey**	**Mortality[e]**	**Growth[f]**
adults	1,2,3, 4,5	nearshore, offshore	reef, sand/shell, banks/shoals, hard bottom	N/A	16-29	4-132	fish, crustaceans, annelids, mollusks, algae	*Z* = 0.38-0.58; *M* =0.11-0.24	max. length = 673 mm TL. Males grow faster, and larger at age than females; L_{inf} = 449 mm FL, *k*= 0.17, t= -2.59, max age = 19 years
spawning adults	1,2,3, 4,5	offshore	*reef, shelf edge/slope*	May-Aug	N/A	*30-70 m*	N/A	N/A	*50% maturity = 230 mm (females), 242 mm (males); 100% maturity > 350 mm TL (females), > 377 mm TL (males)*
Wenchman (*Pristipomoides aquilonaris*)									
eggs	3,4,5	offshore	WCA	summer	20	*80-200*	N/A	N/A	N/A
larvae	3,4,5	offshore	WCA	summer	N/A	*80-200*	N/A	N/A	N/A
postlarvae	3,4,5	offshore	N/A	summer	N/A	*80-200*	N/A	N/A	N/A
early juveniles	3,4,5	offshore	N/A	N/A	N/A	*19-481*	N/A	N/A	N/A
late juveniles	3,4,5	offshore	N/A	N/A	N/A	*19-481*	N/A	N/A	N/A
adults	3,4,5	offshore	hard bottom, shelf edge/slope	year- round	9.1-28.7	19-481	small fish	N/A	L_{inf} = 240 mm FL, *K* = 0.18, t_o = -4.75, max. age (# otolith increments) = 14
spawning adults	3,4,5	offshore	shelf edge/slope	summer	20	80-200	N/A	N/A	N/A
Vermilion Snapper (Rhomboplites aurorubens)									
eggs	1,2,3, 4,5	offshore	WCA	N/A	N/A	*18-100*	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	*Jun-Nov*	N/A	*30-40*	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA	*Jun-Nov*	N/A	*30-40*	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	N/A	N/A	*18-100*	*copepods, nematodes*	N/A	N/A
late juveniles	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	N/A	N/A	*18-100*	*fish scales, copepods, small pelagic crustacea, cephalopods*	N/A	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
adults	1,2,3, 4,5	nearshore, offshore	banks/shoals, reef, hard bottom	*year-round*	*16.4-26.2*	18-100	benthic tunicates, amphipods, juvenile vermilion (rare), *cephalopods*	Recruit to comm. long-line age 7, hand-line age 4, rec. age 3; $Z = 0.39 \pm 0.05$, $M = 0.25$	L_{inf} = 344 mm FL, k= 0.3254, t_o = - 0.7953, max. age = 26 years
spawning adults	1,2,3, 4,5	nearshore, offshore	N/A	May- Sep	N/A	*18-100*	N/A	N/A	50% mature at 138 mm (TL)
Goliath grouper (*Epinephelus itajara*)									
eggs	1,5	offshore	WCA	late summer, early fall	N/A	*36-46*	N/A	N/A	N/A
larvae	1,5	offshore	WCA	late summer, early fall	N/A	*36-46*	N/A	N/A	pelagic larval duration: 30-80 d
postlarvae	1,5	N/A	mangroves	N/A	N/A	N/A	N/A	N/A	pelagic larval duration: 30-80 d
early juveniles	1,5	estuarine, nearshore	SAV, mangroves, emergent marsh	Nov-Jan	N/A	0-5	crustaceans	N/A	growth rate ~ 0.300 mm/d
late juveniles	1,5	estuarine, nearshore	SAV, mangroves, emergent marsh, reefs, hard bottom	N/A	N/A	0-5	crustaceans	N/A	emigrate from mangroves between age 5 and 6 (1000 mm TL); growth rate ~ 0.300 mm/d
adults	1,5	nearshore, offshore	reefs, hard bottom, banks/shoals	N/A	20-25	0-95	crustaceans (esp. lobster), fish, mollusks (cephalopods)	$Z = 0.85$, $F = 0.70$, $M = 0.15$ Vulnerable to overfishing	L_{inf} = 2221 mm TL, K = 0.0937, t_o = -0.6842, max. age = 37 years; Slow growth rate
spawning adults	1,5	offshore	reefs, hard bottom	Jun-Dec peak: Jul- Sep	25-26	36-46	N/A	N/A	N/A
Yellowedge grouper (*Hyporthodus flavolimbatus*)									
eggs	1,2,3, 4,5	offshore	WCA	N/A	N/A	*35-370*	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	N/A	N/A	*35-370*	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA	*July-Oct*	N/A	*35-370*	N/A	N/A	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
early juveniles	1,2,3, 4,5	nearshore, offshore	N/A	N/A	N/A	9-110	N/A	N/A	N/A
late juveniles	1,2,3, 4,5	nearshore, offshore	hard bottom	N/A	N/A	9-110	N/A	N/A	N/A
adults	1,2,3, 4,5	offshore	hard bottom, soft bottom, *shelf edge/slope*	N/A	10.7-27.0	35-370	brachyuran crabs, fish, other inverts	Z = 0.128, M = 0.048-0.090, F =0.038-0.080	max. age = 85 years, max. length = 1228 mm TL; L_{inf} = 1005 mm TL, K = 0.059, t_0 = -4.75
spawning adults	1,2,3, 4,5	offshore	*shelf edge/slope, reefs*	Feb-Sep, Nov peak: Mar-Sep	*14.47*	35-370	N/A	N/A	Protogynous hermaphrodites; 50% maturity = 547 mm TL and 8 years (females), 50% transition = 815 mm TL and 22 years
Warsaw grouper (*Epinephelus nigritus*)									
eggs	1,2,3, 4,5	offshore	WCA	N/A	N/A	*40-525*	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	N/A	N/A	*40-525*	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA	N/A	N/A	*40-525*	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	offshore	N/A	N/A	N/A	*20-30*	N/A	N/A	N/A
late juveniles	1,2,3, 4,5	offshore	reefs	N/A	N/A	20-30	N/A	N/A	N/A
adults	1,2,3, 4,5	offshore	shelf edge/ slope, hard bottom	N/A	12-25	40-525	crabs, shrimp, lobsters, fish	vulnerable to overfishing; overfishing affects size structure; *M= 0.10*	L_{inf} = 2394 mm TL, K = 0.0544, t_0 = -3.616; max. age= 41 years, max. length = 2300 mm
spawning adults	1,2,3, 4,5	offshore	shelf edge/slope, hard bottom, reef	late summer	N/A	40-525	N/A	N/A	protogynous hermaphrodite; mature at 9 years
Yellowmouth grouper (*Mycteroperca interstitialis*)									
eggs	1,5	offshore	WCA	N/A	N/A	*20-189*	N/A	N/A	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico									
Life stage[a]	**Eco-region**	**Habitat Zone**	**Habitat Type[b]**	**Season**	**Temp (°C)[c]**	**Depth (m)[d]**	**Prey**	**Mortality[e]**	**Growth[f]**
larvae	1,5	offshore	WCA	N/A	N/A	*20-189*	N/A	N/A	N/A
postlarvae	1,5	offshore	WCA	N/A	N/A	*20-189*	N/A	N/A	N/A
early juveniles	1,5	estuarine	mangrove	N/A	N/A	N/A	N/A	N/A	N/A
late juveniles	1,5	estuarine	mangrove	N/A	N/A	N/A	*fish*	N/A	N/A
adults	1,2,4,5	offshore	hard bottom, reef, banks/shoals	N/A	19-24	20-189	fish, crustaceans, other invertebrates	vulnerable to overfishing; *Z* = 0.25-0.28; **M* =0.14*	long lived, slow growing, fastest growth in first 2 years; maximum age/length = 28 years/830 mm TL; L_{inf} = 828 mm TL, *K* = 0.076, t_o = -7.5
spawning adults	1,2,5	offshore	N/A	year- round peak: Apr- May (in FL)	N/A	20-189	N/A	N/A	protogynous; females mature at 400-450 mm TL (age 2-4); transition to males at 505- 643 mm TL (age 5-14)
Gag (*Mycteroperca microlepis*)									
eggs	1,2	offshore	WCA	Dec-Apr	N/A	*50-120*	N/A	N/A	hatch in 45h at 21°C
larvae	1,2	offshore	WCA	early spring	N/A	*50-120*	N/A	N/A	pelagic larval duration = 29-52 d
postlarvae	1,2	offshore	WCA	N/A	N/A	*50-120*	N/A	N/A	pelagic larval duration = 29-52 d
early juveniles	1,2	estuarine, nearshore	SAV, mangroves	late spring- early fall	22-32	0-12	crustaceans (amphipods, copepods, grass shrimp)	minimal while in SAV	rapid during association with SAV
late juveniles	1,2	estuarine, nearshore, offshore	SAV, hard bottom, reefs, mangroves	recruit to reefs offshore in fall	22-32	1-50	decapod crustaceans and fish	recreational fishery, shrimp fishery bycatch	N/A
adults	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	year-round	14-24	13-100	fish, crustaceans, cephalopods	sudden low temperatures, fishing mortality; *M* = 0.1342	L_{inf} = 1277.95 mm FL, *k* = 0.1342, t_o = - 0.6687, max. age = 31 years

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
spawning adults	1,2,3, 4,5	offshore	shelf edge/slope, hard bottom	Dec-May peak: Feb- Mar	21-30	50-120	N/A	spawning aggregations vulnerable to fishery	N/A
Tilefish (*Lopholatilus chamaeleonticeps*)									
eggs	1,2,3, 4,5	offshore	WCA	late spring- summer	hatched in 40 hours at 22.0-24.6 (lab)	*80-450*	N/A	N/A	N/A
larvae	1,2,3, 4,5	offshore	WCA	summer	N/A	*80-450*	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA	summer	N/A	*80-450*	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	offshore	WCA	N/A	N/A	*80-450*	N/A	N/A	settlement at 9.0- 15.5 mm SL
late juveniles	1,2,3, 4,5	offshore	shelf edge/slope, soft bottom	N/A	N/A	*80-450*	N/A	N/A	N/A
adults	1,2,3, 4,5	offshore	shelf edge/slope, soft bottom	N/A	9-14.4	80-450	bivalve mollusks, squids, polychaetes, holothurians, decapod crustaceans, elasmobranchs, and ray- finned fishes	over- exploitation; mass mortality from cold water intrusion events; M = 0.137	max. length = 1000 mm SL; males grow faster, reach larger size; L_{inf} = 830 mm TL, k = 0.13, t_0 = -2.14, max. age = 40 years
spawning adults	1,2,3, 4,5	offshore	shelf edge/slope, soft bottom	Jan-Jun peak: Apr	N/A	80-450	N/A	N/A	Fishing pressure may cause males to spawn at smaller sizes; maturity < 1 year and 150 mm FL (male); 2.5 years and 331 mm FL (female); protogynous hermaphrodites
Greater amberjack (*Seriola dummerili*)									
eggs	1,2,3, 4,5	N/A	WCA	N/A	N/A	N/A	N/A	N/A	hatch in 2 days
larvae	1,2,3, 4,5	offshore	WCA	year- round	N/A	N/A	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	offshore	WCA, drifting algae	summer	N/A	N/A	N/A	N/A	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
early juveniles	1,2,3, 4,5	nearshore, offshore	WCA, drifting algae	summer- fall	N/A	N/A	invertebrates	*Z*=0.0045	1.65-2.00 mm/d
late juveniles	1,2,3, 4,5	nearshore, offshore	WCA, drifting algae, hard bottom	summer- fall	N/A	N/A	invertebrates	*Z*=0.0045	1.65-2.00 mm/d
adults	1,2,3, 4,5	nearshore, offshore	WCA, hard bottom, banks/shoals, *reefs*	year- round	14.25	4.6-187	fish, crustaceans, cephalopods	males (7-8 years) have shorter life span than females (10-15 years)	females usually larger than males; L_{inf} = 1436 mm FL, *k* = 0.175, t_0 = -0.954, max. age =15 years
spawning adults	1,2,3, 4,5	offshore	WCA, *reef*	Feb-May	N/A	N/A	N/A	N/A	50% maturity at *644 mm FL (males); 900 mm FL and age 4 (females)
Lesser amberjack (*Seriola fasciata*)									
eggs	1,2,3, 4,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
larvae	1,2,3, 4,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
postlarvae	1,2,3, 4,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	offshore	drifting algae	late summer- fall	N/A	*55- 348*	N/A	N/A	N/A
late juveniles	1,2,3, 4,5	offshore	drifting algae, hard bottom, reef	late summer- fall	N/A	*55- 348*	N/A	N/A	N/A
adults	1,2,3, 4,5	offshore	hard bottom, reef	year- round	N/A	*55- 348*	squid	N/A	females slightly larger than males (408.8 vs 396.2 mm FL)
spawning adults	1,2,3, 4,5	offshore	hard bottom	Sep-Dec, Feb-Mar	N/A	*55- 348*	N/A	N/A	N/A
Almaco jack (*Seriola rivoliana*)									
eggs	1,2,5	N/A	WCA	spring- fall	N/A	N/A	N/A	N/A	N/A
larvae	1,2,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
post larvae	1,2,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
early juveniles	1,2,3, 4,5	nearshore, offshore	drifting algae, WCA	Aug-Jan, Jul- Oct	23.3-31.7	6.7-16.8	*fish, shrimp, copepods*	N/A	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico									
Life stage[a]	**Eco-region**	**Habitat Zone**	**Habitat Type[b]**	**Season**	**Temp (°C)[c]**	**Depth (m)[d]**	**Prey**	**Mortality[e]**	**Growth[f]**
late juveniles	1,2,3, 4,5	nearshore, offshore	WCA, drifting algae	Aug-Jan, Jul- Oct	23.3-31.7	6.7-16.8	*fish, shrimp, copepods*	N/A	N/A
adults	1,2,3, 4,5	offshore	shelf edge/slope, hard bottom, banks/shoals, *reefs*	Summer (N. GOM), year- round (S. GOM)	N/A	21-*179*	fish	N/A	N/A
spawning adults	1,2,5	N/A	N/A	spring-fall	N/A	N/A	N/A	N/A	N/A
Gray triggerfish (*Balistes capriscus*)									
eggs	1,2,3, 4,5	nearshore, offshore	reefs	late spring, summer	N/A	*10-100*	*N/A*	N/A	hatch in 48-55 hours
larvae	1,2,3, 4,5	N/A	WCA, drifting algae	N/A	N/A	N/A	N/A	N/A	spend 4-7 months in pelagic zone
postlarvae	1,2,3, 4,5	N/A	WCA, drifting algae	N/A	N/A	N/A	N/A	N/A	spend 4-7 months in pelagic zone
early juveniles	1,2,3, 4,5	N/A	drifting algae, *mangrove*	N/A	N/A	N/A	algae, hydroids, barnacles, polychaetes	N/A	spend 4-7 months in pelagic zone
late juveniles	1,2,3, 4,5	nearshore, offshore	drifting algae, *mangrove*, reefs	N/A	N/A	*10-100*	algae, hydroids, barnacles, polychaetes	*Z = 0.95, M = 0.28*	N/A
adults	1,2,3, 4,5	nearshore, offshore	hard bottom, reefs	N/A	N/A	10-100	bivalves, barnacles, polychaetes, decapod crabs, gastropods, sea stars, sea cucumbers, brittle stars, sea urchins, sand dollars	predation, recreational fishery (age 3), commercial fishery (age 4). *Z=0.95, M=0.28*	rapid in year one, then slows. Relatively long lived. L_{inf} = 589.7 mm FL, K = 0.0.14, t_0 = -1.66, max. age = 15 years
spawning adults	1,2,3, 4,5	nearshore, offshore	reefs	late spring, summer	20.9-30.0	10-100	bivalves, barnacles, polychaetes, decapod crabs, gastropods, sea stars, sea cucumbers, brittle stars, sea urchins, sand dollars	predation, recreational fishery (age 3), commercial fishery (age 4)	rapid in year one, then slows. Relatively long lived. Males larger than females
COASTAL MIGRATORY PELAGICS									
King mackerel (*Scomberomorus cavalla*)									
eggs	3,4,5	offshore	WCA	spring, summer	hatch = 18-21 hours at 27	35-180	N/A	N/A	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico									
Life stage[a]	**Eco-region**	**Habitat Zone**	**Habitat Type[b]**	**Season**	**Temp (°C)[c]**	**Depth (m)[d]**	**Prey**	**Mortality[e]**	**Growth[f]**
larvae	1,2,3, 4,5	offshore	WCA	May-Oct	20-31	*35-180*	larval fish (carangids, clupeids, engraulids)	predation, starvation	enhanced in N.C. GOM and N.W. GOM, associated with MS River plume
post larvae	1,2,3, 4,5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
early juveniles	3,4,5	nearshore	WCA	May-Oct peak: Jul, Oct	N/A	≤ 9	fish, some squid	bycatch (shrimp fishery), sport fishery	enhanced in N.C. GOM and N.W. GOM, associated with MS River plume
late juveniles	3,4,5	nearshore	WCA	N/A	N/A	N/A	estuarine- dependent fish, some squid	bycatch (shrimp fishery), commercial and recreational fisheries	enhanced in N.C. GOM and N.W. GOM, associated with MS River plume
adults	1,2,3, 4,5	nearshore, offshore	WCA	N/A	> 20	0-200	fish, squid, shrimp; feeding sometimes associated with *Sargassum*	fishing mortality, M = 0.174	highest growth occurs in eastern GOM; L_{inf} = 1154.1 mm FL, k = 0.19, t =-2.60; max. age = 24 years
spawning adults	3,4,5	offshore	WCA	May-Oct	> 20	35-180	N/A	N/A	N/A
Spanish mackerel (*Scomberomorus maculatus*)									
eggs	2,3	nearshore, offshore	WCA	spring, summer	hatch in 25 hours at 26	< 50	N/A	N/A	N/A
larvae	1,2,3 4,5	nearshore, offshore	WCA	May-Oct	20-32	9-84	larval fish, some crustaceans	N/A	N/A
post larvae	1,2,3 4,5	nearshore, offshore	WCA	May-Oct	20-33	9-84	larval fish, some crustaceans	N/A	N/A
early juveniles	2,3	estuarine, nearshore	WCA	Mar- Nov	15.5-34.0	1.8-9.0	mostly fish, some crustaceans, gastropods, shrimp	bycatch in shrimp trawl fishery	N/A
late juveniles	2,3	estuarine, nearshore, offshore	WCA	Mar- Nov	15.5-34.0	1.8-50	fish, squid	bycatch in shrimp trawl fishery, vulnerable to recreational fishery	N/A

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]
adults	1,2,3	estuarine, nearshore, offshore	WCA	N. GOM in spring, S. Florida and Mexico in fall	15.5-34.0	3-75	fish, crustaceans, squid	fishing mortality, impacted by baitfish harvest; *M*= 0.37/year	females grow faster, live longer than males; t_o = -0.5, k= 0.61, L_{inf} = 560 mm FL; max. age = 11 years
spawning adults	2,3	nearshore, offshore	WCA	May- Sep	> 25	< 50	N/A	N/A	N/A
Cobia (*Rachycentron canadum*)									
eggs	2,3,4,5	estuarine, nearshore	WCA	summer	28.1-29.7	top meter of water column	N/A	N/A	hatch within 36 hours
larvae	2,3,4,5	estuarine, nearshore, offshore	WCA	May-Sep	24.2-32	3.1-300, in surface waters	In lab: zooplankton, primarily copepods	N/A	22 mm SL in 22 days (lab)
post larvae	3,4,5	nearshore, offshore	WCA	May-Jul	25.9-30.3	11-53 *in or near surface waters*	In lab: zooplankton, primarily copepods	N/A	25 mm SL in 25 days (lab)
early juveniles	3,4,5	nearshore, offshore	WCA	Apr-Jul	*16.8- 25.2*	5-300 * in or near surface waters*	In lab: *Gambusia*, shrimp and fish parts	N/A	~ 55 mm SL by 50 days (lab)
late juveniles	3,4,5	nearshore, offshore	WCA	May-Oct	N/A	*1-70*	fish, shrimp, squid	N/A	231 mm SL by 130 days (lab)
adults	1,2,3, 4,5	nearshore, offshore	WCA, banks/shoals, hard bottom	Mar-Oct (N. GOM), Nov- Mar (S. GOM, S. FL)	23.0-28.0	1-70	crustaceans and fish	*M* =0.38/year	rapid growth for first 2 years; L_{inf} = 1281.5 mm FL, *k* = 0.42, t_o = -0.53, max. age = 11 years
spawning adults	3,4,5	nearshore, offshore	N/A	Apr-Sep (N. GOM)	23.0-28.0	*1-70*	N/A	N/A	50% maturity at age 2

Attachment 1-A: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life stage[a]	Eco-region	Habitat Zone	Habitat Type[b]	Season	Temp (°C)[c]	Depth (m)[d]	Prey	Mortality[e]	Growth[f]

Source: GMFMC 2004; GMFMC and NMFS 2016

Notes: Information in asterisks comes from studies conducted outside GMFMC jurisdiction; N/A = not applicable (information not available).

[a] mm = millimeters; TL = total length

[b] WCA = water column associated; SAV = submerged aquatic vegetation

[c] °C = degrees Celsius

[d] m = meters

[e] Z = the instantaneous mortality coefficient (M + F); M = natural mortality; F= fishing mortality

[f] CL = caudal tail length ; L_{inf} = average maximum size; k = growth rate; t_0 = the theoretical age at which the fish has a length of 0; SL = standard length; FL = fork length; for additional detail regarding growth rates, see GMFMC 2016

Attachment 1-B: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Attachment 1-B: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life Stage	Geographic Area	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Sailfish (*Istiophorus platypterus*)							
Eggs	Oceanic waters from the Florida Keys to the continental shelf of Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Larvae	Oceanic waters from the Florida Keys to the continental shelf of Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Early Juvenile	Central and northern GOM between Apalachicola and southern Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Late Juvenile	Central and northern GOM between Apalachicola and southern Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Adult	Oceanic water associated with the continental shelf from Louisiana to Texas	N/A	N/A	N/A	N/A	N/A	N/A
Spawning Adults	Oceanic waters from the Florida Keys to the continental shelf of Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Scalloped Hammerhead Shark (*Sphyrna lewini*)							
Neonate and young-of year (YOY)	Coastal areas of Florida and Texas	23.2-30.2	27.6-36.3	5-6	N/A	N/A	N/A
Juvenile	Northern GOM from east Louisiana to Pensacola Florida	N/A	N/A	N/A	N/A	N/A	N/A
Adult	Northern GOM from east Louisiana to Pensacola Florida	N/A	N/A	N/A	N/A	N/A	N/A
Blacktip shark (*Carcharinus limbatus*)							
Neonate and young-of year (YOY)	Coastal areas including estuaries, out to the 30 m depth contour in the GOM, from the Florida Keys to southern Texas.	20.8 -32.2	22.4-36.4	0.9-7.6	summer primary nursery (May – Sept.)	Silt, sand, mud, and seagrass habitats within shallow coastal areas, including estuaries.	N/A
Juvenile	Coastal areas out to 100 m depth contour in the GOM from the Florida Keys to southern Texas	19.8-32.2	7.0-36.8	7.0-9.4	Summer secondary nursery	Multiple substrates including silt, sand, mud, and seagrass habitats.	N/A
Adult	Distributed within the 657 (200 m) depth contour of the GOM.	21.5-31.1	22.3-34.7	0.9-6.6	N/A	Multiple substrates including silt, sand, mud, and seagrass habitats.	Typically found further offshore than juveniles.

Attachment 1-B: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life Stage	Geographic Area	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Bull shark (*Carcharhinus leucas*)							
Neonate and young-of-the-year (YOY)	Coastal areas along Texas to the Mouth of the Mississippi, particularly shallow depth, low salinity estuaries and river mouths.	28.8	16.9	<9	Nurseries: May to August, often into November	In shallow coastal waters, inlets and estuaries	N/A
Juvenile	Coastal areas along the Texas coast, especially Matagorda Bay and San Antonio Bay.	24.2-30.9	10.6-30.8	1.4-5.8	Estuarine nurseries: April through summer months.	In shallow coastal waters, inlets and estuaries	N/A
Adult	Coastal areas along the Texas coast, especially Matagorda Bay and San Antonio Bay.	24.2-30.9	10.6-30.8	1.4-5.8	N/A	In shallow coastal waters, inlets and estuaries	Usually found in higher salinities than juveniles and neonates/YOYs.
Lemonhead Shark (*Negaprion brevirostris*)							
Neonate and young-of-the-year (YOY)	Coastal areas along Texas between Galveston Island and the Texas/Mexico border.	N/A	N/A	N/A	N/A	Shallow coastal areas, especially near coral reefs.	N/A
Juvenile	Coastal areas along Texas between Galveston Island and the Texas/Mexico border.	26.4-31.3	5.2-6.7	< 200 m bathymetric line	N/A	Shallow coastal areas, especially near coral reefs.	N/A
Adult	Coastal areas along the east coast of Louisiana.	29.3-29.9	25.7-29.8	< 200 m bathymetric line	N/A	Shallow coastal areas, especially near coral reefs.	N/A
Sandbar Shark (*Carcharhinus plumbeus*)							
Neonate and young-of-the-year (YOY)	Localized coastal areas on the Florida panhandle	20-31	19-39	2.1-5.2	N/A	Silt and clay habitats.	N/A
Juvenile	Localized coastal areas off Apalachicola Bay, Florida.	15-30	15-35	0.8-23	N/A	Substrates of sand, mud, shell, and rocky habitat.	N/A
Adult	Areas surrounding the continental shelf between Louisiana and South Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Spinner Shark (*Carcharhinus brevipinna*)							
Neonate and young-of-the-year (YOY)	Coastal from the Big Bend Region to South Texas	24.5-30.5	36	N/A	N/A	Shallow, sandy bottom substrates of the continental and insular shelves.	N/A

Attachment 1-B: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico							
Life Stage	**Geographic Area**	**Temperature (°C)**	**Salinity (parts per thousand)**	**Depth (m)**	**Seasonal Occurrence**	**Habitat Description**	**Notes**
Juvenile	Coastal areas from Apalachicola, Florida to southern Texas.	21.9-30.1	21.0-36.2	<20 m	N/A	Shallow, sandy bottom substrates of the continental and insular shelves.	N/A
Adult	Coastal areas from Apalachicola, Florida to southern Texas.	21.9-30.1	21.0-36.2	<90 m	N/A	Shallow, sandy bottom substrates of the continental and insular shelves.	N/A
Whale Shark (*Rhincodon typus*)							
Neonate and young-of-the-year (YOY)	Oceanic waters from the Florida panhandle to Texas.	N/A	N/A	N/A	N/A	N/A	N/A
Juvenile	Oceanic waters from the Florida panhandle to Texas	N/A	N/A	N/A	N/A	N/A	N/A
Adult	Oceanic waters from the Florida panhandle to Texas	N/A	N/A	N/A	N/A	N/A	N/A
Bonnethead shark (*Sphyrna tiburo*)							
Neonate and young-of-the-year (YOY)	All major bay systems along the Gulf coast of Texas from Sabine Lake to the Lower Laguna Madre.	18-33.5	N/A	N/A	Migrate out of nurseries in October.	Shallow coastal waters with sandy or muddy substrates.	N/A
Juvenile	All major bay systems along the Gulf coast of Texas from Sabine Lake to the Lower Laguna Madre.	28.4-31.4	N/A	N/A	N/A	Shallow coastal waters with sandy or muddy substrates.	N/A
Adult	Coastal areas from the Florida Keys to Texas	20.0-33.6	14.4-41.7	7.6-40 m	N/A	Shallow coastal Shallow coastal waters frequenting sandy or muddy substrates.	N/A
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)							
Neonate and young-of-the-year (YOY)	Bay systems along the Gulf coast of Texas from Galveston Bay to the Laguna Madre.	16.7-32	10-38	N/A	N/A	Shallow coastal areas including bays and estuaries	N/A
Juvenile	Bay systems along the Gulf coast of Texas from Galveston Bay to the Laguna Madre.	16-32	10-38	N/A	N/A	Coastal waters	N/A
Life Stage	Geographic Area	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes

Attachment 1-B: Life Histories for GMFMC Managed Fishes Identified in Ecoregion 5 in the Gulf of Mexico

Life Stage	Geographic Area	Temperature (°C)	Salinity (parts per thousand)	Depth (m)	Seasonal Occurrence	Habitat Description	Notes
Adult	Bay systems along the Gulf coast of Texas from Galveston Bay to the Laguna Madre.	16-32	10-38	< 200	N/A	Coastal waters	N/A
Blacknose Shark (*Carcharhinus acronotus*)							
Neonate and young-of-the-year (YOY)	Coastal areas of the west coast of Florida.	17-34	25-27	0.6-60	N/A	N/A	N/A
Juvenile	Southeastern coastal Texas to Galveston Bay	20.8-33.6	32.1	3.7	N/A	N/A	N/A
Adult	Southeastern coastal Texas to Galveston Bay	20.8-33.6	32.1	3.7	N/A	N/A	N/A
Finetooth Shark (*Carcharhinus isodon*)							
Neonate and young-of-the-year (YOY)	Coastal areas of Texas including portions of Corpus Christi, Aransas, Copano, San Antonio, Matagorda, Galveston, and Trinity Bays. Also includes beaches of southeastern Texas.	19.5-31.4	N/A	16-36	N/A	Shallow coastal waters in northern GOM with muddy substrates.	N/A
Juvenile	Coastal areas of Texas including portions of Corpus Christi, Aransas, Copano, San Antonio, Matagorda, Galveston, and Trinity Bays. Also includes beaches of southeastern Texas.	19.2-30.6	N/A	16-36	N/A	Shallow coastal waters in northern GOM with muddy substrates	N/A
Adult	Coastal areas of Texas including portions of Corpus Christi, Aransas, Copano, San Antonio, Matagorda, Galveston, and Trinity Bays. Also includes beaches of southeastern Texas.	19.2-30.6	N/A	16-36	N/A	Shallow coastal waters in northern GOM with muddy substrates	N/A

Source: NMFS 2006, NMFS 2010, NOAA 2017

Note: N/A = not applicable (information not available)