OCS Report
BOEM 2021-007

Outer Continental Shelf

Gulf of Mexico
Catastrophic Spill Event Analysis

High-Volume, Extended-Duration Oil Spill Resulting from Loss of Well Control on the Gulf of Mexico Outer Continental Shelf

2nd Revision

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New Orleans Office

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TABLE OF CONTENTS

Page

FIGURES

Page

TABLES

ABBREVIATIONS AND ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
ACGIH	American Conference of Governmental Industrial Hygienists
AL	Alabama
API	American Petroleum Institute
bbl	barrel
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
BP	British Petroleum
BSEE	Bureau of Safety and Environmental Enforcement
BTEX	benzene, toluene, ethylbenzene, and xylene
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CG	Coast Guard (also: USCG)
cm	centimeter
cm/sec	centimeters per second
CO	carbon monoxide
CPA	Central Planning Area
DOSS	dioctyl sodium sulfosuccinate
e.g.	for example
EIS	environmental impact statement
EPA	Eastern Planning Area
ERCO	Energy Resources Co. Inc.
ERMA	Environmental Response Management Application
ESA	Endangered Species Act of 1973
ESI	Environmental Sensitivity Index
et al.	and others
FL	Florida
FR	*Federal Register*
ft	feet
ft/sec	feet per second
FWS	Fish and Wildlife Service
GOM	Gulf of Mexico
GuLF STUDY	Gulf Long-Term Follow-Up Study
H_2S	hydrogen sulfide
i.e.	that is
in	inch
in/sec	inches per second
km	kilometer
km^2	square kilometer

LA	Louisiana
LP	launch point
m	meter
m/sec	meters/second
MCV	modular capture vessel
mi	mile
mi^2	square mile
MMbbl	million barrels
MMS	Minerals Management Service
MS	Mississippi
MWCC	Marine Well Containment Company
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	nautical-mile
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPS	National Park Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
OCS	Outer Continental Shelf
OSAT	Operational Science Advisory Team
OSHA	Occupational Safety and Health Administration
OSRA	Oil Spill Risk Analysis
PAH	polycyclic aromatic hydrocarbons
PBR	potential biological removal
PM_{10}	particulate matter less than or equal to 10 μm
$PM_{2.5}$	particulate matter less than or equal to 2.5 μm
ppb	parts per billion
ppm	parts per million
PSBF	potentially sensitive biological feature
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
RRT	Regional Response Team
SAV	submerged aquatic vegetation
SIMAP	Spill Impact Model System
SMART	Special Monitoring of Applied Response Technologies
SO_2	sulfur dioxide
SO_x	sulfur oxides
spp.	multiple species
TA&R	Technology Assessment and Research Program

TX	Texas
U.S.	United States
UME	unusual mortality event
USCG	U.S. Coast Guard (also: CG)
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WCR	Blowout Preventer Systems and Well Control Final Rule
WPA	Western Planning Area

1 CATASTROPHIC SPILL EVENT ANALYSIS: IMPACT ASSESSMENT

1.1 INTRODUCTION

In 1986, the Council on Environmental Quality (CEQ) regulations were amended to rescind the requirement to prepare a "worst-case analysis" for an environmental impact statement (EIS) (refer to 40 CFR § 1502.22(b)(4)). The regulation, as amended, states that catastrophic, low-probability impacts must be analyzed if the analysis is "supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason."

The August 16, 2010, CEQ report, prepared following the *Deepwater Horizon* explosion, oil spill, and response in the Gulf of Mexico (GOM), recommended that the Bureau of Ocean Energy Management (BOEM), formerly the Minerals Management Service (MMS) and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), should "Ensure that NEPA [National Environmental Policy Act] documents provide decisionmakers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low-probability catastrophic spills for oil and gas activities on the Outer Continental Shelf" (CEQ, 2010). This evaluation is a robust analysis of the impacts from low-probability catastrophic spills and will be made available to all applicable decisionmakers including, but not limited to, the Secretary of the Department of the Interior (USDOI) for the Five-Year National Program, the Assistant Secretary of Land and Minerals Management for an oil and gas lease sale, and the Regional Supervisors of the New Orleans Office's Office of Environment and Office of Leasing and Plans.

BOEM previously prepared the catastrophic spill event analysis to support GOM Lease Sales 216, 218, and 222 after the *Deepwater Horizon* explosion, oil spill, and response. The analysis was included as an appendix in the Supplemental EISs for those lease sales. The catastrophic analysis continued to be included as an appendix in GOM lease sale EISs and Supplemental EISs throughout the 2012-2017 Five-Year Program and was updated as needed. Throughout that time, the analysis was subject to public review and comment as a part of the EIS or Supplemental EIS. In 2017, BOEM prepared the *Catastrophic Spill Event Analysis* as a standalone technical report in support of the 2017-2022 GOM Multisale EIS and subsequent 2018 GOM Supplemental EIS. This standalone technical report is being updated to ensure that the analysis is accurate and includes any new scientific research since its last publication. The public is invited to comment on the *Gulf of Mexico Catastrophic Spill Event Analysis* technical report during public comment periods related to NEPA reviews of Gulf of Mexico OCS lease sales.

It should be noted that the analysis presented here is intended to be a general overview of the potential effects of a low-probability catastrophic spill in the Gulf of Mexico. As such, the *Gulf of Mexico Catastrophic Spill Event Analysis* should be read with the understanding that further details about accidental oil impacts on a particular resource may be found in BOEM's New Orleans Office's lease sale NEPA documents.

1.1.1 What is a Catastrophic Event?

As applicable to NEPA, Eccleston (2008) describes a catastrophic event as "large-scale damage involving destruction of species, ecosystems, infrastructure, or property with long-term effects, and/or major loss of human life." For oil and gas activities on the Outer Continental Shelf (OCS), a catastrophic event is a high-volume, extended-duration oil spill regardless of the cause, whether natural disaster (e.g., hurricane) or manmade (e.g., human error and terrorism). This high-volume, extended-duration oil spill, or catastrophic spill, has been further defined by the National Oil and Hazardous Substances Pollution Contingency Plan as a "spill of national significance" or "a spill which, because of its severity, size, location, actual or potential impact on the public health and welfare or the environment, or the necessary response effort, is so complex that it requires extraordinary coordination of Federal, State, local, and responsible party resources to contain and cleanup the discharge" (40 CFR part 300, Appendix E).

It is important to note that spill volume is only one factor that influences the nature and severity of an event's impacts. Each oil-spill event is unique; its outcome depends on several factors, including time of year and location, atmospheric and oceanographic conditions (e.g., winds, currents, coastal type, and sensitive resources), specifics of the well (i.e., flow rates, hydrocarbon characteristics, and infrastructure damage), and response effort (i.e., speed and effectiveness). For this reason, the severity of impacts from an oil spill cannot be predicted based on volume alone.

Though large spills may result from non-blowout scenarios, such events are unlikely to result in a catastrophic spill. In the case of a pipeline rupture, the ability to detect leaks and shut off pipelines limits the amount of the spill to the contents of the pipeline. The largest pipeline spill on the Gulf of Mexico OCS occurred in 1967, a result of internal pipeline corrosion following initial damage by an anchor. In 13 days, 160,638 barrels (bbl) of oil leaked (USDOI, BSEE, 2013); however, no significant environmental impacts were recorded as a result of this spill. In 2004, Hurricane Ivan caused a massive undersea mudslide just south of the Mississippi River Delta that toppled Taylor Energy Company's Platform A in Mississippi Canyon Area Block 20. Discharge has been observed over the site nearly every day since the toppling event occurred, often resulting in surface sheens that stretch for several miles. Several rounds of surveys and intervention efforts have occurred, and a rapid response system was installed that can collect and contain the leaking oil temporarily while a permanent solution is designed. Flow rate ranges from surveys of the ongoing leak vary substantially from a low estimate of 0.079-0.145 bbl/day to a mid-estimate of 9-47 bbl/day to a high estimate of 19-108 bbl/day (Mason et al., 2019). Flow rates captured from the rapid response system were observed from 25 to 31 bbl/day. For this analysis, this spill is considered a series of smaller spills to more accurately reflect the environmental impact and spill response requirements for this spill (ABS Consulting Inc., 2016).

Although loss of well control is defined as the uncontrolled flow of reservoir fluids that may result in the release of gas, condensate, oil, drilling fluids, sand, or water, it is a broad term that includes very minor well control incidents as well as the most severe well control incidents. Historically, loss of well control incidents occurred during development drilling operations, but loss of well control incidents can occur during exploratory drilling, production, well completions, or workover operations. These loss of well control incidents may result in the flow of fluids between formations penetrated in the wellbore, at the seafloor, or, in the event of flow up the riser to the drilling rig, at the ocean surface.

Prior to the *Deepwater Horizon* explosion, oil spill, and response, the two largest spills resulting from a loss of well control in U.S. waters of the Gulf of Mexico occurred in 1970 and released 65,000 and 53,000 bbl of oil, respectively (USDOI, BSEE, 2013). These incidents resulted in four human fatalities. Although these incidents occurred only 8-14 miles (mi) (13-26 kilometers [km]) from shore, there was minor shoreline contact with oil (USDOC, NOAA, Office of Response and Restoration, 2010a and 2010b). In 1987, a blowout of the Mexican exploratory oil well, YUM II, resulted in a spill of 58,640 bbl and 75 mi (121 km) of impacted shoreline (USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992). However, none of these spills met the previously described definitions of a catastrophic event or spill.

A blowout is a more severe loss of well control incident that creates a greater risk of a large oil spill and serious human injury. Two blowouts that resulted in catastrophic spills have occurred in U.S. and Mexican waters of the Gulf of Mexico. On June 3, 1979, the *Ixtoc I* well blowout in shallow water (water depth of 164 feet [ft] (50 meters [m]) and 50 mi [80 km] offshore in the Bay of Campeche, Mexico) spilled 3.5 million barrels (MMbbl) of oil in 10 months (USDOC, NOAA, Office of Response and Restoration, 2010b; USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992; ERCO, 1982). On April 20, 2010, the *Macondo* well blowout (i.e., *Deepwater Horizon* explosion, oil spill, and response) in deep water (water depth of 4,992 ft [1,522 m] and 48 mi [77 km] offshore in Mississippi Canyon Block 252) continuously spilled oil until it was capped approximately 3 months later. For purposes of calculating the maximum possible civil penalty under the Clean Water Act, a January 2015 judgement used a quantity of 4.0 million barrels for the total amount of discharged oil and 3.19 million barrels as the actual amount of oil that was released into environment (Barbier and Shushan, 2015). Due to being classified as catastrophic, the *Ixtoc I* and *Macondo* well blowouts and spills were utilized to develop the catastrophic spill event scenario in this analysis.

1.1.2 Methodology

This document primarily addresses environmental and social resources and activities that could be affected by a loss of well control and subsequent catastrophic oil spill event in the Gulf of Mexico OCS, as described above. The analysis herein provides a reasonable scenario and range of potential impacts based on applying modeling, reasonable assumptions, and knowledge acquired from studying past spill events of similar magnitude where possible. It is important to note that this analysis does not make any predictions on the likelihood or volume of any catastrophic event(s). It is only intended to predict where oil might go and how it might affect resources assuming an event has occurred, which is also known as a “conditional” probability. While the risk is not zero, a catastrophic event of the nature considered in this document is well outside the normal probability range despite the inherent risks associated with OCS oil- and gas-related activities.

It is also important to note that the scenario and impacts discussed in **Chapters 1.2 and 1.3** should not be confused with the scenario and impacts that would result from routine OCS oil- and gas-related activities or the more reasonably foreseeable accidental events associated with these activities. Further detail about more reasonably foreseeable, accidental oil spill impacts are analyzed in Gulf of Mexico OCS lease sale NEPA documents.

Two general approaches are used to analyze a catastrophic event under NEPA. The first approach is a bounding analysis for each individual resource category (e.g., marine mammals and sea turtles). A bounding analysis involves selecting and evaluating a different set of factors and scenarios for each resource in the context of a worst-case analysis. The second approach involves the selection of a single set of key events that, when combined, result in catastrophic consequences. The second approach is used for a site-specific analysis and, consequently, its possible application is more limited. Accordingly, this analysis combines the two approaches, relying on a generalized scenario while identifying site-specific severity factors for individual resources where possible. This combined approach allows for the scientific investigation of a range of possible, although not necessarily probable, consequences of a catastrophic blowout and oil spill in the Gulf of Mexico.

1.1.2.1 Geographic Scope

The Gulf of Mexico is a semi-enclosed basin with an extensive history of oil and gas activities and unique environmental conditions and hydrocarbon reservoir properties; consequently, this analysis is only applicable to the Gulf of Mexico OCS and is not intended for other OCS regions. For this analysis, unless otherwise specified, the water offshore of the Gulf Coast can be divided into three regions: shallow water (<1,000 ft; 305 m); deep water (≥1,000 ft but <5,000 ft; ≥305 m but <1,524 m); and ultra-deep water (≥5,000 ft; 1,524 m).

1.1.2.2 Impact-Producing Factors and Scenario

A hypothetical scenario (**Chapter 1.2**) was developed to provide a framework for identifying the potential impacts of an extended oil spill from an uncontrolled blowout. Where possible, this scenario is based on the two largest magnitude, blowout-related oil spills that have occurred in the Gulf of Mexico, i.e., *Ixtoc I* and *Deepwater Horizon* event. As noted above, because each spill event is unique, its outcome depends on many factors, including but not limited to, time of year, location, atmospheric and oceanographic conditions (e.g., winds, currents, coastal type, and sensitive resources), specifics of the well (i.e., flow rates, hydrocarbon characteristics, and infrastructure damage), and response effort (i.e., speed and effectiveness). Therefore, the specific impacts from future spills cannot be predicted based on this scenario, but generalized impacts can be projected.

1.1.2.3 OSRA Catastrophic Run

A special Oil Spill Risk Analysis (OSRA) model run was conducted to estimate the impacts of a possible future catastrophic or high-volume, extended-duration oil spill (**Chapter 2**). This analysis emphasized modeling a spill that continued for 90 consecutive days by launching spills on each of 90 consecutive days, with each trajectory tracked for up to 60 days. Modelling was run annually and for each of the four seasons. The OSRA was conducted for only the trajectories of oil spills from hypothetical spill locations to various onshore and offshore environmental resources. Data from three hypothetical spill locations located in the Central Planning Area (CPA), two hypothetical spill locations located in the Western Planning Area (WPA), and two hypothetical spill locations located in the Eastern Planning Area (EPA) were included and are intended for use as examples of this type of exercise (**Figure 1-1**).

The probability of an oil spill contacting a specific resource within a given time of travel from a spill point is termed a conditional probability; the condition being that a spill is assumed to have occurred. Each trajectory was allowed to continue for as long as 60 days. However, once a hypothetical spill contacts land, the spill trajectory is terminated and the contact is recorded. Although overall the OSRA model is designed for use as a risk-based assessment, for this analysis, only the conditional probability, the probability of contact to the resource, was calculated. The probability of a catastrophic spill occurring was not calculated; thus, the combination of the probability of a spill and the probability of contact to the resources from the hypothetical spill locations were not calculated. Results from this trajectory analysis provide input to the final product by estimating where a spill from a specific geographic location might travel on the ocean's surface and what environmental resources might be contacted if and when a catastrophic spill occurs, but it does not provide input on the probability of a catastrophic spill occurring. Further detail on this catastrophic OSRA run is contained in **Chapter 2**.

1.1.2.4 Environmental and Socioeconomic Impacts

This analysis evaluates the impacts to the Gulf of Mexico's physical, biological, and socioeconomic resources from a catastrophic loss of well control event, oil spill, and associated cleanup activities.

Although BOEM's recent EISs prepared for oil and gas lease sales in the Gulf of Mexico analyze the potential impacts from smaller oil spills that are more reasonably foreseeable (USDOI, BOEM, 2017a), this analysis focuses on the most likely and most significant impacts created by a high-volume, extended-duration spill. Because catastrophic consequences may not occur for all resources, factors affecting the severity of impacts are identified by the individual resource.

1.1.3 How to Use This Analysis

The purpose of this technical analysis is to assist BOEM in meeting the CEQ recommendation to provide decisionmakers with a robust analysis of reasonably foreseeable impacts associated with low probability catastrophic spills for oil and gas activities on the OCS (CEQ, 2010). This analysis, based on credible scientific evidence, identifies the most likely and most significant impacts from a high-volume blowout and oil spill that continues for an extended period. The scenario and impacts discussed in **Chapters 1.2 and 1.3** should not be confused with the scenario and impacts anticipated to result from routine OCS oil- and gas-related activities or the more reasonably foreseeable accidental events associated with these activities.

Chapter 1.2 is intended to clearly describe the scenario presented for all four phases of a catastrophic blowout event and identify the impact-producing factors associated with each phase. **Chapter 1.3** is intended to analyze the impacts of each phase of a catastrophic blowout on various environmental resources. These chapters can be used to differentiate the conditions of a catastrophic spill from the routine activities and accidental events described in lease sale EISs.

This technical analysis is designed to be incorporated by reference in future NEPA documents and consultations. Therefore, factors that affect the severity of impacts of a high-volume, extended-duration spill on individual resources are highlighted for use in subsequent site-specific analyses.

To analyze a hypothetical catastrophic event in an area such as the Gulf of Mexico, several assumptions and generalizations were made. However, future project-specific analyses should also consider specific details such as potential flow rates for the specific proposed activity, the properties of the targeted reservoir, and the proximity to environmental resources of the proposed activities.

1.2 IMPACT-PRODUCING FACTORS AND SCENARIO (PHASES 1-4)

For the purposes of this analysis, an event similar to the *Ixtoc I* well blowout and spill that occurred in 1979 in 164-ft (50-m) water depth will be used as the basis for a shallow-water spill (i.e., <1,000 ft; 305 m). An event similar to the *Deepwater Horizon* explosion, oil spill, and response, that occurred in 2010 in the Mississippi Canyon area in 4,992-ft (1,522-m) water depth, will be used to represent a deep- or ultra-deep water spill (i.e., ≥1,000 ft; 305 m).

1.2.1 Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout incident. While most of the environmental and socioeconomic impacts of a catastrophic blowout would occur during the ensuing high-volume, extended-duration spill (refer to **Chapter 1.3**), it is important to acknowledge the deadly events that could occur in the initial phase of a catastrophic blowout. The following scenario was developed to provide a framework for identifying the most likely and most significant impacts that could occur, if unmitigated, during the initial phase.

Impacts, response, and intervention depend on the spatial location of the blowout and release. While there are several points where a blowout could occur, four major distinctions that are important to the analysis of impacts are described in **Table 1-1**.

For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, a fire could result that could burn for 1 or 2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month (USDOC, NOAA, Office of Response and Restoration, 2010c). The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. For example, when the drilling rig *Deepwater Horizon* sank, it landed 1,500 ft (457 m) away on the seafloor. Regardless of water depth, the immediate response would be from fire-fighting vessels (if needed) and search-and-rescue vessels and aircraft, such as U.S. Coast Guard (USCG) cutters, helicopters, and rescue planes.

While this analysis assumes a catastrophic loss of well control and that a resultant oil spill has occurred and describes the ensuing environmental impacts, there are controls in place to prevent these types of events from occurring in the future. The Bureau of Safety and Environmental Enforcement (BSEE) works to promote safety, protect the environment, and conserve resources offshore through vigorous regulatory oversight and enforcement. Since its establishment in 2011, BSEE has been the lead Federal agency charged with improving safety and ensuring environmental protection related to the offshore energy industry, primarily oil and natural gas, on the United States OCS. The BSEE published the Blowout Preventer Systems and Well Control Final Rule (the WCR) on April 29, 2016. The 2016 WCR consolidated the equipment and operational requirements for well control into one part of BSEE's regulations; enhanced blowout preventer (BOP), well design, and well-control requirements; and incorporated certain industry consensus standards. Most of the 2016 WCR provisions became effective on July 28, 2016. Although the 2016 WCR addressed a significant number of issues that were identified during the analysis of the *Deepwater Horizon* explosion, oil spill, and response, BSEE recognized that BOP equipment and systems continue to improve technologically and that well-control processes also evolve. Additionally, following the 2016 WCR, BSEE continued to engage with the offshore oil and gas industry, Standards Development Organizations, and other stakeholders. During the course of those engagements, BSEE identified areas for regulatory improvement and stakeholders expressed a variety of concerns regarding the implementation of the 2016 WCR. Accordingly, after thoroughly reexamining the 2016 WCR and experiences from the implementation process, BSEE published the 2019 Blowout Preventer Systems and Well Control Revisions, commonly referred to as the 2019 Well Control Rule (*Federal Register*, 2019).

1.2.2 Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. After a well blowout incident occurs, the immediate focus would be to regain control of the well to eliminate the release of hydrocarbons into the environment. Additional efforts would be concentrated on dealing with the oil slick that forms on the surface of the water. These efforts would include booming, skimming, burning, and dispersing the oil. The use of chemical dispersants could include both application to the surface slick and subsurface injection at or near the wellhead.

1.2.2.1 Duration of Spill

The duration of the offshore spill from a blowout depends on the time needed for intervention and the time the remaining oil persists offshore. If a blowout occurs and the damaged surface facilities preclude well re-entry operations, a relief well may be needed to regain control. The time required to drill the relief well depends on the complexity of the intervention, the location of a suitable rig, the type of operation that must be terminated to release the rig (e.g., casing may need to be run before releasing the rig), and the logistics in mobilizing personnel and equipment to the location. A blown out well may also be successfully capped prior to completion of relief wells, as occurred in the *Deepwater Horizon*, oil spill, and response.

1.2.2.1.1 Shallow Water

If a blowout occurs in shallow water, it is estimated that the entire well intervention effort including drilling relief wells, if deemed necessary, could take 2 weeks to 3 months. This estimate would include 13 weeks to transport the drilling rig to the well site. During the *Ixtoc I* incident, several approaches were used, including the use of weighted drilling mud known as a “top kill,” as well as injecting steel, iron, and lead balls into the wellbore. An attempt was also made to deploy a purpose-built capping stack known as “the sombrero.” While these efforts were not successful in stopping the flow of oil completely, they did succeed in reducing the flow rate.

Spilled surface oil is not expected to persist more than 1-2 months (depending upon the season and environmental conditions) after the flow is stopped. Spilled oil is more likely to persist in the offshore environment during colder weather and during wind and hydrodynamic conditions that keep the oil offshore. Therefore, the estimated spill duration resulting from a shallow-water blowout is 1.5-5 months (approximately 2 weeks to 3 months for active spillage and 1-2 months for oil persistence in the environment).

1.2.2.1.2 Deep Water

During the *Deepwater Horizon* event multiple attempts were made using various collection and containment systems to slow or stop the flow of oil, most of these efforts were of limited success. After approximately 3 months, a capping stack was successfully placed over the wellhead, temporarily stopping the flow of oil to the environment. Later, a relief well intersected the damaged wellbore and drilling mud, and eventually cement was used to permanently seal the well.

If a blowout occurs in deep- or ultra-deep water, it is estimated that it would take 2-4 weeks to remove debris and to install a capping stack or a cap and flow system on a well, if conditions allow this type of intervention. The entire intervention effort, if it required drilling relief wells, would likely take 3-4 months (USDOI, MMS, 2000; Regg, 2000). This includes 2-4 weeks to transport the drilling rig to the well site. Spilled surface oil is not expected to persist more than 1-2 months (depending upon the season and environmental conditions) after the flow is stopped. Spilled oil is more likely to persist in the offshore environment during colder weather and during wind and hydrodynamic conditions that keep the oil offshore. Therefore, the estimated spill duration from a deepwater blowout is 1.5-6 months (approximately 2 weeks to 4 months for active spillage and 1-2 months for oil persistence in the environment).

1.2.2.2 Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of surface spreading depends on the type and volume of oil that is released, but would likely be hundreds of square miles. Also, the oil slick could break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Subsurface oil, like that observed during both the *Ixtoc I* and *Deepwater Horizon* oil spills, could also spread to significant distances depending on environmental conditions (such as hydrodynamics), oil chemistry and weathering, and the application of subsea dispersants or mechanical conditions at the release point that would diffuse the oil.

1.2.2.3 Volume of Spill

After 60 years of oil and gas exploration and development activity on the continental shelf of the Gulf of Mexico, the majority of the largest oil and natural gas reservoirs thought to exist in shallow-water areas of the GOM at drill depths less than 15,000 ft (4,572 m) subsea have been identified. The potential for large undiscovered hydrocarbon reservoirs is still possible in shallow-water areas. However, results taken from BOEM's resource assessment studies (USDOI, BOEM, 2012a and 2017b) and a review of the more recent shallow-water drilling and leasing activity suggest that future discoveries of large reservoirs are most likely in lower tertiary sediments in the shallow-water areas of the GOM and are likely at depths greater than 15,000 ft (4,572 m) subsea where geologic conditions are more favorable for natural gas reservoirs to exist than for oil reservoirs. In contrast to the shallow-water areas of the GOM where the discovery of a new, large, prolific oil reservoir is considered a low-probability event, BOEM suggests there is a high probability that many large oil and gas reservoirs have yet to be discovered in deep water (USDOI, BOEM, 2017b). The forecast is also supported by the results of BOEM's analysis of deepwater leasing and drilling activity, which indicates that the industry is leasing acreage in deepwater areas of the GOM where large prospects may be identified and where the majority of exploration and development drilling activity targets potentially thick oil reservoirs capable of achieving the high production rates necessary to offset the high costs associated with deepwater oil development in the GOM.

1.2.2.3.1 Shallow Water

For this analysis, an uncontrolled flow rate of 30,000 bbl per day is assumed for a catastrophic blowout in shallow water. This assumption is based upon the results of well tests in shallow water and the maximum flow rate from the 1979 *Ixtoc I* well blowout, which occurred in shallow water. Using this flow rate, the total volume of oil spilled from a catastrophic blowout in shallow water is estimated at 900,000 bbl to 3 MMbbl from a release occurring over 1-3 months. In addition to the flow rate, it is assumed that any remaining diesel fuel from a sunken drilling rig or platform would also leak.

1.2.2.3.2 Deep Water

For the purposes of this analysis, an uncontrolled flow rate of 30,000-60,000 bbl per day is assumed for a catastrophic blowout in deep water. This flow rate is based on well test results and the maximum flow rate (although restricted flow) estimated for the *Deepwater Horizon* explosion and oil spill, which occurred in deep water. Therefore, the total volume of oil spilled is estimated to be 0.9-7.2 MMbbl over 1-4 months. In addition, deepwater drilling rigs or platforms hold a large amount of diesel fuel (10,000-20,000 bbl). Therefore, it is assumed that any remaining diesel fuel from a sunken structure would also leak and add to the spill.

1.2.2.4 Oil in the Environment: Properties and Persistence

The fate of oil in the environment depends on many factors, such as the source and composition of the oil, as well as its persistence (NRC, 2003). Persistence can be defined and measured in different ways (Davis et al., 2004), but the National Research Council (NRC) generally defines persistence as how long oil remains in the environment (NRC, 2003). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (NRC, 2003). These processes may interact and affect the properties and persistence of the oil through the following:

- evaporation (volatilization);
- emulsification (the formation of a mousse);
- dissolution;
- oxidation (including respiration); and
- transport processes (NRC, 2003; Scholz et al., 1999).

Horizontal transport takes place via spreading, advection, dispersion, and entrainment while vertical transport takes place via dispersion, entrainment, Langmuir circulation, sinking, overwashing, partitioning, and sedimentation (NRC, 2003). The persistence of an oil slick is influenced by the effectiveness of oil-spill response efforts and affects the resources needed for oil recovery (Davis et al., 2004). The persistence of an oil slick may also affect the severity of environmental impacts as a result of the spilled oil.

Crude oils are not a single chemical, but instead are complex mixtures with varied compositions. Thus, the behavior of the oil and the risk the oil poses to natural resources depends on the composition of the specific oil encountered (Michel, 1992). Generally, oils can be divided into three groups of compounds: (1) light-weight; (2) medium-weight; and (3) heavy-weight components. On average, these groups are characterized as outlined in **Table 1-2**.

Of the oil reservoirs sampled in the Gulf of Mexico OCS, the majority fall within the light-weight category, while less than one quarter are considered medium-weight and a small portion are considered heavy-weight. Oil with an American Petroleum Institute (API) gravity of 10° or less would sink and has not been encountered in the Gulf of Mexico OCS; therefore, it is not analyzed in this document (USDOI, BOEMRE, 2010).

Heavy-weight oil may persist in the environment longer than the other two types of oil, but the medium-weight components within oil present the greatest risks to organisms because, with the exception of the alkanes, these medium-weight components are persistent, bioavailable, and toxic (Michel, 1992).

Previous studies (e.g., Johansen et al., 2001) supported the theory that most, if not all, released oil would reach the surface of the water column. However, data and observations from the *Deepwater Horizon* explosion, oil spill, and response and another spill in October of 2017 challenge that theory. Measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the water column as subsurface "plumes" , entrained in the water column via pressurized release, and on the seafloor in the vicinity of the release. It is important to note that the North Sea experiment (Johansen et al., 2001) did not include the use of dispersants at or near the source of the subsea oil discharge.

1.2.2.5 Release of Natural Gas

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. Although there is not a "typical" makeup of natural gas, it is primarily composed of methane (NaturalGas.org, 2012). When natural gas leaks from infrastructure (e.g., pipelines, wells, etc.), methane is released into the environment. In marine settings, the fate of leaked methane depends on ambient temperature and pressure conditions in the water column. When methane is released in shallow water, the gas forms bubbles that expand in size as they rise to the surface. When the bubbles break the surface, the gas enters the atmosphere. However, in deep water, in addition to bubbles rising to the surface, leaked methane may be compressed by ambient pressure such that it does not form bubbles and enters into the water in a dissolved phase. Dissolved gas is neutrally buoyant and does not float to the surface. Instead, the dissolved gas moves with the water as it drifts in currents and interacts with particulate organic matter (Karl and Tilbrook, 1994).

Limited research is available for the biogeochemistry of hydrocarbon gases in the marine environment (Patin, 1999). Theoretically, methane could stay in the marine environment for long periods of time (Patin, 1999) as methane is highly soluble in seawater at the high pressures and cold temperatures found in deepwater environments (NRC, 2003, page 108). Methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974). Methane is a carbon source and its introduction into the marine environment could result in diminished dissolved oxygen concentrations due to microbial degradation.

The *Deepwater Horizon* explosion and oil spill resulted in the emission of an estimated 9.14×10^{9} to 1.29×10^{10} moles of methane from the wellhead (Kessler et al., 2011; Valentine et al., 2010) with maximum subsurface methane concentrations of 183-315 micromoles measured in May/June 2010 (Valentine et al., 2010; Joye et al., 2011). According to the Ideal Gas Law, 1 mole of gas (including methane and oxygen) is equal to 22.4 liters volume at standard temperature and pressure (20 °Celsius [°C] [68 °Fahrenheit; °F] at 1 atmosphere). This methane release corresponded to a measurable decrease in oxygen in the subsurface plume due to respiration by a community of methanotrophic bacteria. During the *Deepwater Horizon* explosion and oil spill, methane and oxygen distributions were measured at 207 stations throughout the affected region (Kessler et al., 2011). Based on these measurements, it was concluded that within ~120 days from the onset of release ~3.0×10^{10} to 3.9×10^{10} moles of oxygen were respired, primarily by methanotrophs, and left behind a residual microbial community containing methanotrophic bacteria. The researchers further suggested that a vigorous deepwater (800-1,200 m; 2,625-3,937 ft) bacterial bloom respired nearly all the released methane within this time and that by analogy, large-scale releases of methane from hydrates in the deep ocean are likely to be met by a similarly rapid methanotrophic response. However, hypoxic conditions were never reached (OSAT, 2010). Hypoxic conditions are generally agreed to occur when dissolved oxygen falls below 2 milligrams/liter (1.4 milliliter/liter) (OSAT, 2010). Note that methane released from the *Deepwater Horizon* explosion and oil spill was generally confined to the subsurface, with minimal amounts reaching the atmosphere (Kessler et al., 2011; Ryerson et al., 2011).

1.2.2.6 Deepwater Subsea Containment

Notice to Lessees and Operators (NTL) 2010-N10 and 30 CFR § 250.462 requires that offshore operators address containment system expectations to be able to rapidly contain a spill as a result of a loss of well control from a subsea well. This resulted in the development of rapid response containment systems that are available through either the Marine Well Containment Company or Helix Well Containment Group in the Gulf of Mexico. In addition, industry has a multitude of vendors available within the GOM region that can provide the services and supplies necessary for debris removal capability, dispersant injection capability, and top-hat deployment capability. Many of these vendors are already cited for use by the Marine Well Containment Company and Helix Well Containment Group. The BSEE will not allow an operator to begin drilling operations until adequate subsea containment and collection equipment, as well as subsea dispersant capability, is determined by BSEE to be available to the operator and is sufficient for use in response to a potential incident from the proposed well(s).

Marine Well Containment Company

The Marine Well Containment Company's (MWCC) Containment System includes two modular capture vessels (MCVs); enhanced subsea umbilical, risers, and flowlines equipment; three capping stacks; and additional ancillary equipment. A capping stack is uniquely designed to shut off the flow of fluid from the well or to provide a conduit to safely flow well fluids to the MCVs. The processing equipment on the MCVs can separate sand and can process liquids and gases flowed from a damaged subsea well. The MWCC Containment System is capable of being deployed in water depths from 500 to 10,000 ft (152-3,048 m), temperatures up to 350 °F (177 °C), and pressures up to 15,000 pounds per square inch (psi). The MWCC's suite of containment equipment enables the company to mobilize and deploy the most appropriate well containment technology based upon the unique well control incident and equipment requirements. The system has the capacity to contain up to 100,000 bbl of liquid per day (4.2 million gallons/day) and handle up to 200 million standard cubic feet of gas per day. The containment system combines equipment from the company's previous Interim Containment System and the Expanded Containment System. This system is designed to fully contain oil flow in the event of a potential future underwater blowout and to address a variety of scenarios (Marine Well Containment Company, 2015).

The MWCC's subsea umbilical, risers, and flowlines equipment, which is used to flow fluid from the capping stack to the MCVs as well as to provide dispersant and hydrate mitigation injection, is staged in Theodore, Alabama. The MWCC houses, stores, and tests the processing equipment for the two MCVs, as well as its capping stacks, in Ingleside, Texas. The MWCC also provides fully trained crews to operate the system, ensures the equipment is operational and ready for rapid response, and conducts research on new containment technologies (Marine Well Containment Company, 2015).

In the summer of 2012, a full-scale deployment of MWCC's critical well control equipment to exercise the oil and gas industry's response to a potential subsea blowout in the deep waters of the Gulf of Mexico was conducted by BSEE. The MWCC's 15,000-psi capping stack system, a 30-ft (9-m) tall, 100-ton piece of equipment similar to the one that stopped the flow of oil from the *Macondo* well following the *Deepwater Horizon* explosion in 2010, was successfully tested during this deployment drill. During this exercise, the capping stack was deployed from its storage location in Ingleside, Texas, to an area in the Gulf of Mexico nearly 200 mi (322 km) from shore. Once on site, the system was lowered to a simulated wellhead (a pre-set parking pile) on the ocean floor in nearly 7,000 ft (2,134 m) of water, connected to the wellhead, and then pressurized to 10,000 psi.

HWCG

Another option for source control and containment in the Gulf of Mexico is through Helix Well Containment Group (now HWCG). HWCG contracted the equipment that it found useful in the *Deepwater Horizon* explosion, oil spill, and response and offered it to oil and gas producers for use beginning January 1, 2011. The HWCG system has the ability to fully operate in up to 10,000 ft (3,048 m) of water and has intervention equipment to cap and contain a well with the mechanical integrity to be shut-in. The HWCG system also has the ability to capture and process 130,000 bbl of oil per day and 220 million standard cubic feet per day (Helix Well Containment Group, 2015).

In April-May 2013, a full-scale deployment of the HWCG's critical well control equipment to exercise the oil and gas industry's response to a potential subsea blowout in the deep water of the Gulf of Mexico was conducted by BSEE. The HWCG's capping stack system is a 20-ft (6-m) tall, 146,000-pound piece of equipment similar to the one that stopped the flow of oil from the *Macondo* well following the *Deepwater Horizon* explosion in 2010. It was successfully tested during this unannounced deployment drill. The capping stack was deployed from its storage location and once onsite, the system was lowered to a simulated wellhead (a pre-set parking pile) on the ocean floor in nearly 5,000 ft (1,524 m) of water, connected to the wellhead, and then pressurized to 8,400 psi.

1.2.2.7 Offshore Cleanup Activities

As demonstrated by the *Ixtoc I* and *Deepwater Horizon* oil spills, a large-scale response effort is certain to follow a catastrophic blowout. The number of vessels and responders would steadily increase as the spill continued. In the event of a spill, particularly a loss of well control, there is no single method of containment and removal that would be 100 percent effective. Removal and containment efforts to respond to an ongoing spill offshore would likely require multiple technologies, including source containment, mechanical cleanup, *in-situ* burning of the slick, and the application of chemical dispersants. Even with the deployment of all of these spill-response technologies, with the operating limitations of today's spill-response technology, not all of the oil would be contained and removed offshore.

1.2.2.7.1 Shallow Water

The following estimates are for the deployment of equipment and personnel during a shallow-water spill response. Within 2 weeks of an oil spill originating in shallow water, up to 100 skimming vessels could be deployed to recover oil. This includes up to 30 skimmers in the vicinity of the source at any given time, as well as recovery systems operating offshore, nearshore and in bays and marshes as the as the geographic distribution of the oil continues to spread. In addition, recovered oil may be barged to shore from recovery vessels. It is anticipated that thousands of vessels would be used for all response operations during this response. Over 1,000 responders are estimated to be deployed within the first 2 weeks, which would steadily increase up to 25,000 responders before capping or killing the well within 2-4 months. Up to 55 aircraft are estimated to respond per day at the peak of a response to a shallow-water spill. Response to an oil spill in shallow water is expected to involve up to 75,000 ft (2,286 m) of containment boom used in on-water oil recovery. Additionally, as the spill begins to threaten and impact shoreline resources, the response could deploy hundreds of thousands of feet of boom along the shore to protect shoreline resources from oiling and to contain and recover oil that impacted shoreline resources. The amount of nearshore and shoreline boom that is deployed is dependent upon the amount of the potentially impacted shoreline, the type of shoreline impacted, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. Containment and recovery of oil along the shore can be passive through the use of sorbents, or active recovery through skimming, vacuuming, manual collection, flushing, marsh burning, or other mechanical removal, such as beach cleaning machines.

Dispersant use must be in accordance with the Regional Response Team's (RRT) Preapproved Dispersant Use Manual and with any conditions outlined within an RRT's site-specific, dispersant approval given after a spill event. Consequently, dispersant use would likely be in accordance with the restrictions for specific water depths, distances from shore, and monitoring requirements. At this time, this manual does not give preapproval for the application of dispersant use subsea. Aerial dispersants would likely be applied from airplanes as a mist, which settles on the oil on the water's surface. Along the Gulf Coast, surface dispersants are presently preapproved for use greater than 3 nautical miles (nmi) (3.5 mi; 5.6 km) from shore and in water depths greater than 33 ft (10 m), with the exception of Florida (U.S. Dept. of Homeland Security, CG, 2016). At this time, pursuant to a letter from the Florida Department of Environmental Protection dated May 5, 2011, sent to USCG, preapproval for dispersant use is not approved for any Florida State waters. However, the U.S. Environmental Protection Agency (USEPA) is presently revisiting these RRT preapprovals in light of the dispersant issues, such as subsea application that arose during the *Deepwater Horizon* explosion, oil spill, and response. In addition, revisions are presently being made to the RRT IV and VI's Preapproved Dispersant Use Manuals. The USEPA issued a letter dated December 2, 2010, that provided interim guidance on the use of dispersants for major spills that are continuous and uncontrollable for periods greater than 7 days and for expedited approval of subsurface applications. This letter outlined the following exceptions to the current preapprovals until they are updated:

- dispersants may not be applied to major spills that are continuous in nature and uncontrollable for a period greater than 7 days;
- additional dispersant monitoring protocols and sampling plans may be developed that meet the unique needs of the incident; and
- subsurface dispersants may be approved on an incident-specific basis as requested by the USCG On-Scene Commander.

More robust documentation of dispersant usage may be required. This documentation would include daily reports that contain the products used, the specific time and locations of application, equipment used for each application, spotter aircraft reports, photographs, vessel data, and analytical data. Additionally, in light of the dispersant issues that arose during the *Deepwater Horizon* response, the State of Florida’s Department of Environmental Protection submitted a letter dated May 5, 2011, to the USEPA Region IV, Regional Response Team in which the State of Florida withdrew all State waters (9 nmi [10 mi; 17 km] off the coast of Florida in the Gulf of Mexico) from the Green Zone (or approved area) for dispersant preapproval as outlined within the “Region IV Dispersant Use Policy in Ocean and Coastal Waters.” The State indicated in the letter that this change was requested due to the enormous changes that have occurred in communication and response technologies since the preapproval was first agreed to in 1996. The State indicated that they felt that the “Region IV Dispersant Use Policy in Ocean and Coastal Waters” document needed to be updated to reflect technological advances and lessons learned during the response to the *Deepwater Horizon* oil spill (State of Florida, Dept. of Environmental Protection, 2011).

The USEPA has issued a proposed rule to amend the requirements in Subpart J of the National Contingency Plan that governs the use of dispersants, other chemical and biological agents, and other spill mitigating substances when responding to oil discharges into waters of the United States. The proposed rule addresses the efficacy, toxicity, environmental monitoring of dispersants, and other chemical and biological agents, as well as public, local, State, and Federal officials’ concerns regarding their use (*Federal Register*, 2015).

In addition to dispersants, controlled burns may also occur. It is estimated that 5-10 controlled burns would be conducted per day in suitable weather. During the response it is estimated that about 400 burns, which would remove approximately 240,000 bbl of oil, could occur (National Response Committee, 2011).

1.2.2.7.2 Deep Water

The following estimates are for the deployment of equipment and personnel during a deepwater spill response. This includes up to 30 skimmers in the vicinity of the source at any given time, as well as recovery systems operating offshore, nearshore and in bays and marshes as the as the geographic distribution of the oil continues to spread. Additional recovery systems could cascade in from other regions, such as the Atlantic and Pacific, as well as internationally as the oil continues to spread. The types of vessels sourced to the deepwater areas would typically be at least 75 ft (23 m) long and equipped with high-volume skimming capabilities, temporary storage, and crew accommodations to remain underway for an extended period. In the nearshore zone, which is from the coastline to approximately 3 mi (5 km) offshore, vessels would be less than 75 ft (23 m) long. Agile skimming platforms would be utilized in the nearshore area as they would be most effective because they could move in between patches of oil (National Response Committee, 2011). Using the Deepwater Horizon response as a proxy, a peak of approximately 9,700 vessels could be used for all response operations (National Incident Command, 2010). In addition, recovered oil would likely be shuttle tankered to shore from recovery vessels and storage barges. For an oil spill in deep water, over 1,600 responders are estimated to be deployed within the first 2 weeks, which would steadily increase up to 48,000 responders before capping or killing the well within 3-5 months (National Response Committee, 2011). Response to an oil spill in deep water is expected to involve up to 100,000 ft (2,286 m) of containment boom used in on-water oil recovery. Additionally, as the spill begins to threaten and impact shoreline resources, the response could deploy hundreds of thousands of feet of boom along the shore to protect shoreline resources from oiling and to contain and recover oil that impacted shoreline resources. The amount of nearshore and shoreline boom deployed is dependent upon the amount of the potentially impacted shoreline, the type of shoreline impacted, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. Containment and recovery of oil along the shore can be passive through the use of sorbents, or active recovery through skimming, vacuuming, manual collection, flushing, marsh burning, or other mechanical removal, such as beach cleaning machines. Approximately 127 aircraft are estimated to respond per day during peak response during a deepwater spill (National Incident Command, 2010).

With the exception of special Federal management areas or designated exclusion areas, dispersants have been preapproved for surface use in the vicinity of a deepwater blowout (U.S. Dept. of Homeland Security, CG, 2016). However, the USEPA is presently examining these preapprovals, and restrictions are anticipated regarding the future use of dispersants as a result of this examination. No preapproval presently exists for the use of subsea dispersants, and approval must be obtained before each use of this technology. The use of subsea dispersants depends on the location of the blowout, as shown in **Table 1-1**. Due to the unprecedented volume of dispersants applied for an extended period of time in situations not previously envisioned or incorporated in existing dispersant use plans (i.e., during the *Deepwater Horizon* spill response), the U.S. National Response Team has developed guidance for monitoring atypical dispersant operations. The guidance document, which was approved on May 30, 2013, is titled *Environmental Monitoring for Atypical Dispersant Operations: Including Guidance for Subsea Application and Prolonged Surface Application* (U.S. National Response Team, 2013). The subsea guidance generally applies to the subsurface ocean environment and focuses on operations in waters below 300 m (984 ft) and below the pycnocline, or the interface between an upper mixed density gradient and a lower stable density gradient. The surface application guidance supplements and complements the existing protocols as outlined within the existing Special Monitoring of Applied Response Technologies (SMART) monitoring program where the duration of the application of dispersants on discharged oil extends beyond 96 hours from the time of the first application (U.S. National Response Team, 2013). This guidance is provided to the Regional Response Teams by the U.S. National Response Team to enhance existing SMART protocols and to ensure that their planning and response activities will be consistent with national policy.

Aerial dispersants are usually applied from airplanes as a mist, which settles on the oil on the water's surface. Major spills that are continuous and uncontrollable for periods greater than 7 days and the approval of subsurface dispersant application are presently subject to the guidance outlined in the USEPA's letter dated December 2, 2010. This letter provides interim guidance on the use of dispersants for major spills and outlines exceptions to the current preapprovals until they are updated, as discussed more fully in **Chapter 1.2.2.7.1**. For a deepwater spill, dispersant application may be a preferred response in the open-water environment to prevent oil from reaching a coastal area; this would be in addition to a mechanical response. However, the window of opportunity for successful dispersant application may be somewhat narrower for some deepwater locations depending on the physical and chemical properties of the oil, which tend to be somewhat heavier or more likely to emulsify than those found closer to shore. A significant reduction in the window of opportunity for dispersant application may render this response option ineffective. The USEPA has recently issued a proposed rule to amend the requirements in Subpart J of the National Contingency Plan, which governs the use of dispersants, other chemical and biological agents, and other spill mitigating substances when responding to oil discharges into waters of the United States. The proposed rule addresses the efficacy, toxicity, environmental monitoring of dispersants, and other chemical and biological agents, as well as public, local, State, and Federal officials' concerns regarding their use (*Federal Register*, 2015).

In addition to dispersants, controlled burns may also occur. It is estimated that 5-10 controlled burns would be conducted per day in suitable weather. During the response it is estimated that about 400 burns, removing approximately 240,000 bbl of oil, could occur (National Response Committee, 2011).

1.2.2.7.3 Vessel Decontamination Stations

To avoid contaminating inland waterways, multiple vessel decontamination stations may be established offshore in Federal and State waters. The selected locations to conduct decontamination of oiled vessels will, due to the unique aspects of each spill response, be decided by the Unified Command during the spill response effort. Since the Unified Command includes representatives of the affected state(s), the States will have a prominent voice regarding whether a location in State waters will be acceptable.

Vessels responding to the spill and commercial and recreational vessels passing through the spill would anchor, awaiting inspection. If decontamination is required, workboats would use fire hoses to clean oil from the sides of the vessels. This could result in some oiling of otherwise uncontaminated waters. While these anchorage areas would be surveyed for buried pipelines that could be ruptured by ship anchors, they may not be surveyed adequately for benthic communities or archaeological sites. Therefore, some damage to benthic communities or archaeological sites may occur because of vessel decontamination activities associated with an oil spill (Nodar, 2010; Unified Incident Command, 2010a, 2010b, and 2010c; USDOC, NOAA, 2010a; USEPA, 2012).

During the peak of a deepwater spill response, a decontamination operations system could involve up to 17 individual sites across the Gulf of Mexico, employing approximately 4,000 personnel (National Response Committee, 2011).

1.2.2.8 Severe Weather

A hurricane could accelerate biodegradation, increase the area affected by the spill, and slow or stop the response effort. The movement of oil would depend on the track, wind speed, and size of a hurricane. The official Atlantic hurricane season runs from June 1st through November 30th, with a peak of hurricane probability in September. From 2010 through 2018 in an average Atlantic season, there are 15 named storms, 7 hurricanes, and 3 major hurricanes (USDOC, NOAA, Atlantic Oceanographic and Meteorological Laboratory, 2020). As a result of a hurricane, high winds and seas would mix and weather the oil from an oil spill. This can help accelerate the biodegradation process (USDOC, NOAA, National Weather Service, 2012). The high winds may distribute oil over a wider area (USDOC, NOAA, National Weather Service, 2012).

Weather has been recognized as one of the most important factors in predicting oil-spill fate and behavior and in predicting the success of an oil-spill response. During an oil spill, booms, skimmers, oil burn, and the use of dispersants have been used to remove oil from the water surface. Adverse weather conditions would affect the use, performance, and effectiveness of booms and skimmers. Skimmers work best in calm wind; for wave heights greater than 1 m (3 ft), some skimmers would not work effectively. Conventional booms would not work at a current velocity of 0.5 meters per second (m/sec) (1.6 feet per second [ft/sec]) or greater. For oil burn, ignition cannot be carried out at wind speeds greater than 10 m/sec (33 ft/sec). The minimum wind speed for dispersant use is about 5 m/sec (16 ft/sec), and the maximum wind speed for the limit of dispersant applications is about 12-14 m/sec (39-46 ft/sec) (Fingas, 2004).

There are tradeoffs in deciding where and when to place boom because, once deployed, boom is time consuming to tend and to relocate. As previously noted, booming operations are sensitive to wind, wave, and currents, and those sections of boom need to be tethered and secured to keep them from moving. Furthermore, it was discovered during the *Deepwater Horizon* explosion, oil spill, and response that hard boom often did more damage than anticipated in the marsh it was intended to protect after weather conditions ended up stranding the boom back into the marsh. Due to time constraints prior to a hurricane event, it is therefore unlikely that much effort could be expended to move large amounts of deployed boom, particularly given the effort that would be required to move skimming equipment to safer locations inland and to move large numbers of response personnel to safer areas. However, since the conditions for each spill response are unique, these considerations would be examined and a site-specific hurricane response plan developed during the actual spill response effort by the Unified Command at the beginning of the official hurricane season.

In addition, adverse weather would reduce the ability to respond to the spill and could result in delayed transport and placement of the capping stack. The action of wind on the water surface would generate waves. Typically, waves greater than 3 ft (1 m) would prevent smaller vessels from skimming in offshore waters; waves greater than 5 ft (1.5 m) would prevent even the larger vessels from getting offshore to skim. The new high-speed skimmers under development are very promising; some skimmers have recovered oil with wave heights of up to 10 ft (3 m) with corresponding winds of up to 15 m/sec (49 ft/sec).

In the event of a hurricane, vessels would evacuate the area, delaying response efforts, including the drilling of relief wells and any well capping or collection efforts. Severe weather, such as a hurricane, would delay the transport and placement of the capping stack. If a cap is applied and oil is flowed to a collection vessel, severe weather would cause the collection vessel to vacate its location and the oil would flow until the collection vessel could return and resume collection. Severe weather could also require that response assets be relocated inland. The response would be delayed because following the severe weather event the assets would need to be transported back to the staging areas. The speed with which the assets could be brought back to the locations would depend on the condition of the roads and bridges for traffic resumption and the amount of debris potentially blocking the roads.

1.2.3 Phase 3—Onshore Contact

1.2.3.1 Duration

The duration of shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. The time needed to cap or kill a well may vary, depending on, among other things, the well's water depth, its location, the well and geologic formation characteristics, and the associated debris. Depending on the spill's location in relation to winds and currents and the well's distance to shore, oil could reach the coast within 1 week to 1 month, based on evidence from previous spills in the Gulf of Mexico OCS (e.g., it was nearly 4 weeks after the *Deepwater Horizon* explosion and oil spill). While it is assumed that the majority of spilled oil would dissipate offshore within 30-60 days of stopping the flow, some oil may remain in coastal areas for some time after a spill, as was observed along the Gulf Coast following the *Deepwater Horizon* explosion and oil spill.

1.2.3.1.1 Shallow Water

Due to the distance from shore, oil spilled as a result of a blowout in shallow water could reach shore within 1-3 weeks and could continue until the well is killed or capped and the oil dissipates offshore. Therefore, it is estimated that initial shoreline oiling would likely occur for 1.5-5 months following a catastrophic blowout. Some shoreline areas could be re-oiled during this timeframe dependent upon the weather conditions at the time of the spill as well as the persistence of the spilled oil.

1.2.3.1.2 Deep Water

Intervention is more difficult and would take longer in deeper water, in part, because intervention efforts are conducted by remotely operated vehicles. In general, most of the deep water in the Gulf of Mexico is located farther from shore and, therefore, it is assumed that oil would reach shore within 2-4 weeks. However, for the few deepwater areas that are located closer to shore, such as in the Mississippi Canyon Area, the amount of estimated time until shoreline contact could be the same as the shallow-water scenario above (1-3 weeks). The length of shoreline oiled would continue to increase and previously oiled areas could be re-oiled until the well is killed or capped (3-4 months) and the oil dissipates offshore (1-2 months). Therefore, initial shoreline oiling could occur from 3 months up to 6 months following a catastrophic blowout. Persistent shoreline oiling is discussed in **Chapter 1.2.4** (Phase 4) below.

1.2.3.2 Volume of Oil Contacting Shore

In the event of a catastrophic spill, not all of the oil spilled would contact shore. The amount of oil recovered and chemically or naturally dispersed would vary. For example, the following are recovery and cleanup rates from previous high-volume, extended spills:

- 10-40 percent of oil recovered or cleaned up (including burned, chemically dispersed, and skimmed);
- 25-40 percent of oil naturally dispersed, evaporated, or dissolved; and
- 20-65 percent of the oil remains available for offshore or inshore contact.

In the case of the *Deepwater Horizon* explosion, oil spill, and response, the “expected” scenario was developed by the Oil Budget Calculator Science and Engineering Team of The Federal Interagency Solutions Group. This scenario suggests that more than one quarter (29%) was naturally or chemically dispersed into Gulf waters, while burning, skimming, and direct recovery from the wellhead removed one quarter (25%) of the oil released. Less than one quarter (23%) of the total oil naturally evaporated or dissolved. The residual amount, just under one quarter (23%), remained in the Gulf of Mexico as a light sheen or as tarballs that have washed ashore or are buried in sand and other sediments (The Federal Interagency Solutions Group, 2010).

For planning purposes, the USCG estimates that 5-30 percent of oil would reach shore in the event of an offshore spill (33 CFR part 154, Appendix C, Table 2). Using the USCG’s assumptions, a catastrophic spill could result in a large amount of oil reaching shore.

1.2.3.3 Length of Shoreline Contacted

While larger spill volumes increase the chance of oil reaching the coast, other factors that influence the length and location of shoreline contacted include the duration of the spill and the well’s location in relation to winds, currents, and the shoreline. Depending upon winds and currents throughout the spill event, already impacted areas could be re-oiled. As seen with the *Deepwater*

Horizon oil spill, as the spill continued, the length of oiled shoreline at any one time increased by orders of magnitude as follows:

Duration of Spill	Length of Shoreline Oiled[1]
30 days	0-50 miles (0-80 kilometers)
60 days	50-100 miles (80-161 kilometers)
90 days	100-1,102 miles (161-1,773 kilometers)
120 days	>1,102 miles (1,773 kilometers)[2]

[1] Not cumulative.
[2] Length was extrapolated.

Sources: USDOC, NOAA, 2020a; Michel et al., 2013.

1.2.3.3.1 Shallow Water

While a catastrophic spill from a shallow-water blowout is expected to be lower in volume than a deepwater blowout (refer to **Chapter 1.2.2.3**), the site would typically be closer to shore, allowing less time for oil to be weathered, dispersed, and recovered. This could result in a more concentrated and toxic oiling of the shoreline.

1.2.3.3.2 Deep Water

While a catastrophic spill from a deepwater blowout is expected to have a much greater volume than a shallow-water blowout (refer to **Chapter 1.2.2.3**), the site would typically be farther from shore, allowing more time for oil to be weathered, dispersed, and recovered. This could result in broader, patchier oiling of the shoreline.

Translocation of the spilled oil via winds and currents is also a factor in the length of shoreline contacted. For example, oil could enter the Loop Current and then the Gulf Stream. However, the longer it takes oil to travel, the more it would degrade, disperse, lose toxicity, and break into streamers and tarballs (USDOC, NOAA, Office of Response and Restoration, 2010d).

1.2.3.4 Severe Weather

In the event of a hurricane, vessels would evacuate the area, delaying response efforts, including the drilling of relief wells. The storm surge may push oil to the coastline and inland as far as the surge reaches, or the storm surge may remove the majority of oil from shore, as seen in some of the previous spills reviewed.

Movement of oil during a hurricane would depend greatly on the track of the hurricane in relation to the slick. A hurricane's winds rotate counter-clockwise. In general, a hurricane passing to the west of the slick could drive oil to the coast, while a hurricane passing to the east of the slick could drive the oil away from the coast.

Severe weather may distribute spilled oil over a wide area. Storm surge may carry oil into the coastal and inland waters and shore. Debris resulting from severe weather may be contaminated by oil. Thus, the responders need to take proper precautions, as needed. Weather that results in waves greater than 3 ft (1 m) prevents skimming in coastal waters so there is a greater likelihood of contact with the shoreline. Severe weather would also displace or destroy shoreline boom so that oil could come into contact with the shoreline until responders put the boom back in place. Severe weather could require that assets be relocated inland. The response would be delayed because following the severe weather event the assets would need to be transported back to the staging areas. The speed with which the assets could be brought back to the locations would depend on the condition of the roads and bridges for traffic resumption and the amount of debris potentially blocking the roads.

The USEPA, USCG, other Federal response agencies, and applicable State agencies would work together to address oil spills reported to the National Response Center or reported by emergency responders before, during, or after a hurricane occurs. Response personnel would clean up significant spills and take other actions appropriate to protect public health and the environment. This response would cover any OCS spills that may occur as a result of the hurricane or preexisting at the time of the hurricane. Response activities may be interrupted or complicated during a hurricane event. Oil from an ongoing OCS spill event may be washed ashore during a hurricane event; could be weathered, diluted, or washed farther inland; and could be mixed with other contaminants from other sources released during a hurricane event (e.g., heating oil or industrial chemicals). For example, onshore sources account for most of the oil spilled during the past few hurricane seasons that has resulted in oiled property. After Hurricane Sandy, some oil heating tanks flooded and caused oiling of a property owner’s own building(s). As such, depending on circumstances, a hurricane event during an OCS spill event could complicate and exacerbate spill impacts and response operations, but it could also increase weathering and dilution.

1.2.3.5 Onshore Cleanup Activities

A large-scale response effort would be expected for a catastrophic blowout. The number of vessels and responders would increase steadily as the spill continued. In addition to the response described in **Chapter 1.2.2.7**, the following response is also estimated to occur once the spill contacts the shore.

1.2.3.5.1 Shallow Water

- There could be 5-10 staging areas established.
- Weathering permitting, up to 100 skimmers could be deployed near shore to protect coastlines.

1.2.3.5.2 Deep Water

- There could be 10-20 staging areas established.
- Weather permitting, up to 100 skimmers could be deployed near shore to protect coastlines. As seen in Louisiana following the *Deepwater Horizon* explosion and oil spill, many coastal skimmers could still be in operation a few months after the well is capped or killed (State of Louisiana, 2010).

1.2.3.5.3 Response Considerations for Sand Beaches for Both Shallow-Water and Deepwater Spills

- No mechanical techniques allowed in some areas.
- Surface residence balls, also commonly known as tarballs, and surface residence patties are subject to smearing during the day; therefore, much of the beach cleanup could be expected to be conducted at night, if the weather is warm.
- There are marked differences in the sediments on the central Louisiana coast as compared with the Gulf beaches of Alabama, Florida, and Mississippi; therefore, no single technique would be universally applicable for cleaning sand beaches.
- Typically, sand sieving, shaking, and sifting beach cleaning machines would be used. The depth of cut below the sand surface can be expected to typically range from 0 to 12 inches (in) (0 to 30 centimeters [cm]) when using this equipment.
- It is anticipated that the responders would be instructed that no disturbance would be allowed below 18 in (46 cm). However, oil can be expected down to a depth of 24-26 in (61-66 cm) below the sand surface.
- Repetitive tilling and mixing may be used at beaches such as Grand Isle, Louisiana, using agriculture plows and discs in combination with beach cleaning machines. Sand washing treatment also may take place at beaches such as Grand Isle’s beach. Sand washing includes a sand sieve/shaker to remove debris and large oil particles and a heated washing system. Average daily throughput for these systems would be 290 cubic yards per day. Sand treated in this manner is typically treated by sediment relocation, which is where the sand is moved to an active intertidal zone.

1.2.3.5.4 Response Considerations for Marshes for Both Shallow-Water and Deepwater Spills

- Lightly oiled marsh may be allowed to recover naturally; the oil may be allowed to degrade in place or to be removed by tidal or wave action.
- Moderately or heavily oiled marsh could be cleaned by vacuuming or skimming from boats in conjunction with flushing to enhance oil recovery rates, low-pressure

flushing (with water comparable to marsh type), manual removal by hand or mechanized equipment, or vegetation cutting.

- In some heavily oiled areas, *in-situ* burning may be an option if water covers the sediment surface. This technique is only considered when the source is contained due to potential re-oiling of the area. Surface washing agents are also a technique that might be used.
- Bioremediation may be used but mostly as a secondary treatment after bulk removal.

1.2.3.5.5 Response Considerations for Nearshore Waters for Both Shallow-Water and Deepwater Spills

- Nearshore submerged oil is difficult to recover and hard to locate; vacuums and snares could be used.
- In the vicinity of marsh areas, skimming techniques with flushing could be used where warranted. In areas too shallow to use skimmers, oil removal could be accomplished using vacuum systems, in conjunction with flushing as needed. Booming could also be used to temporarily contain mobile slicks until they are recovered.

1.2.4 Phase 4—Post-Spill, Long-Term Recovery

During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and that cleanup activities are concluding. While it is assumed that the majority of spilled oil floating on surface waters would be dissipated within 30-60 days of stopping the flow, oil has the potential to persist in the environment long after a spill event and it has been detected in sediment 30 years after a spill, depending upon the impacted environment (USDOI, FWS, 2010a). On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms (USDOI, FWS, 2010a).

The multiple-year response required for the *Deepwater Horizon* explosion, oil spill, and response provided one example of a long-term recovery to a catastrophic spill in the Gulf of Mexico. After the *Deepwater Horizon* explosion, oil spill, and response, a multi-agency Operational Science Advisory Team (OSAT), under the direction of the USCG, was convened to provide information to help guide response activities and to provide a better understanding of the potential environmental and health risks after the *Deepwater Horizon* explosion, oil spill, and response. A summary of the OSAT findings include the following:

- OSAT, issued in December 2010, concluded that no recoverable oil from the *Deepwater Horizon* oil spill remained in the water column. In addition, none of the roughly 17,000 water samples collected and analyzed exceeded the USEPA's benchmarks for protection of human health (OSAT, 2010).

- OSAT-2, issued in February 2011, found that residual oil in nearshore and sandy shoreline areas was highly weathered and that concentrations of constituents of concern were well below levels of concern for human health (OSAT, 2011a).
- The OSAT Ecotoxicity Addendum, issued in July 2011, found that, with respect to the indicators considered in the OSAT (2010) report, the results discussed in this addendum are consistent with the OSAT conclusions that "no exceedances of the EPA's dispersant benchmarks were observed" and that "since 3 August 2010 (last day with potentially recoverable oil on the ocean surface), <1% of water samples and ~1% of sediment samples exceeded EPA's aquatic life benchmarks for polycyclic aromatic hydrocarbons (PAHs)." In addition, results of the toxicity tests support the conclusions of the OSAT report regarding the distribution of actionable (i.e., amenable to removal actions) oil and dispersant-related constituents (OSAT, 2011b).
- OSAT-3, finalized in early 2014, used a sophisticated scientific approach to identify potential discrete pockets of subsurface material. The OSAT-3 information was used to locate and recover potential subsurface material (British Petroleum, 2014). The OSAT-3 report also identified actions to be taken for reducing the potential recurrence of oil along the northeastern shores of the Gulf of Mexico. In addition, the report evaluated the feasibility of each action taken to recover or remove oil from the *Deepwater Horizon* oil spill and the net environmental benefit of employing each recovery technique recommended. This scientific support was provided to the Federal On-Scene Coordinator with shoreline segment-specific information to facilitate the operational decisionmaking process to recover residual oil from the *Deepwater Horizon* oil spill (OSAT, 2013).

If a shoreline is oiled, the selection of the type of shoreline remediation to be used would depend on the following: (1) the type and amount of oil on the shore; (2) the nature of the affected coastline; (3) the depth of oil penetration into the sediments; (4) the accessibility and the ability of vehicles to travel along the shoreline; (5) the possible ecological damage of the treatment to the shoreline environment; (6) weather conditions; (7) the current state of the oil; and (8) jurisdictional considerations. To determine which cleanup method is most appropriate during a spill response, decisionmakers must assess the severity and nature of the injury using Shoreline Cleanup and Assessment Team survey observations. These onsite decisionmakers must also estimate the time it would take for an area to recover in the absence of cleanup (typically considering short term to be 1-3 years, medium term to be 3-5 years, and long term greater than 5 years) (U.S. National Response Team, 2010).

1.2.4.1 Response Considerations for Sand Beaches, Marshes, and Nearshore Waters for both Shallow-Water and Deepwater Spills

Once oiled, it can be expected that the shoreline response techniques employed in the initial phase of a response would become more extensive and continue for some time (**Chapters 1.2.3.5.3,**

1.2.3.5.4, and 1.2.3.5.5). For example, the *Deepwater Horizon* oil-spill response continued for years in some of the more heavily oiled areas in Louisiana and in other areas, such as Florida, Mississippi, and Alabama, which experienced periodic re-oiling from submerged oil mats that lie in the inshore surf zone in troughs between the sand bars or from buried oil onshore that resurfaces. The three types of oil residue that were identified as challenging or potentially damaging to the environment if removed includes the following: (1) supra-tidal buried oil (buried below the 6-in [15-cm] surface-cleaning depth restriction near sensitive habitats); (2) small surface residual tarballs, which are oil residue left behind after beaches are cleaned; and (3) surf zone submerged oil mats. Active shoreline cleanup ended in June 2013 for the States of Florida, Mississippi, and Alabama. Active shoreline cleanup for Louisiana ended on April 15, 2014 (British Petroleum, 2014). However, efforts would continue to clean up any reported re-oiled shoreline in the GOM area as it is reported to the USCG. Although the re-oiling of some areas was anticipated to sporadically continue, it was determined that a better and more efficient long-term cleanup effort at this stage could be handled through the USCG. From the spill-response initiation in 2010 until April 15, 2014, aerial reconnaissance flights were flown across approximately 14,000 mi (22,531 km) of shoreline during this spill-response effort. During this same timeframe, nearly 4,400 mi (7,081 km) were ground-surveyed, with teams identifying 1,104 mi (1,777 km) that experienced some level of oiling and 778 mi (1,252 km) that required some measure of cleaning (British Petroleum, 2014).

Amenity beaches were generally cleaned to depths of up to 5 ft (1.5 m) using mechanical equipment that sifts out residual oil and other debris from below the beach surface while returning clean sand to the beach. Nonrecreational beaches and environmentally sensitive areas were generally hand-cleaned to depths of up to 6 in (15 cm), but they were cleaned deeper if it was ecologically safe and approved by the USCG, stakeholders, and others. Multiple techniques were used to treat oiled marsh areas, with the goal of promoting natural attenuation without causing further damage. A scientific effort was launched in mid-2012 to locate and remove potential pockets of subsurface material in Louisiana. During this effort, more than 40,000 holes and pits were excavated across seven barrier islands. The vast majority either had no visible oil or levels so low that treatment was not appropriate or required. For example, just 3 percent of the more than 16,000 auger holes had oiling levels that required cleanup and less than 2 percent of the over 24,000 pits had heavy or moderate oiling. Assessment teams continuously surveyed the shoreline and recommended treatment options. More than 100,000 tons of material were collected from the cleanup efforts. The total consists of not only the mixed residual material, which was typically 10-15 percent residual oil and 85-90 percent sand, shells, and water, but, during the first year of operations, it also included other solid material such as debris and protective clothing (British Petroleum, 2014). Although at the height of the spill-response operations (summer of 2010) response personnel numbered over 47,000, in April 2015, only 30 response personnel, including Federal officials and civilians, were working on activities related to the *Deepwater Horizon* explosion, oil spill, and response. In February 2015, a USCG memorandum was released announcing that, in March 2015, the Gulf Coast Incident Management Team would transition from Phase III (Operations) and reconstitute as a Phase IV Documentation Team. As part of this transition, the USCG field unit commanders would respond to reports of oil spills in their respective areas of responsibility, which would include any resurfacing of submerged *Deepwater Horizon* oil; consequently, there would be no one dedicated solely to the

Deepwater Horizon spill response from this time forward (Ramseur, 2015). It is anticipated that any future catastrophic event that might occur in the GOM would follow a similar pattern and timing. Additional information regarding shoreline response considerations can be found in Chapter 3.2.7 of the 2017-2022 GOM Multisale EIS (USDOI, BOEM, 2017a).

1.3 DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

1.3.1 High-Volume, Extended-Duration Spill within the Gulf of Mexico

The following resource descriptions and impact analyses examined only the applicable portions of the scenario (described fully in Chapter 3 of the 2017-2022 GOM Multisale EIS and summarized in **Table 1-3** of this document).

1.3.1.1 Air Quality

Phase 1—Initial Event

A catastrophic blowout close to the water surface would initially emit significant amounts of gases into the atmosphere. If high concentrations of sulfur are present in the produced gas, hydrogen sulfide (H_2S) could present a hazard to personnel. The natural gas H_2S concentrations in the Gulf of Mexico OCS are generally low; however, there are areas such as the Norphlet formation in the northeastern Gulf of Mexico, for example, that contain levels of H_2S up to 9 percent. Ignition of the blowout gas and subsequent fire would result in emissions of nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$). The fire could also produce PAHs, which are known to be hazardous to human health. The pollutant concentrations would decrease with downwind distance. A large plume of black smoke would be visible at the source and may extend a considerable distance downwind. However, with increasing distance from the fire, the gaseous pollutants would undergo chemical reactions, resulting in the formation of fine particulate matter ($PM_{2.5}$) that includes nitrates, sulfates, and organic matter. The $PM_{2.5}$ concentrations in the plume would have the potential to temporarily degrade visibility in any affected Prevention of Significant Deterioration (PSD) Class I areas (i.e., National Wilderness Areas and National Parks) and other areas where visibility is of significant value.

Phase 2—Offshore Spill

In the Gulf of Mexico, evaporation from the oil spill would result in concentrations of VOCs in the atmosphere, including chemicals that are classified as being hazardous. The *Deepwater Horizon* oil spill contributed to the formation downwind of organic aerosols from VOC compounds (de Gouw et al., 2011). As documented in de Gouw et al. (2011), most of the volatile fraction from oil spills evaporates within hours, leading to a narrow plume whose extension downwind depends on atmospheric conditions and circulation. The less volatile compounds take longer to evaporate during a time when the oil spreads over a larger area and chemical transformations simultaneously take place. Some of the compounds emitted could be hazardous to workers in close vicinity of the spill site and populated areas along the Gulf Coast (Middlebrook et al., 2011). The hazard to workers can be reduced by monitoring and using protective gear, including respirators, as well as limiting exposure through limited work shifts, rotating workers in close vicinity of the spill site and out of high exposure areas, and pointing vessels into the wind. During the *Deepwater Horizon* explosion, oil spill, and response, air samples collected by individual offshore workers of British Petroleum (BP), the Occupational Safety and Health Administration (OSHA), and USCG showed levels of benzene, toluene, ethylbenzene, and xylene that were mostly under detection levels. All samples had concentrations below the OSHA permissible exposure limits and the more stringent American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (U.S. Dept. of Labor, OSHA, 2010a).

The VOC emissions that result from the evaporation of oil contribute to the formation of particulate matter ($PM_{2.5}$) in the atmosphere (Brock et al., 2011). In addition, VOCs could cause an increase in ozone levels, especially if the release were to occur on a hot, sunny day with sufficient concentrations of NO_x present in the lower atmosphere. However, if there were any effects to onshore ozone concentrations, they would be likely only be temporary in nature and last at most the length of time of the spill duration.

A comprehensive analysis of marine oil spills in the National Academies of Sciences, Engineering and Medicine (2019) report (NAS-2019) discussed a wide range of oil spills and its consequences in the context of human and environmental impacts, oil-spill response operations, and decisionmaking tools to minimize the effects. According to NAS-2019, for air quality, floating oil may pose health risks for people (especially spill responders), as well as airbreathing marine species. Regarding human exposure to crude oil, the VOCs (i.e., benzene, toluene, ethylbenzene, and xylene) and PAHs are primary constituents of concern because of their carcinogenicity effects. Also, VOCs released from oil-spill sites can contribute to the formation of secondary air pollutants such as ozone, which can be transported downwind. On the other hand, deepwater injection of dispersant could cause a mitigation effect on inhalation exposure by increasing the dissolution of VOCs.

It is assumed that response efforts would include *in-situ* or controlled burns. In an experiment of an *in-situ* burn off Newfoundland, it was found that CO, sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) were measured only at background levels and were frequently below detection levels (Fingas et al., 1995). Limited amounts of formaldehyde and acetaldehyde were measured, but concentrations were close to background levels. Measured values of dioxins and dibenzofurans were at background levels. Measurements of PAH in the crude oil, residues, and air indicated that the PAHs in the crude oil are largely destroyed during combustion (Fingas et al., 1995). As reported in Perring et al. (2011), the black carbon aerosol mass mixing ratio and microphysical properties were measured from NOAA's P-3 aircraft during active surface oil burning subsequent to the *Deepwater Horizon* explosion in April 2010. Approximately 4 percent of the combusted material was released into the atmosphere as black carbon. The total amount of black carbon introduced to the Gulf of Mexico atmosphere via surface burning of oil during the 9-week spill is estimated to be (1.35 ± 0.72) x 106 kilograms.

While containment operations may be successful in capturing some of the escaping oil and gas, recovery vessels may not be capable of storing the crude oil or may not have sufficient storage capacity. In this case, excess oil would be burned; captured gas cannot be stored or piped to shore so it would be flared. During the *Deepwater Horizon* explosion, oil spill, and response, aerosols were measured during active surface oil burning. Oil was gathered with special booms and set afire. For ignition to occur with most oils, the oil film must generally be greater than 2-3 millimeters (0.08-0.12 in); however, ignition would depend upon the water content of the oil and the environmental conditions of winds and waves, which prevent ignition. Approximately 5 percent of the total leaked oil (approximately 4.9 MMbbl) was burned (Lehr et al., 2010). Approximately 4 percent of the combusted material was released to the atmosphere as black carbon aerosols or particulate matter. The total amount of black carbon introduced to the atmosphere via the surface burning of oil during the 9-week spill is estimated to be 1.350 ± 0.72 million kilograms (2.98 ± 1.59 million pounds) (Perring et al., 2011). The estimated NO_x emissions are about 13 tons per day. The SO_2 emissions would be dependent on the sulfur content of the crude oil. For crude oil with a sulfur content of 0.5 percent, the estimated SO_2 emissions are about 16 tons per day. Particulate matter in the plume would also affect visibility. Flaring or burning activities upwind of a PSD Class I area, e.g., the Breton National Wilderness Area, could adversely affect air quality there because of increased levels of SO_2, PM_{10}, and $PM_{2.5}$, and because of reduced visibility.

Phase 3—Onshore Contact

As the spill nears shore, it is expected that low-level concentrations of odor-causing pollutants associated with evaporative emissions from the oil spill. These may cause temporary eye, nose, or throat irritation, nausea, or headaches, but the doses are not thought to be high enough to cause long-term harm (USEPA, 2010a). However, responders could be exposed to levels higher than OSHA occupational permissible exposure levels (U.S. Dept. of Labor, OSHA, 2010b). During the *Deepwater Horizon* explosion, oil spill, and response, the USEPA took air samples at various onshore locations along the length of the Gulf coastline. All except three measurements of benzene were below 3 parts per billion (ppb). The highest level was 91 ppb. Emissions of benzene to the atmosphere result from gasoline vapors, auto exhaust, and chemical production and user facilities. Ambient concentrations of benzene up to and greater than 5 ppb have been measured in industrial areas such as Houston, Texas; in various urban areas during rush hour; and inside the homes of smokers (U.S. Dept. of Health and Human Services, 2007). The following daily median benzene air concentrations were reported in the Volatile Organic Compound National Ambient Database (1975-1985): remote (0.16 ppb); rural (0.47 ppb); suburban (1.8 ppb); urban (1.8 ppb); indoor air (1.8 ppb); and workplace air (2.1 ppb). The outdoor air data represent 300 cities in 42 states, while the indoor air data represent 30 cities in 16 states (Shah and Singh, 1988).

During the *Deepwater Horizon* explosion, oil spill, and response, air samples collected by BP, OSHA, and USCG near shore showed levels of benzene, toluene, ethylbenzene, and xylene that were mostly under detection levels. Among the 28,000 personal benzene samples taken by BP, there was only 1 sample where benzene exceeded the OSHA occupational permissible exposure limits, and 6 additional validated constituents were in excess of the ACGIH threshold limit value. All other sample concentrations were below the more stringent ACGIH threshold limit values (U.S. Dept. of Labor, OSHA, 2010a). All measured concentrations of toluene, ethylbenzene, and xylene were well within the OSHA occupational permissible exposure levels and ACGIH threshold limit values.

Phase 4—Post-Spill, Long-Term Recovery and Response

There would be some residual air quality impacts after the well is capped or killed. As most of the oil would have been burned, evaporated, or weathered over time, air quality would return to pre-oil spill conditions. While impacts to air quality are expected to be localized and temporary, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences.

Overall Summary and Conclusion (Phases 1-4)

The OCS oil- and gas-related catastrophic event could include the release of oil, condensate, or natural gas or chemicals used offshore or pollutants from the burning of these products. A catastrophic blowout close to the water surface would initially emit significant amounts of gases into the atmosphere (Phase 1). If a fire was associated with the event, it would produce a broad array of pollutants that could include the USEPA-regulated National Ambient Air Quality Standards criteria pollutants (e.g., NO_2, CO, SO_x, VOC, PM_{10}, and $PM_{2.5}$). Catastrophic events involving high concentrations of H_2S could result in deaths as well as environmental damage. Regulations and NTLs mandate safeguards and protective measures, which are in place, to protect workers from H_2S releases. In Phase 2, evaporation from the oil spill would result in concentrations of VOCs in the atmosphere, including chemicals that are classified as being hazardous. Response activities that could impact air quality include *in-situ* burning, the use of flares to burn gas and oil, and the use of dispersants. Measurements taken during an *in-situ* burning show that a major portion of compounds was consumed in the burn; therefore, pollutant concentrations would be reduced. These response activities are temporary in nature and occur offshore; therefore, there are little expected impacts from these actions to onshore air quality. As the spill nears shore (Phase 3), it is expected that low-level concentrations of odor-causing pollutants associated with evaporative emissions from the oil spill. While impacts to air quality are expected to be localized and temporary, adverse effects that may occur from the exposure of humans and wildlife to air pollutants could have long-term consequences (Phase 4). Other emissions of pollutants into the atmosphere from catastrophic events are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline.

Overall, since loss of well control events, blowouts, and fires are rare events and of short duration, potential impacts to air quality are not expected to be significant except in the rare case of a catastrophic event such as the *Deepwater Horizon* explosion, oil spill, and response.

1.3.1.2 Water Quality

Phase 1—Initial Event

Offshore Water Quality

During the initial phase of a catastrophic blowout, water quality impacts include the disturbance of sediments and the release and suspension of oil and natural gas (primarily methane) into the water column. These potential impacts are discussed below. As this phase deals with the immediate effects of a blowout that would be located at least 3 nmi (3.5 mi; 5.6 km) from shore, it is assumed that there would be no impacts on coastal water quality during this initial stage.

Disturbance of Sediments

A catastrophic blowout below the seafloor outside the wellbore (**Table 1-1**) has the potential to resuspend sediments and disperse potentially large quantities of bottom sediments. Some sediment could travel several kilometers, depending on particle size and subsea current patterns. Beyond the Gulf of Mexico continental shelf, surficial sediments are mostly composed of silt and clay, and, if resuspended, could stay in the water column for several hours to days. Bottom current measurements in the deep Gulf of Mexico were synthesized as part of the MMS Deepwater Reanalysis study (USDOI, MMS, 2001) and have been measured to reach 90 centimeters/second (cm/sec) (35.4 inches/second [in/sec]) with mean flows of 0.4-21 cm/sec (0.2-8.3 in/sec) (Nowlin et al., 2001). At these mean flow rates, resuspended sediment could be transported 0.3-18 km per day (0.2-11 mi per day).

Sediment resuspension can lead to a temporary change in the oxidation-reduction chemistry in the water column, including a localized and temporal release of any formally sorbed metals, as well as nutrient recycling (Caetano et al., 2003; Fanning et al., 1982). Sediments also have the potential to become contaminated with oil components.

Release and Suspension of Oil into the Water Column

A subsea release of hydrocarbons at a high flow rate has the potential to disperse and suspend plumes of oil droplets (chemically dispersed or otherwise) within the water column and to induce large patches of sheen and oil on the surface. These dispersed hydrocarbons may adsorb onto marine detritus (marine snow) and suspended sediments (Daly et al., 2016). Mitigation efforts such as *in-situ* burning may introduce hydrocarbon byproducts into the marine environment, which would be distributed by surface currents. The acute and chronic sublethal effects of these dilute suspended “plumes” are not well understood and require future research efforts.

As a result of the *Deepwater Horizon* oil spill, a subsurface oil and gas plume was discovered in deep waters between ~1,100 and 1,300 m (~3,609 and 4,265 ft) (e.g., Diercks et al., 2010) in addition to the surface slick. Measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the subsurface plumes and on the seafloor in the vicinity of the release (e.g., Diercks et al., 2010; OSAT, 2010). In the *Deepwater Horizon* oil-spill subsurface plume, half-lives were estimated for petroleum hydrocarbons and n-alkanes on the order of 1 month and several days, respectively, indicating the impacts of various weathering processes (Reddy et al., 2011 and references therein). After the *Ixtoc I* well blowout and spill in 1979, which was located 50 mi (80 km) offshore in the Bay of Campeche, Mexico, subsurface oil was observed dispersed within the water column (Boehm and Fiest, 1982); however, the scientific investigations were limited (Reible, 2010). The water quality of offshore waters would be affected by the dissolved components and oil droplets that are small enough that they do not rise to the surface or are mixed down by surface turbulence. In the case of subsurface oil plumes, it is important to remember that these plumes would be affected by subsurface currents, dilution, and natural physical, chemical, and biological degradation processes including weathering.

Large quantities of oil released into offshore waters may alter the chemistry with unforeseeable results. The properties and persistence of oil, including oil in the Gulf of Mexico, is further discussed in **Chapter 1.2.2.4**. The VOCs, including benzene, toluene, ethylbenzene, and xylenes (also referred to as BTEX), are highly soluble and can have acutely toxic effects; however, VOCs are light-weight oil components and tend to evaporate rather than persist in the environment (Michel, 1992). Middle-eight organic components tend to pose the greatest risk in the environment because they are more persistent in the environment, are more bioavailable, and include PAHs, which have high toxicities (Michel, 1992). To determine the overall toxicity of PAHs in water or sediment, the contributions of every individual PAH compound in the petroleum mixture must be included (USEPA, 2016). This approach was used during the *Deepwater Horizon* explosion, oil spill, and response in determining the potential risk of PAHs in both water and sediment to humans or animals in the environment (OSAT, 2010). Heavier components of crude oil tend to pose less risk of toxicity because they are not very soluble in water and therefore are less bioavailable.

The oil that entered the Gulf of Mexico from the *Deepwater Horizon* oil spill was a South Louisiana sweet crude oil (i.e., low in sulfur) (USDOC, NOAA, 2010b). This oil is less toxic than other crude oils in general because it is lower in PAHs than many other crude oils. Crude oil from the *Deepwater Horizon* oil spill contained approximately 3.9 percent PAHs by weight, which results in an estimated release of 2.1 x 10^{10} grams of PAHs (Reddy et al., 2011; Reddy, official communication, 2012). The oil was also fairly high in alkanes (organic compounds containing only carbon and hydrogen and single bonds, sometimes called paraffin or aliphatic compounds) (USDOC, NOAA, 2010b). Because alkanes are simple hydrocarbons, these oils are likely to undergo biodegradation more easily (USDOC, NOAA, 2010b).

Release of Natural Gas (Methane) into the Water Column

A catastrophic blowout could release natural gas into the water column; the amount of gas released is dependent upon the water depth, the natural gas content of the formation being drilled, and its pressure. Methane is the primary component of natural gas. Methane may stay in the marine environment for long periods of time (Patin, 1999), as methane is highly soluble in seawater at the high pressures and cold temperatures found in deepwater environments (NRC, 2003, page 108). However, methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974). In addition to methane, natural gas contains smaller percentages of other gases such as ethane, propane, and to a much lesser degree H_2S (NaturalGas.org, 2012), which can be toxic in the environment. The majority of natural gas components including methane are carbon sources, and their introduction into the marine environment could result in reducing the dissolved oxygen levels because of microbial degradation potentially creating hypoxic or “dead” zones. Further discussion of natural gas released during a catastrophic spill is given in **Chapter 1.2.2.5**.

Phase 2—Offshore Spill

Offshore Water Quality

For the purposes of this report, the water offshore of the Gulf Coast can be divided into three regions: shallow water (<2,624 ft; 800 m); deep water (≥2,624 ft but <5,249 ft; ≥800 m but <1,600 m); and ultra-deep water (≥5,249 ft; 1600 m). Shallow waters on the continental shelf and slope are heavily influenced by the Mississippi and Atchafalaya Rivers, the primary sources of freshwater, sediment, nutrients, and pollutants from a huge drainage basin encompassing 41 percent of the contiguous United States. The basin covers more than 1,245,000 square miles (3,224,535 square kilometers), and includes all or parts of 31 states and two Canadian provinces (U.S. Dept. of the Army, Corps of Engineers, 2015). Lower salinities are characteristic nearshore where freshwater from the rivers mix with Gulf waters. The presence or extent of a nepheloid layer, a body of suspended sediment at the sea bottom (Kennett, 1982), affects water quality on the shelf and slope. Deep waters east of the Mississippi River are affected by the Loop Current and associated warm-core (anti-cyclonic) eddies, which flush the area with clear, low-nutrient water (Muller-Karger et al., 2001) (**Figure 1-1**). However, cold-core cyclonic eddies (counter-clockwise rotating) also form at the edge of the Loop Current and are associated with upwelling and nutrient-rich, high-productivity waters, although the extent of this flushing can vary seasonally.

While response efforts would decrease the fraction of oil remaining in Gulf waters, significant amounts of oil would remain. Natural processes physically, chemically, and biologically aid the degradation of oil (NRC, 2003). The physical processes involved include evaporation, emulsification, and dissolution, while the primary chemical and biological degradation processes include photo-oxidation and biodegradation (i.e., microbial oxidation). Water quality would not only be impacted by the oil, gas, and their respective components but also to some degree, from cleanup and mitigation efforts, such as from increased vessel traffic and the addition of dispersants and methanol to the marine environment.

In the case of a catastrophic subsea blowout in deep water, it is possible that the use of subsea dispersant injection at the wellhead could be authorized. The positive effect of using dispersants is that the oil, once dispersed, may be more available to be degraded (however, we note that contrary findings for beached oil were presented by Hamdan and Fulmer, 2011). The negative effect is that the oil, once dispersed, is also more bioavailable to have toxic effects to microorganisms as well. The toxicity of dispersed oil in the environment would depend on many factors, including the effectiveness of the dispersion, temperature, salinity, degree of weathering, type of dispersant, and degree of light penetration in the water column (NRC, 2005). The toxicity of dispersed oil is primarily because of the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

As a result of the use of dispersants, it would be more likely for clouds or plumes of dispersed oil to occur near the blowout site as was seen during the *Deepwater Horizon* explosion, oil spill, and response. Dissolved oxygen levels are a concern with any release of a carbon source, such as oil and natural gas, and became a particular concern during the D*eepwater Horizon* explosion, oil spill, and response since dispersants were used in deep waters for the first time. In areas where plumes of dispersed oil were previously found, dissolved oxygen levels decreased by about 20 percent from long-term average values in the GOM of ~6.9 milligrams/liter (spring climatological mean at 1,500-m [4,921-ft] depth); however, scientists reported that these levels stabilized and were not low enough to be considered hypoxic (Joint Analysis Group, 2010; USDOC, NOAA, 2010c). The decrease in oxygen, which did not continue over time, has been attributed to the microbial degradation of the oil.

Phase 3—Onshore Contact

Coastal Water Quality

Water quality governs the suitability of waters for plant, animal, and human use. Water quality is important in the bays, estuaries, and nearshore coastal waters of the Gulf because these waters provide feeding, breeding, and/or nursery habitat for many invertebrates and fishes, as well as sea turtles, birds, and marine mammals. A catastrophic spill would significantly impact coastal water quality in the Gulf of Mexico. Water quality prior to the *Deepwater Horizon* explosion, oil spill, and response was rated as fair while sediment quality was rated as poor (USEPA, 2008). In addition, the coastal habitat index, a rating of wetlands habitat loss, was also rated as poor. Both sediment quality and coastal habitat index can have an effect on overall water quality.

Though response efforts would decrease the amount of oil remaining in Gulf waters and reduce the amount of oil contacting the coastline, significant amounts of oil would remain. Coastal water quality would be impacted not only by the oil, gas, and their respective components but also to some degree by cleanup and mitigation efforts. Increased vessel traffic, hydromodification, and the addition of dispersants and methanol in an effort to contain, mitigate, or clean up the oil may also stress the environment.

The use of dispersants as a response tool involves a tradeoff. The purpose of chemical dispersants is to facilitate the movement of oil into the water column in order to encourage weathering and biological breakdown of the oil (i.e., biodegradation) (NRC, 2005; Australian Maritime Safety Authority, 2010). Thus, the tradeoff is generally considered to be oiling of the shoreline and surface waters versus the water column and benthic resources (NRC, 2005). If the oil moves into the water column and is not on the surface of the water, it is less likely to reach sensitive shore areas (USEPA, 2010a). Since sea birds are often on the surface of the water or in shore areas, dispersants are also considered to be very effective in reducing the exposure of sea birds to oil (Australian Maritime Safety Authority, 2010). In addition to dispersion being enhanced by artificial processes, oil may also be dispersed from natural processes including both (bio)chemical and physical processes. For instance, microbial metabolism of crude oil results in the dispersion of oil (Bartha and Atlas, 1983), and conditions at the source of the oil/gas release (e.g., orifice size and shape) may cause physical dispersion of the oil. Dispersion has both positive and negative effects. The positive effect is that the oil, once dispersed, is more available to be degraded. The negative effect is that the oil, once dispersed, is also more bioavailable to have toxic effects to microorganisms as well. For example, a recent study using mesocosm experiments suggested that dispersed oil could disrupt coastal microbial food webs in the northern Gulf of Mexico, reducing the flow of carbon to higher trophic levels (Ortmann et al., 2012). The toxicity of dispersed oil in the environment would depend on many factors, including the effectiveness of the dispersion, temperature, salinity, degree of weathering, type of dispersant, and degree of light penetration in the water column (NRC, 2005). The toxicity of dispersed oil is primarily because of the toxic components of the oil itself (Australian Maritime Safety Authority, 2010).

Oxygen and nutrient concentrations in coastal waters vary seasonally. The zone of hypoxia (depleted oxygen) on the Louisiana-Texas shelf typically occurs during hotter summer months and is affected by the timing of freshwater discharges from the Mississippi and Atchafalaya Rivers. The hypoxic conditions continue until local wind-driven circulation mixes the water again. The hypoxic zone was not linked to the *Deepwater Horizon* explosion, oil spill, and response in either a positive or a negative manner (Louisiana Universities Marine Consortium, 2010). Nutrients from the Mississippi River nourished phytoplankton and contributed to the formation of the hypoxic zone.

Phase 4—Post-Spill, Long-Term Recovery and Response

The leading source of contaminants that impairs coastal water quality in the Gulf of Mexico is urban runoff. It can include suspended solids, heavy metals, pesticides, oil, grease, and nutrients (such as from lawn fertilizer). Other pollutant source categories include (1) agricultural runoff, (2) municipal point sources, (3) industrial sources, (4) hydromodification (e.g., dredging), and (5) vessel sources (e.g., shipping, fishing, and recreational boating). The NRC (2003) estimated that, on average, approximately 26,324 bbl of oil per year entered Gulf waters from petrochemical and oil refinery industries in Louisiana and Texas. The Mississippi River introduced approximately 3,680,938 bbl per year (NRC, 2003) into the waters of the Gulf. Hydrocarbons also enter the Gulf of Mexico through natural seeps at a rate of approximately 980,392 bbl per year (a range of approximately 560,224-1,400,560 bbl per year) (NRC, 2003). Produced water (formation water) is, by volume, the largest waste stream from the oil and gas industry that is legally discharged to GOM waters (e.g., Table 3-10 of the 2017-2022 GOM Multisale EIS). The NRC has estimated the quantity of oil in produced water entering the Gulf per year to be 473,000 bbl (NRC, 2003).[1] These sources total about 5.5 MMbbl of oil per year that routinely enters Gulf of Mexico waters. In comparison, a catastrophic spill of 30,000-60,000 bbl per day for 90-120 days would spill a total of 2.7-7.2 MMbbl of oil. When added to the other sources of oil listed above, this would result in a 48- to 129-percent increase in the volume of oil entering the water during the year of the spill. In addition, the oil from a catastrophic spill will be much more concentrated in some locations than the large number of other activities that release oil into the Gulf of Mexico. **Chapter 1.2.2.4** discusses the properties and persistence of oil in the environment.

Overall Summary and Conclusion (Phases 1-4)

During Phase 1 of the catastrophic blowout scenario, impacts are not expected to coastal water quality. Instead, the initial impacts would include degradation of offshore water quality, disturbance and degradation of sediments, and the release and suspension of oil and natural gas into

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[1] These numbers were generated from converting the units reported in the noted reference and do not imply any level of significance.

the water column, including the possible formation of plumes. Fine sediments could be transported away from the spill site.

As the spill continues during Phase 2, response efforts and natural degradation processes would decrease the amount of oil in the Gulf, but significant amounts of oil would remain, impacting water and sediment quality. Water and sediment quality would not only be impacted by the oil, gas, and their respective components but also to some degree from cleanup and mitigation efforts. The use of dispersants as a response tool may make the oil more available to degradation, but it can also make the oil more bioavailable to have toxic effects on microorganisms as well. Furthermore, dispersed oil is more likely to form a plume.

Onshore contact is made during Phase 3, so coastal sediment and water quality would be significantly impacted during this phase despite response efforts. Response efforts may even stress the coast to some degree. Natural and chemical dispersion may reduce the contact of oil with the shoreline but result in more oil in the water column and greater bioavailability of the dispersed oil.

The long-term recovery (Phase 4) of the water and sediment quality of the GOM would depend on the properties and persistence of the oil as noted in **Chapter 1.2.2.4**. Though the spill would increase the amount of oil entering the Gulf of Mexico, oil regularly enters the GOM through sources such as oil refineries, the Mississippi River, produced water, and natural seeps. However, oil from a spill would be more localized than the oil input from these other sources.

1.3.1.3 Coastal Habitats

1.3.1.3.1 Wetlands

Phase 1—Initial Event

There would likely be no adverse impacts to wetlands as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 2—Offshore Spill

There would likely be no adverse impacts to wetlands as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 3—Onshore Contact

Herein, coastal wetland habitats in the GOM includes bands around waterways; broad expanses of saline, brackish, and freshwater marshes; mud and sand flats; and forested wetlands of cypress-tupelo swamps and bottomland hardwoods. The NOAA created the Environmental Sensitivity Index (ESI) to assess the risk posed to coastal habitats in the event of a nearby oil spill. The ESI ranks shorelines according to their sensitivity to oil, the natural persistence of oil, and the expected ease of clean up after an oil spill. These factors affect the impacts of oil spills in coastal and estuarine areas. Based on the National Oceanic and Atmospheric Administration's ESI, marshes, mangroves, and swamps are the most sensitive shoreline habitats to oiling as oil tends to persist in these areas, as coastal wetlands accumulate oil and are difficult to clean (USDOI, MMS, 2010; USDOC, NOAA, 2020b). The GOM shoreline is dominated by marshes and wetlands; therefore, they are highly sensitive to oil spills. However, oil from an OCS spill may not reach these coastal wetland habitats due to the distance of the spill to the coast; the likely weathered condition of oil (through evaporation, dilution, and biodegradation) should it reach the coast; and protection from barrier islands, peninsulas, sand spits, and offshore currents. However, the protective capacity of barrier islands has been reduced due to land lost from hurricanes and anthropogenic factors.

Mangroves, which occur on the coasts of Florida, Louisiana, and parts of Texas, are also highly vulnerable to oil spills (Swan et al., 1994; Duke et al., 1999; Duke and Burns, 2003; Hensel et al., 2014). Oil can coat breathing surfaces of the mangroves, which kills shorter plants and animals within days. Symptoms of chronic impacts from oil spills include the death of trees with seedling regeneration, defoliation and canopy thinning, leaf yellowing, reduced height growth for surviving trees, and poor seedling establishment (Duke et al., 1997; Hensel et al., 2014; Lewis et al., 2011). Toxic response deformities and morphological changes may also occur after oil exposure, including pneumatophore branching (Duke et al., 2005), reduced lenticel numbers (Böer, 1993), and genetic mutations like variegated leaves and chlorophyll-deficient propagules (Duke and Watkinson, 2002). These effects could result in the loss of ecosystem function and structure, as well as loss of recreational opportunities and value.

The primary factors that affect vegetation responses to oil are the toxicity of the oil, oiling intensity, amount of contact with and penetration of the soil, plant species affected, oiling frequency, season, and cleanup activities (Mendelssohn et al., 2012; Tatariw et al., 2018). Previous studies of other large spills have shown that, when oil has a short residence time in the marsh and is not incorporated into the sediments, the marsh vegetation has a high probability of survival, even though aboveground die-off of marsh vegetation may occur (Lin et al., 2002). After the *Deepwater Horizon* explosion and oil spill, coastal marshes impacted by crude oil were observed to show evidence of recovery within 1 year after the spill, with shoot production in heavily oiled areas along the Louisiana coast (Delaune and Wright, 2011). This recovery held true in heavily oiled areas where the stems and leaves of the marsh vegetation was oiled, although depending on vegetation type, the amount of recovery varied (Delaune and Wright, 2011; Kokaly et al., 2011). However, if re-oiling occurs after the new shoots from an initial oiling are produced, such that the new shoots are killed, then the marsh plants may not have enough stored energy to produce a second round of new shoots. Other studies noted that the use of dispersants in the proper dosages results in a reduction in marsh damage from oiling (Lin and Mendelssohn, 2009). The works of several investigators (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989) evaluated the effects of potential spills to Gulf of Mexico wetlands. For wetlands along the central Louisiana coast, the critical oil concentration is estimated to be 0.025 gallons per ft^2 (1.0 liter per m^2) of marsh. Concentrations less than this may cause diebacks for one growing season or less, depending upon the concentration and the season during which contact occurs. The duration and magnitude of a spill resulting from a catastrophic blowout could result in concentrations above this critical level and would result in longer-term effects to wetland vegetation, including some plant mortality and potential loss of land.

While a catastrophic spill from a shallow-water blowout is expected to be lower in volume than a deepwater blowout, a potential shallow-water site could be closer to shore, allowing less time for oil to be weathered, dispersed, and recovered before it impacts coastal resources. The oil from the *Deepwater Horizon* explosion and oil spill was documented by shoreline assessment teams to have stranded on approximately 687 mi (1,105 km) of marsh shoreline (Nixon et al., 2016). In most areas, the oil was stranded along the marsh edge, usually spreading into the marsh no more than about 33-49 ft (10-15 m) perpendicular to the shoreline. Cleanup activities were conducted on 8.9 percent of the affected marsh (Michel et al., 2013). Various cleanup techniques were employed but, as of 2012, recovery was not complete and negative effects were ongoing (Zengel et al., 2015). One study of the impacts of the *Deepwater Horizon* explosion, oil spill, and response to salt marshes in Louisiana estimated the area affected to be between 350 and 400 square kilometers (km^2) (135 and 154 square miles [mi^2]), based on decreased primary production (Mishra et al., 2012).

In the case of catastrophic spills in the GOM, preemptive oil-response strategies would be initiated and include the deployment of oil booms, skimmer ships, and barge barriers to protect the beaches and adjacent wetlands. Boom deployment must also include plans for monitoring and maintaining the protective boom systems to ensure that these systems are installed and functioning properly and that they are not damaging the wetlands they are trying to protect. The distance of the blowout event from shore and the implemented response procedures lessen the possibility of such a spill reaching coastal wetlands with the toxicity to significantly impact the habitat (it is assumed that oil would reach shore within 2-4 weeks). A spill from a shallow-water blowout is more likely to contribute to wetland damage. However, for the few areas that are located closer to shore where an event could occur (e.g., Mississippi Canyon Area), the amount of time before shoreline contact would be similar to the shallow-water scenario (i.e., 1-3 weeks).

Offshore skimming, burning, and dispersal treatments for the oil near the spill site could result in the capture, detoxification, and dilution of a portion of the spilled oil. The use of nearshore booming protection for beaches and wetlands could also help to reduce oiling of these resources, if done correctly. However, booms deployed adjacent to marsh shorelines can be lifted by wave action onto marsh vegetation, resulting in plant mortality under the displaced booms. After the *Deepwater Horizon* explosion and oil spill, the use of barriers such as booms and sand berms did not work as well as planned (Martinez et al., 2012; Jones and Davis, 2011; Zengel and Michel, 2013). More than 497 mi (800 km) of boom were stranded in marshes, injuring vegetation and birds. The removal of stranded boom also affected the wetlands. Vegetation was crushed by airboats, walking boards, foot traffic, and dragging the boom across the wetland surface (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

The activity of oil cleanup can result in additional impacts on wetlands if not done properly. During the *Deepwater Horizon* explosion, oil spill, and response, aggressive onshore and marsh cleanup methods (such as the removal by mechanized equipment, *in-situ* burning, etc.) were not extensively used. The severity of oiling is the main factor that dictates the appropriate marsh cleanup method to be used (refer to **Table 1-3**).

Phase 4—Post-Spill, Long-Term Recovery and Response

Wetlands serve several important ecological functions. For example, Louisiana's coastal wetlands support more than two-thirds of the wintering waterfowl population of the Mississippi Flyway (State of Louisiana, Dept. of Wildlife and Fisheries, 2021). Therefore, loss of wetlands would also impact a significant portion of the waterfowl population. Another important ecological function of wetlands is their use as a nursery for estuarine-dependent species of fish and shellfish. Wetland loss would reduce the available nursery habitat.

Oil has been found or estimated to persist for at least 17-20 years in low-energy environments like salt marshes (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). If thick oil is deposited on marsh in low-energy environments, effects on marsh vegetation can be severe and recovery can take decades (Baca et al., 1987; Baker et al., 1993). The duration and magnitude of a spill resulting from a catastrophic blowout could result in high concentrations of oil that would result in long-term effects to wetland vegetation, including some plant mortality and loss of land. Silliman et al. (2012) found that after the *Deepwater Horizon* explosion and oil spill, oil coverage of Louisiana salt marshes was primarily concentrated on their seaward edges. Oil-driven plant death on the edges of these marshes more than doubled the rates of shoreline erosion, further driving marsh loss that is likely to be permanent. Eighteen months after the *Deepwater Horizon* explosion and oil spill, in previously oiled, non-eroded areas, marsh grasses had largely recovered and the elevated shoreline retreat rates observed at oiled sites had decreased to levels at reference marsh sites. Another study documented increased erosion at highly oiled sites 26 months after the spill (McClenachan et al., 2013); and in another study, oiled islands were found to have greatly increased the rates of erosion, which were 200 percent of the rates of unoiled islands for the first 2.5 years after the oiling (Turner et al., 2016). Studies of impacted wetlands have demonstrated that wetlands can recover from the impacts of oil spills, but the recovery process varies from extremely slow in mangrove swamps (Burns et al., 1993 and 1994) to relatively rapid in grass-dominated marshes subject to *in-situ* burning of oil (Baustian et al., 2010).

Land loss caused by the oiling of wetlands would add to continuing impacts of other factors, such as hurricanes, subsidence, saltwater intrusion, and sea-level rise. The wetlands along the Gulf Coast have already been severely damaged by the 2005 and 2008 hurricane seasons, leaving the mainland less protected. Barras (2006) reported that 562 km^2 (217 mi^2) of Louisiana land was lost during the 2005 hurricane season. Coastal Louisiana is estimated to have lost roughly 5,000 km^2 (1,931 mi^2) between 1932 and 2016 or about 25 percent of the baseline 1932 land area (Couvillion et al., 2017). This loss rate corresponds to a minimum of a football field of wetland lost every 100 minutes. The rate of wetland loss has been decreasing over time, possibly due to a decrease in major storms and restoration efforts. A catastrophic spill occurring nearshore would contribute further to this land loss. By way of comparison, the *Deepwater Horizon* explosion and oil spill affected an area of salt marsh in Louisiana equivalent to approximately 9 years of land loss (Mishra et al., 2012; Couvillion et al., 2011). Hurricanes and other coastal storms may remobilize and/or redistribute oil-contaminated wetland soils (Rabalais and Turner, 2016).

Following Hurricanes Katrina and Rita, another series of hurricanes (Gustav and Ike) made landfall along the Louisiana and Texas coasts in September 2008. Hurricane Gustav affected the eastern portion of the Louisiana coast, while Hurricane Ike affected Louisiana's western coast and the Texas coast. The storm surges caused wetland loss, heavily eroded the dune systems, and significantly lowered beach elevations along the coasts (Doran et al., 2009). The loss of the protective beach elevations has increased the vulnerability of coastal wetlands to catastrophic oil-spill events.

A poorly executed oil cleanup can result in additional impacts. Aggressive onshore and marsh cleanup methods (such as removal by mechanized equipment, *in-situ* burning, marsh cutting, and foot entry into the marsh for manual removal) probably would not be initiated until the oil spill has been stopped. Depending on the marsh remediation methods used, further impacts to the wetlands may occur from cleanup activities. Zengel and Michel (2013) found that, while natural recovery was the preferred response for the vast majority of oiled salt marsh shorelines, the most effective treatment of the ~1 percent most heavily oiled shorelines was a treatment that involved mechanized grappling, vegetation raking and cutting, and scraping. Careful use of walk boards reduced the impact of the response to the marsh vegetation. Follow-up work showed that mechanical treatment followed by vegetation planting was the most effective in restoring the marsh (Zengel et al., 2014). Boat traffic in marsh areas from the thousands of response vessels associated with a catastrophic spill could produce an incremental increase in erosion rates, sediment resuspension, and turbidity (i.e., an adverse but not significant impact to coastal wetland and seagrass habitats).

Overall Summary and Conclusion (Phases 1-4)

There would be no adverse impacts to wetlands resulting from Phase 1 of a catastrophic event due to the likely great distance of the spill event to coastal wetlands. Also, with regards to an offshore spill event (Phase 2), there would likely be no adverse impacts to wetlands before the spill reaches shore. It is assumed that when coastlines are contacted with oil (Phase 3), the associated wetlands are considered oiled. A spill from a catastrophic blowout could oil up to several hundred miles of wetland shoreline depending on its proximity to the spill, the volume spilled, and the response, among other factors. This would vary from light to heavy oiling. Resulting impacts and recovery rates of wetlands would vary according to the severity of the oiling. A catastrophic spill could result in long-term effects to wetland vegetation, including some plant mortality and loss of land. Submerged oil mats, or buried oil becoming remobilized after a disturbance (e.g., hurricane), could be another source of potential long-term impacts to wetlands from a catastrophic oil spill, as they could cause similar effects as the original oiling event (Phase 4).

1.3.1.3.2 Submerged Aquatic Vegetation

Phase 1—Initial Event

There would likely be no adverse impacts to submerged aquatic vegetation (SAV) as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because of the likely distance from the spill event to the nearest SAV beds.

Phase 2—Offshore Spill

There would likely be no adverse impacts to SAV as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because of the likely distance from the spill event to the nearest SAV beds.

Phase 3—Onshore Contact

According to the most recent and comprehensive data available, approximately 500,000 hectares (1.25 million acres) of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters and embayments of the northern GOM, and over 80 percent of this area is in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). The SAV distribution and composition depend on an interrelationship among a number of environmental factors that include water temperature, depth, turbidity, salinity, turbulence, and substrate suitability (Kemp, 1989; Onuf, 1996; Short et al., 2001). Marine seagrass beds generally occur in shallow, relatively clear, protected waters with predominantly sand bottoms (Short et al., 2001). Freshwater SAV species occur in the low-salinity waters of coastal estuaries (Castellanos and Rozas, 2001). Seagrasses and freshwater SAVs provide important nursery and permanent habitat for sunfish, killifish, immature shrimp, crabs, drum, trout, flounder, and several other nekton species, and they provide a food source for species of wintering waterfowl and megaherbivores (Rozas and Odum, 1988; Rooker et al., 1998; Castellanos and Rozas, 2001; Heck et al., 2003; Orth et al., 2006).

If oil occurs in areas with SAV beds, increased water turbulence from waves, storms, or vessel traffic could break apart the surface oil sheen and disperse some oil into the water column or mix oil with sediments that would settle and coat an entire plant. Coating of the plant from the oil and sediment mixture would cause reduced chlorophyll production and could lead to a decrease in vegetation (Teal and Howarth, 1984; Burns et al., 1994; Erftemeijer and Lewis, 2006). This coating situation also happens when oil is treated with dispersants because the dispersants break down the oil and it sinks into the water column (Thorhaug et al., 1986; Runcie et al., 2004). As reviewed in Runcie et al. (2004), oil mixed with dispersants has shown an array of effects on seagrass depending on the species and dispersant used.

Communities residing within SAV beds may experience direct and indirect impacts from oil exposure, the severity of which would depend on the severity and duration of the spill event (den Hartog and Jacobs, 1980; Jackson et al., 1989; Kenworthy et al., 1993; Taylor et al., 2006). Community effects could range from either direct mortality due to smothering or indirect mortality from loss of food sources and habitat to a decrease in ecological performance of the entire system depending on the severity and duration of the spill event (Zieman et al., 1984). Prevention and cleanup efforts could also affect the health of SAV communities (Zieman et al., 1984). Many physical prevention methods such as booms, barrier berms, and diversions can alter hydrology, specifically changing salinity and water clarity. These changes would harm certain species of SAV because they are tolerant to specific salinities and light levels (Zieman et al., 1984; Kenworthy and Fonseca, 1996; Frazer et al., 2006). With cleanup, there is increased boat and human traffic in these sensitive areas that generally are protected from this degree of human disturbance prior to the response. Increased vessel traffic would lead to elevated water turbidity and increased propeller scarring. While the elevated levels of water turbidity from vessels would be short-term and the possible damages from propellers could be longer, both events would be localized during the prevention and cleanup efforts (Zieman, 1976; Dawes et al., 1997).

Phase 4—Post-Spill, Long-Term Recovery and Response

A source of potential long-term impacts to submerged beds from a catastrophic spill event is the possibility of buried or sequestered oil becoming resuspended after a disturbance, which would have similar effects as the original oiling event. This could occur in the event of hurricane impacts, which exacerbate the problem with numerous other short-terms stresses, such as turbidity, abrasion, breakage, uprooting SAV and seagrasses, and the alteration of bottom profiles and hydrology. Because different species have different levels of sensitivity to oil, it is difficult to compare studies and extrapolate what variables caused the documented differences in vegetation and community health (Thorhaug et al., 1986; Runcie et al., 2004). In general, studied seagrasses did not show significant negative effects from an oil spill (den Hartog and Jacobs, 1980; Kenworthy et al., 1993; Taylor et al., 2006 and 2007). The impacts of the *Deepwater Horizon* oil spill on seagrass is relatively understudied. One study in the Chandeleur Islands, Louisiana, documented over 100 acres of seagrass loss along the coastal shelf after the *Deepwater Horizon* oil spill (Kenworthy et al., 2017). Interestingly, the seagrass beds grew in area by 228 acres on the landward side of the islands during the same time period.

If bays and estuaries accrue oil, there is an assumption that there would be a decrease in seagrass cover and negative community impacts. The SAV serves important ecological functions. For example, seagrasses and freshwater SAVs provide important habitat and are a food source for a wide range of species in multiple life history stages (Castellanos and Rozas, 2001; Short and Coles, 2001; Caldwell, 2003). Therefore, loss of SAV would adversely impact these species with a loss of valuable habitat and food.

Physical prevention methods such as booms, barrier berms, and diversions can alter hydrology, specifically changing salinity and water clarity in SAV habitat. These changes could cause mortality or reduced productivity in certain species of SAV because the species are only tolerant to certain salinities and light levels (Zieman et al., 1984; Kenworthy and Fonesca, 1996; Frazer et al., 2006). Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Overall Summary and Conclusion (Phases 1-4)

Because of the likely distance of an initial catastrophic spill event to SAV communities, there would be no adverse impacts to SAV resulting from the initial event (Phase 1). Also, with regards to an offshore spill event (Phase 2), there would likely be no adverse impacts to SAV before the spill reaches shore. An estimated probability of oil contacting the coastline from the OSRA run can be found in **Chapter 2**. It is assumed that, when these coastlines are contacted with oil (Phase 3), all associated habitat are considered oiled. If oil comes into areas with SAV, oil mixed with sediments or with dispersants could settle and coat an entire plant and could cause reduced chlorophyll production and could lead to a decrease in vegetation. Depending on the species and environmental factors (e.g., temperature and wave action), seagrasses may exhibit minimal impacts, such as localized loss of pigmentation, from an oil spill; however, communities residing within the beds could accrue greater negative outcomes. Increased vessel traffic from cleanup efforts would lead to elevated water turbidity and increased propeller scarring. A source of potential long-term impacts to submerged beds from a catastrophic spill event (Phase 4) is the possibility of buried or sequestered oil becoming resuspended after a disturbance, which would have similar effects as the original oiling event. While there are impacts on SAV from an oiling event, the probabilities of an event to occur and contact coastlines are generally low, and any impacts that can occur depend on a variety of factors (e.g., plant species, oil type, current environmental conditions, etc.). In general, studied seagrasses did not show significant negative effects from a spill.

1.3.1.3.3 Coastal Barrier Beaches and Associated Dunes

Phase 1—Initial Event

There would likely be no adverse impacts to coastal barrier beaches and associated dunes as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 2—Offshore Spill

There would likely be no adverse impacts to coastal barrier beaches and associated dunes as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline.

Phase 3—Onshore Contact

Sand beaches provide several key services as a habitat, including sediment storage and transport; wave dissipation and buffering during storms; scenic vistas and recreation; groundwater filtration, nutrient mineralization, and recycling; maintenance of biodiversity and genetic resources; carbon transfer; and functional links between terrestrial and marine environments (Defeo et al., 2009).

Barrier islands make up more than two-thirds of the northern GOM shoreline. The effects from oil spills depend on the geographic location, volume, and rate of the spill; type of oil; oil-slick characteristics; oceanic conditions and season at the time of the spill; and response and cleanup efforts. The effects could include changes in plant species diversity that could result in changes in forage areas for species using microfauna as a food base (Teal and Howarth, 1984).

Offshore-based crude oil would be lessened in toxicity when it reaches the coastal environments due to distance from shore, weather, the time oil remains offshore, and microbial degradation. As a result of a catastrophic spill, many of the barrier islands and beaches would receive varying degrees of oiling. The depth of oiling would be variable, based on the wave environment and sediment source at a particular beach head. Layering of oil and sand could occur if it was not cleaned before another tidal cycle. The severity of oiling would dictate the appropriate cleanup method to be used (refer to **Table 1-3**). Manual rather than mechanized removal techniques would be used in these areas and only if heavy oiling occurred. Thus, these areas may not be treated as thoroughly as other shorelines. Oil would remain in place longer, weathering gradually while continuing to contaminate habitat, though mechanical disturbance would be minimized.

Once oil has reached the beaches and barrier islands and becomes buried or sequestered, it becomes difficult to treat. The oil is generally toxic to barrier beach vegetation (Ko and Day, 2004). During wave events when the islands and beaches erode, the oil can become remobilized and transported (Daylander et al., 2014). Thus, the fate of oil is not as simple as either reaching land, becoming sequestered, or being treated; it must be considered in terms of a continuing process of sequestration, remobilization, and transport. For spilled oil to move onto beaches or across dunes, strong southerly winds must persist for an extended time prior to, during, or immediately after the spill to elevate water levels. Strong winds, however, could reduce the impact severity at a landfall site by accelerating the processes of oil-slick dispersal, spill spreading, and oil weathering.

Oil from the *Deepwater Horizon* explosion and oil spill was documented by shoreline assessment teams to have stranded on approximately 600 mi (965 km) of beach shoreline (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). Cleanup activities were conducted on 410 mi (660 km) of the affected beach. Two years after the spill, some oil remained on 427 mi (687 km) but at much lesser amounts (Michel et al., 2013; OSAT, 2011b). Beach shorelines were affected by oiling and response actions, with the most severe cleanup actions killing all creatures that burrow in beach sand (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). As beaches experienced erosion and deposition, oil would become buried, exposed, and remobilized multiple times, resulting in chronic re-oiling. Tropical Storm Lee (2011) and Hurricane Isaac (2012) caused extensive beach erosion and remobilization of oil residues. Oil residue mats were observed between the toe of the beach and the first offshore sand bar, providing another source of chronic sources of surface residue balls and surface residue patties (Michel et al., 2013). Over time, more of the remaining oil has continued to be removed, while toxicity has decreased as the oil is further weathered. Analysis of samples showed that the buried supratidal oil underwent less biodegradation, apparently due to lack of oxygen, but they were estimated in 2011 to decrease to 20 percent of current levels within the next 5 years (OSAT, 2011b). Numerous studies have shown that bacterial communities present in beaches gradually degrade the oil (Urbano et al., 2013; Newton et al., 2013; Kostka et al., 2011).

Due to the distance of beaches from deepwater blowouts and the combination of weathering and dispersant treatment of the oil offshore, the toxicity and quantity of the oil reaching shore should be greatly reduced, thereby minimizing the chances of irreversible damage to the impacted areas. A blowout in shallower waters near shore may have equal or greater impacts because of a shorter period of weathering and dispersion prior to shoreline contact, even though a smaller volume of spilled oil would be expected.

Phase 4—Post-Spill, Long-Term Recovery and Response

Oil or its components that remain in the sand after cleanup may be (1) released periodically when storms and high tides resuspend or flush beach sediments, (2) decomposed by biological activity, or (3) volatilized and dispersed. While it is likely that most spilled oil would be dissipated offshore within 1-2 months of stopping the flow (depending on season and temperature), oil has the potential to persist in the environment long after a spill event (Lindeberg et al., 2018). For example, on sandy beaches, oil can sink deep into the sediments (Bernabeu et al., 2006). As stranded oil weathers, some oil may become buried through natural beach processes and appear as surface residual balls or as surface residual patties or tar mats (**Table 1-3**). Such residual oil continues to provide a source of contamination with accompanying toxic effects. For at least 4 years after the *Deepwater Horizon* explosion and oil spill, tarballs were observed washing up on Alabama beaches, and submerged oil mats were observed between the shoreline and the longshore sandbar (Hayworth et al., 2015). Residual *Deepwater Horizon* oil in the form of sediment-oil-agglomerates on sandy Florida beaches is slow to degrade and may persist for at least 3 decades (Bociu et al., 2019).

Oil-spill response may damage sand beaches and barrier islands and alter and/or diminish their ecosystem functions. Cleanup activities can require extensive and prolonged uses of mechanical and manual treatments. Most mechanical beach cleanup activities occur in the supratidal zone where wrack commonly accumulates. Wrack can support a community of up to 40 percent of intertidal species and important prey resources for higher trophic levels (Dugan et al., 2003). The intertidal zone comprises a much higher invertebrate biomass than the supratidal zone (Raffaelli et al., 1991; Colombini and Chelazzi, 2003; Janssen and Mulder, 2005). These intertidal species are considered tolerant to disturbances due to their adaptation to a dynamic environment. Despite their high tolerance, these fauna can be directly and indirectly impacted by spill-response cleanup activities. Mechanical sifting of sand to remove oil removes wrack and organisms that are present, impacting community ecology of the beach. Intertidal fauna are indirectly impacted by response activities through alteration of the habitat and its suitability, reproduction disruption, and food supply removal (Michel et al., 2017).

The cleanup impacts of a catastrophic spill could result in short-term (up to 2 years) adjustments in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. Some oil contact to lower areas of sand dunes is expected. This contact would not likely result in significant destabilization of the dunes. The long-term stressors to barrier beach communities caused by the physical effects and chemical toxicity of an oil spill may lead to decreased primary production, plant dieback, and hence, further erosion (Ko and Day, 2004).

The protection once afforded to inland marshes by coastal barrier beaches has been greatly reduced because of decreased elevations and the continued effect of subsidence, sea-level rise, and saltwater intrusion. A catastrophic spill has the potential to contribute to this reduction through increased erosion as a result of plant dieback and cleanup efforts.

Overall Summary and Conclusion (Phases 1-4)

There would likely be no adverse impacts to coastal barrier beaches and associated dunes as a result of the events and the potential impact-producing factors that could occur throughout Phases 1 and 2 of a catastrophic spill event because these resources would not be contacted until the oil reached the shoreline. As a result of a catastrophic spill reaching the shoreline (Phase 3), many of the barrier islands and beaches would receive varying degrees of oiling. The long-term stressors to barrier beach communities caused by the physical effects and chemical toxicity of an oil spill (Phase 4) may lead to decreased primary production, plant dieback, and hence, further erosion.

1.3.1.4 Deepwater Benthic Communities

BOEM defines “deepwater benthic communities” as including both chemosynthetic communities (chemosynthetic organisms plus seep-associated fauna) and deepwater coral communities (deepwater coral plus coral-associated fauna). Deep water is defined here as water depths ≥300 m (984 ft); such communities are relatively rare in shallower waters (<300 m; 984 ft). Refer to Chapter 3.4 of the *Biological Environmental Background Report* (USDOI, BOEM, 2020) for background information about these communities and the habitats in which they occur. The possible impacts to deepwater benthic communities from a catastrophic spill depend on the location and nature of the event.

1.3.1.4.1 Chemosynthetic Communities

Phase 1—Initial Event

During the initial phase of a catastrophic blowout, impacts may include the disturbance of sediments, destruction of the drilling rig, release of oil and natural gas (methane), and emergency response efforts. This phase deals with the immediate effects of a blowout located at least 3 nmi (3.5 mi; 5.6 km) from shore.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying organisms within a few hundred meters of the wellhead (Brooks et al., 1978). Allers et al. (2013) demonstrated initial resilience of the deepwater coral *Lophelia pertusa* to sedimentation but noted lethal or sublethal impacts from complete burial or partial sedimentation that continued for an extended period of time. Although this study considered deepwater coral and not chemosynthetic organisms, similar impacts from partial or complete sedimentation could be expected. Some live bottom organisms, such as flexible sea fans, are naturally adapted to turbid conditions and may not be as negatively affected as others without such adaptations (Gittings et al., 1992).

Restrictions described in NTL 2009-G40, "Deepwater Benthic Communities," require drilling to be distanced at least 610 m (2,000 ft) from potential chemosynthetic communities. Because OCS-permitted wells would have been distanced from deepwater benthic habitats before installation, it is expected that the heaviest sediment concentrations would fall out of suspension and disperse before reaching sensitive benthic communities, preventing most sediment-related impacts. During a blowout, sediment may become contaminated with oil and subsequently deposit that oil down-current from the source. The highest concentrations of contaminated sediments would be nearest the well, and concentrations would diminish with distance. A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the blowout preventer /wellhead) would not disturb the seafloor sediment.

As with the *Deepwater Horizon* explosion, oil spill, and response, a rig may sink to the seafloor as a result of a blowout. Destruction of the oil drilling rig and associated equipment could have an acute negative effect on any benthic organisms and/or hard substrates caught under the direct impact of falling equipment. The benthic features and communities upon which the rig settles would likely be destroyed or smothered. Encrusting organisms would be crushed. A settling rig would also likely suspend sediments, which may smother nearby benthic communities if the sediment is redeposited on sensitive features. The habitats beneath the rig may be permanently lost if sediments cover them. The benthic communities that were smothered by sediment could eventually repopulate from nearby stocks through spawning recruitment and immigration. The distancing requirements of NTL 2009-G39 somewhat mitigate the risk that a rig would sink directly on sensitive habitat.

A catastrophic blowout would likely result in released oil rapidly rising to the sea surface because typical reserves in the GOM have specific gravity characteristics that are much lighter than water (refer to **Chapter 1.2.2.4**; Environment Canada, 2011; Trudel et al., 2001). The oil would likely surface almost directly over the source location. Oil floating to the sea surface would be effectively removed from the seafloor and any deepwater benthic communities. Even oil treated with chemical dispersants on the sea surface would not generally be expected to have widespread impacts to deepwater communities. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil found in the top 2 m (7 ft) of water (McAuliffe et al., 1981; Lewis and Aurand, 1997). Lubchenco et al. (2010) report that most chemically dispersed surface oil from the *Deepwater Horizon* explosion and oil spill remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. In one extraordinary circumstance with an unusual combination of meteorological and oceanographic conditions, a tropical storm forced a large volume of *Deepwater Horizon* oil spill-linked surface oil/dispersant mixture to as deep as 246 ft (75 m), causing temporary exposure to mesophotic corals in the Pinnacle Trend area and leading to some coral mortality and sublethal impacts (Silva et al., 2015). However, that depth is still far shallower than that of the deepwater benthic communities considered here. If subsea oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). Upward movement of oil may also be reduced if methane mixed with the oil is dissolved into the water column, reducing the buoyancy of the oil/gas stream (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010).

Chemosynthetic organisms are naturally adapted to handle the limited amounts of hydrocarbons that are typical at slow-flowing seeps. While they have not been as well studied as deepwater corals, there have as yet been no documented impacts (e.g., mortality of organisms) from the *Deepwater Horizon* oil spill to chemosynthetic communities (USDOI, BOEM, 2012a; Shedd, official communication, 2020).

The likelihood that a chemosynthetic community would be affected by the initial stage of a catastrophic event would be further reduced with adherence to NTL 2009-G40 guidelines that distance drilling activities from sensitive habitats because released oil would rise rapidly above the habitat and because surface oil would not be expected to mix to the depths of chemosynthetic communities. The required separation distance would also allow for a subsea plume to mix with the surrounding water and become diluted before it reached a deepwater community.

Phase 2—Offshore Spill

During the second phase of a catastrophic blowout, the major impact of concern is the release of oil and methane over time. Response efforts may produce additional impacts. This phase deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

Oil and chemical spills that originate at the sea surface are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depths at which these communities are located. These surface-originating spills would tend not to sink, and the risk of weathered components of a surface slick reaching the benthos in any measurable concentration would be very small. Large concentrations of surface oil are unlikely to physically mix to the depths of deepwater communities under natural conditions (Lange, 1985; McAuliffe et al., 1975 and 1981; Tkalich and Chan, 2002).

However, a spill resulting from a catastrophic blowout in deep water has the potential to impact offshore benthic communities, as occurred following the *Deepwater Horizon* explosion and oil spill. Studies such as White et al. (2012) have documented serious impacts to deepwater coral communities from that spill. However, spill impact data specific to chemosynthetic communities is lacking. There have as yet been no documented impacts (e.g., mortality of organisms) from the *Deepwater Horizon* oil spill to chemosynthetic communities (USDOI, BOEM, 2012a; Shedd, official communication, 2020).

There are natural environmental conditions that may reduce impacts from such a spill. Although subsurface plumes can be generated when oil is ejected under high pressure or when dispersants are used subsea, a majority of the oil originating from a seafloor blowout in deep water is expected to rise rapidly to the sea surface. Upward movement of the oil may also be reduced if methane mixed with the oil is dissolved into the water (Adcroft et al., 2010). A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column would become diluted over time, reducing transport to the seafloor (Vandermeulen, 1982). Concentrations of dispersed and dissolved oil in the *Deepwater Horizon* explosion and oil spill's subsea plume were reported to be in the part per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010; Lubchenco et al., 2010). In addition, microbial degradation of oil occurs in the water column rendering oil less toxic when it contacts the seafloor (Hazen et al., 2010).

Oil can precipitate to the seafloor as "marine snow" by adhering to other particles (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2011, Passow et al., 2012). Oil could also reach the seafloor through planktonic consumption and associated excretion, which is distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2011). These mechanisms could result in a wide distribution of small amounts of oil. Throughout these processes, oil would be biodegraded from bacterial action, which would continue by benthic bacteria, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). If a spill does occur close to a deepwater benthic habitat, some of the organisms may become smothered by marine snow particles and/or other sediments, and may experience long-term exposure to hydrocarbons and/or oil-dispersant mixtures that could persist within the sediments (Hsing et al., 2013; Fisher et al., 2014; Valentine et al., 2014). Beyond the localized area of impact in such cases, particles would become increasingly biodegraded and dispersed. Localized impacts to deepwater benthic organisms from marine snow would be expected to be mostly sublethal and could include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment (Rogers, 1990; Kushmaro et al., 1997).

A sustained spill may result in elevated exposure concentrations to chemosynthetic communities if a subsea oil plume contacts them directly. Dispersed oil is mixed with water, and its movement is then dictated by water currents and the physical, chemical, and biodegradation pathways. BOEM's policy (refer to NTL 2009-G40) prevents wells from being placed immediately adjacent to sensitive deepwater benthic communities; however, in the event of a seafloor blowout, some oil could be carried to these communities by subsea plumes. Although chemosynthetic organisms are naturally dependent on hydrocarbon seeps and thus tolerant of some level of hydrocarbon exposure, natural seepage is very constant and occurs at very low rates compared with the potential volume of hydrocarbons released from a catastrophic event. Chemosynthetic organisms are not necessarily tolerant to the higher exposure levels that could be experienced during a catastrophic blowout and could therefore experience negative impacts. If a concentrated plume comes into continuous contact with a deepwater benthic community, the general impacts could include mortality, tissue loss, opportunistic hydroid overgrowth, failed reproductive success, reduced biodiversity, reduced coverage of fauna and flora on hard substrates, and changes in community structure (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014; Silva et al., 2015). Exact impacts would depend on the location, age of the spill, and the hydrographic characteristics of the area.

Concentrated oil plumes reaching chemosynthetic communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. The longer the oil remains suspended in the water column, the more dispersed, less concentrated, and more biodegraded it would become. Depending on how long oil remained suspended in the water column, it may be thoroughly degraded by biological action before contacting the seafloor (Hazen et al., 2010; Valentine et al., 2010). Biodegradation rates in cold, deepwater environments are not well understood. In general, the potential impacts to chemosynthetic communities would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. While a few localized habitats could be affected, the Gulfwide population of chemosynthetic communities would not be expected to suffer significant effects.

Drilling muds may be pumped into a well to stop a blowout. If such a "kill" is not successful, the mud (possibly thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on the requirements described in NTL 2009-G40, a well should be sufficiently distanced from chemosynthetic communities to prevent smothering by extruded drilling muds.

Phase 3—Onshore Contact

The third phase of a catastrophic blowout focuses on the approach of oil to the shoreline. This involves the possible oiling of coastal resources, including beaches, wetlands, SAV and seagrasses, the shallow seafloor, and any resources drifting in the water column. Response efforts can produce additional serious impacts. There would be no additional adverse impacts to deepwater chemosynthetic communities as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because chemosynthetic communities are located far offshore in deep water (>300 m; 984 ft).

Phase 4— Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine what long-term effects may occur. Contaminants degrade over time but may become sequestered as inert forms (e.g., buried in sediment) until disturbed and reactivated, producing renewed impacts.

If oil is ejected under high pressure or dispersants are applied at the source near the seafloor, oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor in some form, either concentrated (near the source) or dispersed and decayed (farther from the source). The oil could then impact patches of chemosynthetic community habitat in its path. The farther the dispersed oil travels, the more diluted it would become as it mixes with surrounding water. Chemosynthetic communities distanced greater than 610 m (2,000 ft) away from a blowout could experience minor impacts from suspended sediments that travel with currents, although the sediment concentration would become more diluted with distance.

One recent study following the *Deepwater Horizon* explosion, oil spill, and response (White et al., 2014) evaluated possible long-term persistence of both oil and the dispersant used during that spill, i.e., the anionic surfactant DOSS (dioctyl sodium sulfosuccinate). Samples were taken from both seafloor sediments and flocculent material in an affected deepwater coral community of Mississippi Canyon Block 294 and compared with other *Deepwater Horizon* oil spill-derived samples collected on coastal beaches. While this study did not measure or link toxicity of oil or DOSS to organisms, it noted that DOSS was found to persist for 6 months in the samples taken from the coral community, and up to 4 years in the beach samples. These findings contrast the shorter DOSS persistence durations observed in laboratory conditions that mimicked the solar and temperature conditions in surface waters and could present an additional concern if sediments containing DOSS are demonstrated to be toxic to deepwater benthic organisms. Krasnec et al. (2015) measured the toxicity of sediments collected within 2 km (1.2 mi) of the *Macond*o wellhead, although they did not measure the effects on deepwater megafauna. The study found varying levels of mortality and growth inhibition for a small shrimp-like crustacean species, with the relative degree of toxicity decreasing over time (lower toxicity found in 2014 samples than in 2011 samples).

Other studies indicate that periods of decades to hundreds of years are required to reestablish a seep community once it has disappeared, depending on the community type (Powell, 1995; Fisher, 1995). There is evidence that substantial impacts on these communities could permanently prevent reestablishment, particularly if hard substrate required for recolonization is buried by resuspended sediments. A catastrophic spill combined with the application of dispersant has the potential to cause impacts to local patches of habitat in the path of subsea plumes where they physically contact the seafloor. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect. Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contacting the seafloor. Water currents can carry a plume to contact the seafloor directly but a more likely scenario would be for oil to adhere to other particles and precipitate to the seafloor as marine snow (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2011; Passow et al., 2012). Oil would also reach the seafloor through planktonic consumption and associated excretion, which is distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2011). These mechanisms would result in a wide distribution of small amounts of oil (or oil by-products). This oil would be in the process of biodegradation from bacterial action, which would continue by benthic bacteria on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Habitats directly under the path of the oil plume as it disperses and “rains” down to the seafloor may experience minor effects, but because the oil would be deposited in a widely scattered and decayed state, little overall effect is anticipated.

Overall Summary and Conclusion (Phases 1-4)

Chemosynthetic communities would potentially be subject to detrimental effects from a catastrophic seafloor blowout. Sediment and oiled sediment from the initial event (Phase 1) could have lethal or sublethal impacts should they occur in heavy amounts in close proximity, but that is unlikely because of the distancing requirements described in NTL 2009-G40. Finer sediments from a blowout may still reach the location of sensitive habitats, producing sublethal effects. The initial accident could result in the drilling rig and equipment falling on a sensitive seafloor habitat.

The ongoing spill event (Phase 2) would have the greatest effect on chemosynthetic communities. These communities are at risk from subsea oil plumes that could directly contact localized patches of sensitive habitat. Oil plumes reaching chemosynthetic communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. However, the potential impacts would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. The more likely scenario would be exposure to widely dispersed, biodegraded particles that “rain” down from a passing oil plume. While a few patch habitats could be affected, the Gulfwide population of chemosynthetic communities would be expected to suffer no significant effects.

Oil reaching the shore (Phase 3) presents no additional adverse impacts to chemosynthetic communities because the chemosynthetic communities are located offshore in deep water (>300 m; 984 ft).

The recovery of chemosynthetic communities (Phase 4) depends on the severity of the initial impacts. A catastrophic spill combined with the application of dispersant has the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. Studies indicate that periods from decades to hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type) (Powell, 1995; Fisher, 1995). The burial of hard substrate could permanently prevent recovery of organisms dependent on hard substrate. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary reduction in feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. However, most chemosynthetic communities are expected to experience no impacts from a catastrophic seafloor blowout because of the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution.

1.3.1.4.2 Deepwater Coral Communities

Deepwater coral communities are known to occur throughout the GOM (**Figure 4-12**), and new communities are routinely discovered with almost every new deepwater research cruise. Certain deepwater coral species, such as *Lophelia pertusa*, attach to exposed hard substrates and can create complex three-dimensional structural microhabitats and are therefore sometimes termed “framework forming” corals. These microhabitats are often used by benthic invertebrates including echinoderms (e.g., brittle stars and basket stars), sea anemones, crustaceans, and various other benthic megafauna. Other species of soft corals and Gorgonians (commonly known as sea whips and sea fans) may also provide a lesser degree of usable habitat for other megafauna.

Phase 1—Initial Event

During the initial phase of a catastrophic blowout, impacts may include disturbance of sediments, destruction of the drilling rig, release of oil and natural gas (methane), and emergency response efforts. This phase deals with the immediate effects of a blowout located at least 3 mi (3.5 mi; 5.6 km) from shore.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying organisms within a few hundred meters of the wellhead (Brooks et al., 1978). If a blowout were to occur close enough to a sensitive deepwater coral community, suspended sediment may impact a localized area of the organisms. Allers et al. (2013) demonstrated initial resilience of *Lophelia pertusa* to sedimentation but noted lethal or sublethal impacts from complete burial or partial sedimentation that continued for an extended period of time. Some live bottom organisms, such as flexible sea fans, are naturally adapted to turbid conditions and may not be as negatively affected as others without such adaptations (Gittings et al., 1992). Restrictions described in NTL 2009-G40, “Deepwater Benthic Communities,” require drilling to be distanced at least 610 m (2,000 ft) from potential deepwater benthic communities. Because OCS-permitted wells would have been distanced from deepwater benthic habitats before installation, it is expected that the heaviest sediment concentrations would fall out of suspension and disperse before reaching sensitive benthic communities, preventing most sediment-related impacts. During a blowout, suspended sediment may become contaminated with oil and subsequently deposit that oil down-current from the source. The highest concentrations of contaminated sediment would be nearest the well, and concentrations would diminish with distance. A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the seafloor sediment.

As with the *Deepwater Horizon* explosion, oil spill, and response, a rig may sink to the seafloor as a result of a blowout. Destruction of the oil drilling rig and associated equipment could have an acute negative effect on any benthic organisms and/or hard substrates caught under the direct impact of falling equipment. The benthic features and communities upon which the rig settles would likely be destroyed or smothered. Encrusting organisms would be crushed. A settling rig would also likely suspend sediments, which may smother nearby benthic communities if the sediment is redeposited on sensitive features. The habitats beneath the rig may be permanently lost if sediments cover them. The benthic communities that were smothered by sediment could eventually repopulate from nearby stocks through spawning recruitment and immigration. The distancing requirements of NTL 2009-G39 somewhat mitigate the risk that a rig would sink directly on sensitive habitat. A catastrophic blowout would likely result in released oil rapidly rising to the sea surface because typical reserves in the GOM have specific gravity characteristics that are much lighter than water (Environment Canada, 2011; Trudel et al., 2001). The oil would surface almost directly over the source location. Oil floating to the sea surface would be effectively removed from the seafloor and any deepwater benthic communities. Even oil treated with chemical dispersants on the sea surface would not generally be expected to have widespread impacts to deepwater communities under normal conditions. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (7 ft) of water (McAuliffe et al., 1981; Lewis and Aurand, 1997). Lubchenco et al. (2010) report that most chemically dispersed surface oil from the *Deepwater Horizon* explosion and oil spill remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. In one extraordinary circumstance with an unusual combination of meteorological and oceanographic conditions, a tropical storm forced a large volume of *Deepwater Horizon* oil spill-linked surface oil/dispersant mixture to as deep as 246 ft (75 m), causing temporary exposure to mesophotic corals in the Pinnacle Trend area and leading to some coral mortality and sublethal impacts (Silva et al., 2015). However, that depth is still far shallower than that of the deepwater benthic communities considered here. If subsea oil is ejected under high pressure, micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). Upward movement of the oil may also be reduced if methane mixed with the oil is dissolved into the water column, reducing the buoyancy of the oil/gas stream (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010).

It is possible that some deepwater coral species have limited capabilities to endure small amounts of oil exposure. Results from DeLeo et al. (2015) suggested that *Callogorgia delta*, a soft coral often associated with natural hydrocarbon seeps, may have some natural adaptation to short-term oil exposure. Al-Dahash and Mahmoud (2013) suggest that a possible mechanism for this is coral harboring of symbiotic oil-degrading bacteria.

The likelihood that a deepwater coral community would be affected by the initial stage of a catastrophic event would be further reduced with adherence to NTL 2009-G40 guidelines that distance drilling activities from sensitive habitats, because released oil would rapidly rise above the habitat and because surface oil would not be expected to mix to the depths of such communities. The required separation distance would also allow for a subsea plume to mix with the surrounding water and become diluted before it reached a deepwater community.

Phase 2—Offshore Spill

During the second phase of a catastrophic blowout, the major impact of concern is the release of oil and methane over time. Response efforts may produce additional impacts. This phase deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

Oil and chemical spills that originate at the sea surface are not considered to be a potential source of measurable impacts on deepwater coral communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink, and the risk of weathered components of a surface slick reaching the benthos in any measurable concentration would be very small. Large concentrations of surface oil are unlikely to physically mix to the depths of deepwater communities under natural conditions (Lange, 1985; McAuliffe et al., 1975 and 1981; Tkalich and Chan, 2002).

However, a spill resulting from a catastrophic blowout in deep water has the potential to impact deepwater habitats and communities. During the *Deepwater Horizon* oil spill, dispersants were applied subsea at the source of the blowout. Stratified density layers of water allowed the oil/dispersant plume to remain at depth instead of dispersing up into the water column (Joint Analysis Group, 2010), and these concentrated plumes likely contributed to serious (but localized) damage to deepwater coral communities. If a concentrated plume comes into continuous contact with a deepwater benthic community, the general impacts could include mortality, tissue loss, opportunistic hydroid overgrowth, failed reproductive success, reduced biodiversity, reduced coverage of fauna and flora on hard substrates, and changes in community structure (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014a; Silva et al., 2015). For example, White et al. (2012) and Hsing et al. (2013) documented a deepwater coral site at a depth of 1,370 m (4,495 ft) that was severely damaged following the *Deepwater Horizon* explosion, oil spill, and response. Flocculent material was observed covering these corals, and biomarker signatures from residual hydrocarbon compounds matched that of *Deepwater Horizon* oil. The site is in Mississippi Canyon Block 294, 11 km (7 mi) southwest of the spill location. The site includes hard substrate supporting coral in an area approximately 10 x 12 m (33 x 39 ft). The published results document damage to the coral community. Forty-three coral colonies were analyzed via close-up imagery: 86 percent of these colonies exhibited some signs of impact; 46 percent of the colonies exhibited impact to at least half of the colony; and 23 percent of the colonies sustained impact to more than 90 percent of the colony (White et al., 2012). Many other associated invertebrates also exhibited signs of stress. Fisher et al. (2014) described two additional deepwater coral communities with negative impacts attributed to the *Deepwater Horizon* oil spill in Mississippi Canyon Block 297 (6 km [4 mi] south of the *Macondo* wellhead) and in Mississippi Canyon Block 344 (22 km [14 mi] southeast of the *Macondo* wellhead). Observed impacts Mississippi Canyon Block 297 were roughly similar to those seen in Mississippi Canyon Block 294 (White et al., 2012), but impacts in Mississippi Canyon Block 344 were less severe. In a 7-year repetitive imagery analysis of affected deepwater corals, Girard and Fisher (2018) determined that the ability of impacted coral colonies to recover is dependent on the initial impact of the oil spill, indicating a long-term, non-acute effect. Recovery of colony health may take considerable time, and colonies with extensive injuries may not fully recover. Numerous other deepwater coral communities investigated since the spill have remained healthy (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014).

Although (as shown in the *Deepwater Horizon* oil spill) subsurface plumes can be generated when oil is ejected under high pressure or when dispersants are used subsea, in most cases, a majority of the oil originating from a seafloor blowout in deep water is expected to rise rapidly to the sea surface. In normal oceanographic conditions, surface oil does not become resubmerged in large quantities. Silva et al. (2015) describe a possible exception, hypothesizing that unusually rough seas from Tropical Storm Bonnie in July 2010 may have submerged toxic quantities of surface oil, causing serious injury to shallow-water corals in the Pinnacle Trend area. Upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water (Adcroft et al., 2010). A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column would become diluted over time, reducing transport to the seafloor (Vandermeulen, 1982). Concentrations of dispersed and dissolved oil in the *Deepwater Horizon* oil-spill subsea plume were reported to be in the parts per million range or less and were generally lower away from the water's surface and away from the wellhead (Adcroft et al., 2010; Haddad and Murawski, 2010; Joint Analysis Group, 2010; Lubchenco et al., 2010). In addition, microbial degradation of the oil occurs in the water, rendering the oil less toxic when it contacts the seafloor (Hazen et al., 2010).

For any catastrophic spill, it is expected that a certain quantity of oil may eventually settle on the seafloor through a binding process with suspended sediment particles (adsorption) or after being consumed and excreted by phytoplankton (International Tanker Owners Pollution Federation Limited, 2011, Passow et al., 2012, Valentine et al., 2014) and precipitate to the seafloor as "marine snow." As evidenced by White et al. (2012), subsea plumes can still retain toxic concentrations over a distance of at least 11 km (7 mi). These mechanisms would result in a wide distribution of small amounts of oil. Throughout these processes, oil would be biodegraded from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). If a spill does occur close to a deepwater benthic habitat, some of the organisms may become smothered by marine snow particles and/or other sediments, and may experience long-term exposure to hydrocarbons and/or oil-dispersant mixtures that could persist within the sediments (Hsing et al., 2013; Fisher et al., 2014; Valentine et al., 2014). Beyond the localized area of impact in such cases, particles would become increasingly biodegraded and dispersed. Localized impacts to deepwater benthic organisms from marine snow would be expected to be mostly sublethal and could include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment (Rogers, 1990; Kushmaro et al., 1997).

Recent research improves our understanding of the spatial distribution of the effects of the 2010 *Deepwater Horizon* oil spill. Approximately 2-3 months after the *Macondo* (*Deepwater Horizon*) well was capped, 227 stations were sampled to collect data on impacts from the oil spill on benthic communities. Fifty-eight of those stations were analyzed (summarized in Reuscher et al., 2020). Reuscher et al. (2020) analyzed data from an additional 58 of these stations to measure impacts of the spill to infauna communities, doubling the footprint analyzed. The authors concluded that oil and spill-related products spread farther in the northeastern and southwestern directions from the wellhead than previously thought, causing damage to meio- and microfauna in an area of ~263 km^2 (102 mi^2). High nematode to copepod ratios confirmed meiofauna community disturbance.

A sustained spill may result in elevated exposure concentrations to deepwater coral communities if a subsea oil plume of oil or oil/dispersant mixture contacts them directly. Dispersed oil is mixed with water, and its movement is then dictated by water currents and the physical, chemical, and biological degradation pathways. BOEM's policy (refer to NTL 2009-G40) prevents wells from being placed immediately adjacent to sensitive deepwater coral communities; however, in the event of a seafloor blowout, some oil could be carried to such communities by subsea plumes. If a concentrated plume comes into continuous contact with a deepwater benthic community, the general impacts could include mortality, tissue loss, opportunistic hydroid overgrowth, failed reproductive success, reduced biodiversity, reduced coverage of fauna and flora on hard substrates, and changes in community structure (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014; Silva et al., 2015). Exact impacts would depend on the location, age of the spill, and the hydrographic characteristics of the area. Concentrated oil plumes reaching deepwater coral communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. The longer the oil remains suspended in the water column, the more dispersed, less concentrated, and more degraded it would become. Depending on how long the oil remained suspended in the water column, it may be thoroughly degraded by biological action before contacting the seafloor (Hazen et al., 2010; Valentine et al., 2010). Biodegradation rates in cold, deepwater environments are not well understood. In general, the potential impacts to deepwater coral communities would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. While a few localized habitats could be affected, the Gulfwide population of deepwater coral communities as a whole would not be expected to suffer significant effects. This is evidenced by the numerous other deepwater coral communities that have been investigated since the spill and that have remained healthy (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014).

Drilling muds may be pumped into a well to stop a blowout. If such a “kill” is not successful, the mud (possibly thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on the requirements described in NTL 2009-G40, a well should be sufficiently distanced from sensitive deepwater coral communities to prevent smothering by extruded drilling muds.

Phase 3—Onshore Contact

The third phase of a catastrophic blowout focuses on the approach of oil to the shoreline. This involves the possible oiling of coastal resources including beaches, wetlands, SAV and seagrasses, the shallow seafloor, and any resources drifting in the water column. Response efforts can produce additional serious impacts. There would be no adverse impacts to deepwater coral communities in deep water as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because communities are located far offshore in deep water (>300 m; 984 ft).

Phase 4—Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine what long-term effects may occur. Contaminants degrade over time, but they may become sequestered as inert forms (e.g., buried in sediment) until disturbed and reactivated, producing renewed impacts. Deepwater coral have relatively slow metabolic growth rates that could increase their vulnerability to disturbance (Prouty et al., 2014).

Although deepwater coral and other deepwater benthic organisms often live in close association with hydrocarbon seeps (since authigenic carbonate substrate is locally precipitated by chemosynthetic communities), this does not mean they are necessarily tolerant to the effects of oil contamination. Natural seepage is very constant and flows at very low rates compared with the potential volume of oil released from a catastrophic event (blowout or pipeline rupture). In addition, deepwater coral organisms, such as *Lophelia pertusa*, typically inhabit areas around the perimeter of seeps and sites where hydrocarbon seepage has reduced or stopped its flow. Typical Gulf of Mexico oil is light and floats rapidly to the surface rather than being carried horizontally across benthic communities by water currents (Johansen et al., 2001; MacDonald et al., 1995; Trudel et al., 2001). So, although deepwater benthic communities are found relatively close to naturally occurring oil seeps, they are not typically exposed to concentrated oil.

If oil is ejected under high pressure or if dispersants are applied at the source near the seafloor, oil would mix into the water column, be carried by underwater currents, and eventually contact the seafloor in some form, either concentrated (near the source) or dispersed and decayed (farther from the source). The oil could then impact patches of deepwater benthic community habitat in its path. The farther the dispersed oil travels, the more diluted it would become as it mixes with surrounding water. Sensitive deepwater coral communities distanced greater than 610 m (2,000 ft) away from a blowout could still experience minor impacts from suspended sediments that travel with currents, although the sediment concentration would become more diluted with distance.

White et al. (2014) following the *Deepwater Horizon* explosion, oil spill, and response evaluated possible long-term persistence of both oil and the dispersant used during that spill, the anionic surfactant DOSS (dioctyl sodium sulfosuccinate). Samples were taken from both seafloor sediments and flocculent material in an affected deepwater coral community in Mississippi Canyon Block 294 and compared with other *Deepwater Horizon* oil spill-derived samples collected on coastal beaches. While this study did not measure or link toxicity of oil or DOSS to coral tissues, it noted that DOSS was found to persist for 6 months in the samples taken from the coral community and up to 4 years in the beach samples. These findings contrast the shorter DOSS persistence durations observed in laboratory conditions that mimicked the solar and temperature conditions in surface waters and could present an additional concern if sediments containing DOSS are demonstrated to be toxic to deepwater coral organisms. Krasnec et al. (2015) measured toxicity of sediments collected within 2 km (1.2 mi) of the *Macond*o wellhead, although they did not measure the effects on deepwater megafauna. The study found varying levels of mortality and growth inhibition for a small shrimp-like crustacean species, with the relative degree of toxicity decreasing over time (lower toxicity found in 2014 samples than in 2011 samples). Another study of this same area (Hsing et al., 2013) indicated that some of the corals with the least damage appear to be improving in health over time.

Experiments with shallow tropical corals indicate that some corals have a high tolerance to oil exposure. The mucus layers on coral resist penetration of oil and slough off the contaminant. Longer exposure times and areas of tissue where oil adheres to the coral are more likely to result in tissue damage and death of polyps. Corals with branching growth forms appear to be more susceptible to damage from oil exposure (Shigenaka, 2001). The most common deepwater coral, *Lophelia pertusa*, is a branching species. Tests with shallow tropical gorgonians indicate relatively low toxic effects to the coral (Cohen et al., 1977), suggesting deepwater gorgonians may have a similar response. Depending on the level of exposure, the response of deepwater coral to oil from a catastrophic spill would vary. Exposure to widely dispersed oil adhering to organic detritus and partially degraded by bacteria may be expected to result in little effect. Direct contact with plumes of relatively fresh dispersed oil droplets in the vicinity of the incident could cause the death of affected coral polyps through exposure and potential feeding on oil droplets by polyps. Median levels of exposure to dispersed oil in a partly degraded condition may result in effects similar to those of shallow tropical corals, with often no discernible effects other than temporary contraction and some sloughing. The health of corals may be degraded by the necessary expenditure of energy as the corals respond to oiling (Shigenaka, 2001).

Communities exposed to more concentrated oil may experience detrimental effects, including death of affected organisms, tissue damage, lack of growth, interruption of reproductive cycles, and loss of gametes. Many invertebrates associated with deepwater coral communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. A 7-year, post-spill assessment concluded that infaunal communities at deepwater coral sites impacted by the *Deepwater Horizon* oil spill did not resemble those of non-impacted sites or any other GOM habitat (Bourque et al., 2019). The recolonization of severely damaged or destroyed communities could take years or decades. Burial of hard substrate could permanently prevent recovery. However, because of the relative scarcity of deepwater hard substrate and the distancing requirements set by BOEM in NTL 2009-G40, it is unlikely that a sensitive habitat would be located adjacent to a seafloor blowout or that concentrated oil would contact the site.

A catastrophic spill combined with the application of dispersant has the potential to cause impacts to local patches of habitat in the path of subsea plumes where they physically contact the seafloor. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary lack of feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect. Depending on how long it remains in the water column, oil may be thoroughly degraded by biological action before contacting the seafloor. Water currents can carry a plume to contact the seafloor directly, but a more likely scenario would be for oil to adhere to other particles and precipitate to the seafloor as marine snow (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2011; Passow et al., 2012). Oil also would reach the seafloor through consumption by plankton with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2011). These mechanisms would result in a wide distribution of small amounts of oil (or oil by-products). This oil would be in the process of biodegradation from bacterial action, which would continue on the seafloor, resulting in scattered microhabitats with an enriched carbon environment (Hazen et al., 2010). Habitats directly under the path of the oil plume as it disperses and "rains" down to the seafloor may experience minor effects, but because the oil would be deposited in a widely scattered and decayed state, little overall effect is anticipated.

Overall Summary and Conclusion (Phases 1-4)

Deepwater coral communities would potentially be subject to detrimental effects from a catastrophic seafloor blowout. Sediment and oiled sediment from the initial event (Phase 1) could have lethal or sublethal impacts should they occur in heavy amounts in close proximity, but that is unlikely because of the distancing requirements described in NTL 2009-G40. Finer sediments from a blowout may still reach the location of sensitive habitats, producing sublethal effects. The initial accident could result in the drilling rig and equipment falling on a sensitive seafloor habitat.

The ongoing spill event (Phase 2) would have the greatest effect on deepwater coral communities. These communities are at risk from subsea oil plumes that could directly contact localized patches of sensitive habitat. Oil plumes reaching deepwater coral communities could cause oiling of organisms, resulting in the death of entire populations on localized sensitive habitats. However, the potential impacts would be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. The more likely result would be exposure to widely dispersed, biodegraded particles that "rain" down from a passing oil plume. While a few patch habitats could be affected, the Gulfwide population of deepwater coral communities as a whole would be expected to suffer no significant effects. This is evidenced by the numerous other deepwater coral communities investigated since the *Deepwater Horizon* oil spill that have remained healthy (White et al., 2012, Hsing et al., 2013; Fisher et al. 2014).

Oil reaching the shore (Phase 3) presents no additional adverse impacts to deepwater coral communities because the communities are located offshore in deep water (>300 m; 984 ft).

The recovery of deepwater coral communities (Phase 4) depends on the severity of initial impacts. A catastrophic spill combined with the application of dispersant has the potential to cause devastating effects on local patches of sensitive habitat in the path of subsea plumes where they physically contact the seafloor. The recolonization of severely damaged or destroyed communities could take years or decades. Burial of hard substrate could permanently prevent recovery of organisms dependent on hard substrate. Sublethal effects are possible for communities that receive a lower level of impact. Examples of these effects could include temporary reduction in feeding, expenditure of energy to remove the oil, loss of gametes and reproductive delays, and loss of tissue mass. However, most deepwater coral communities are expected to experience no impacts from a catastrophic seafloor blowout because of the directional movement of oil plumes by the water currents and because the habitats have a scattered, patchy distribution.

1.3.1.5 *Sargassum* and Associated Communities

Pelagic *Sargassum* algae is a floating, brown algae that occurs in all parts of the GOM throughout the year. The life history of *Sargassum* in the Gulf is part of a larger cycle that includes the mid-Atlantic Ocean and the Caribbean Sea (Frazier et al., 2015). This cycle begins in the Sargasso Sea where *Sargassum* remains year-round. However, winds and currents move some of this *Sargassum* south into the Caribbean Sea and eventually into the Gulf via the Yucatan Channel. Once in the Gulf of Mexico, it moves into the western area where it feeds off the nutrient input from coastal rivers, including the Mississippi River. As *Sargassum* abundance increases, plants would continue to travel east during the summer months; however, a large quantity of plants would travel into the nearshore where they would be deposited on coastal beaches. Eventually the plants moving east would be incorporated into the Gulf Stream where they return to the Sargasso Sea. Throughout this cycle, plants would continue to grow, die, and reproduce. When a plant dies, it can sink to the seafloor, transporting nutrients and resources to the seafloor (Coston-Clements et al., 1991; Parr, 1939; Wei et al., 2012). Although the cycle continues year-round, the rapid growth of *Sargassum* populations in the western Gulf typically occur during the spring/summer of the year (Gower et al., 2006; Gower and King, 2008 and 2011). Estimates suggest that between 0.6 and 6 million metric tons (0.66-6.61 million tons) of *Sargassum* are present annually in the Gulf of Mexico with an additional 100 million metric tons (110 million tons) exported to the Atlantic basin (Gower and King, 2008 and 2011; Gower et al., 2013). *Sargassum* deposition on Gulf beaches is important because *Sargassum* facilitates dune stabilization and provides a pathway for nutrient and energy transfer from the marine environment to the terrestrial environment (Webster and Linton, 2013). The spatial expanse of this life history facilitates the rapid recovery from episodic environmental perturbations because of the remote probability that any single event could impact the entire spatial distribution.

Sargassum occurs in patches, floating on and near the sea surface. Wind and water currents commonly drive it into long lines or windrows; when conditions are turbulent, it becomes more scattered and mixed into the upper water column. A key to understanding impacts to *Sargassum* is that the algae is ubiquitous and occurs in scattered patches in the very top part of the water column. *Sargassum* also provides habitat for pelagic species, including fish, invertebrates, and sea turtles.

Since 2011, the density and areal coverage of *Sargassum* has dramatically increased in the Gulf of Mexico. In 2018, the extent of *Sargassum* created the largest macroalgae bloom ever recorded (Wang et al., 2019). The Great Atlantic *Sargassum* Belt stretches from West Africa to the Gulf of Mexico and may be caused by excess nutrient discharge from the Amazon River and changes in ocean circulation (Wang et al., 2019; Oviatt et al., 2019).

Phase 1—Initial Event

During the initial phase of a catastrophic blowout, impacts may include disturbance of sediments, destruction of the drilling rig, release of oil and natural gas (methane), and emergency response efforts. This phase deals with the immediate effects of a blowout that would be located at least 3 nmi (3.5 mi; 5.6 km) from shore.

Since *Sargassum* is a floating pelagic (open ocean) algae, it would only be affected by impacts that occur in the top-most part of the water column. In deep water (≥ 300 m; 984 ft), sediment disturbed by the blowout would not affect *Sargassum* because the sediment would not reach the surface waters. However, in shallow water (<300 m; 984 ft), sediment from a blowout could have minor effects on *Sargassum* algae in the immediate vicinity. The sediment would have little effect on the algae itself, producing only slight, temporary silting that could reduce photosynthesis. If the sediment is contaminated with oil, then the oil could have adverse effects on the algae. Depending on the severity of oiling, the algae could be damaged or destroyed, but this would only affect the algae in the local vicinity of the blowout. Sediment and oil would have a more acute effect on the associated invertebrate, fish, and sea turtle community that uses *Sargassum* as a habitat. Impacts from sedimentation to these organisms may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003). Impacts from oil could range from negligible to severe, including death if oil concentrations in the water column are great enough to result in ingestion of oil or coating of the organisms (Fucik et al., 1995; Brewton et al., 2013, and references therein).

Destruction of the oil drilling rig and associated equipment could have an acute effect on patches of *Sargassum* algae that happen to be caught in the structure (if it sinks) or destroyed by fuel leaks and possible fire on the sea surface. This could destroy local patches of *Sargassum*, but it would have no measurable effect on the *Sargassum* community as a whole.

The release of oil during the initial blowout event would be expected to cover local patches of *Sargassum* algae with oil, destroying the algae and associated organisms. Methane gas may also bathe local patches of algae as it rises through the sea surface; it would have little effect on the algae itself but may poison associated organisms. The initiation of oil and gas release (as defined for this phase) at the site of the blowout event would affect only local patches of *Sargassum*, but it would have no measurable effect on the *Sargassum* community as a whole.

Emergency response activities would have minor impacts to *Sargassum* algae that come in contact with vessels. This is mostly the simple impingement of the algae on the ships' water intake screens, including water that may be pumped in fire-fighting efforts. This minor and local effect would have no measurable effect on the *Sargassum* community as a whole.

Phase 2—Offshore Spill

During the second phase of a catastrophic blowout, the major impact of concern is the release of oil and methane over time. Response efforts may produce additional minor impacts to *Sargassum*. This phase deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

Since *Sargassum* is a floating, pelagic algae, it would be affected by impacts that occur in the top-most part of the water column. This makes *Sargassum* habitat particularly susceptible to damage from offshore oil spills. Oceanographic processes that concentrate *Sargassum* into mats and rafts would also concentrate toxic substances. Therefore, it may be assumed that *Sargassum* would be found in areas where oil, dispersants, and other chemicals have accumulated following a catastrophic spill. Oil spreads on the sea surface to form extremely thin layers (0.01-0.1 micrometers) that cover large areas (MacDonald et al., 1996). Since *Sargassum* is ubiquitous in surface waters of the GOM, oil spreading on the sea surface can be expected to coincide with floating mats of the algae. The larger the quantity of spill and the longer it flows, the larger the area of sea surface it would cover. A catastrophic spill would cover a large area and result in impacts to a large quantity of *Sargassum* algae. Studies of the impact of the *Deepwater Horizon* oil spill on *Sargassum* have shown that the spilled oil affected 23 percent of the *Sargassum* in the northern Gulf of Mexico with heavy oil. In addition to the 873-1,749 km^2 (337-675 mi^2) of area in which *Sargassum* was contacted by oil, total loss to the population was estimated to include an additional 4,524-9,392 km^2 (1,747-3,626 mi^2) of foregone area from lost growth (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The severity of oiling to *Sargassum* depends largely on physical conditions. Factors include the quantity of oil at a particular launch point and its physical state, distance from the source, weather conditions, and the possible use of dispersants.

Obviously, more oil leads to increased oiling, but the physical state of the oil changes as it weathers, biodegrades, dissipates, and emulsifies over time and distance. Storms can mix oil into the water column (expected maximum of 10-20 m [33-66 ft]; Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985; Scarlett et al., 2005; Hemmer et al., 2010; George-Ares and Clark, 2000), possibly increasing its contact with *Sargassum* as it also mixes the *Sargassum* into the water column. However, when storms are not mixing the oil, they are also not mixing the *Sargassum*, so the *Sargassum* would float near the sea surface, just as the oil would. Convergence zones, places in the ocean where strong opposing currents meet, would collect both oil and *Sargassum*. Sea turtles, especially post-hatchlings and juveniles, use these areas for food and cover. Witherington et al. (2012) surveyed sea turtles in the eastern Gulf of Mexico and Atlantic Ocean off Florida and found that 89 percent of the turtles documented were observed within 1 m (3 ft) of floating *Sargassum*. The use of dispersants on surface oil slicks could reduce the proportion of oil floating on the sea surface and could increase biodegradation of the oil, resulting in lower concentrations of oil contacting *Sargassum.* Regardless, any exposure that is enough to cause visible oiling can be expected to have significant detrimental effects on the organisms associated with *Sargassum* and, likely, effects on the *Sargassum* itself.

Findings from a study by Stout et al. (2018) showed that *Sargassum* in the northern GOM was directly exposed to weathered oil from the *Deepwater Horizon* oil spill. All four floating *Sargassum* samples collected from two locations within the known area of floating oil during the active spill contained weathered oil; one was visibly oiled upon inspection. The absence of oil in other samples collected soon after the spill ended may be partly due to the application of chemical dispersants, which could have caused oiled *Sargassum* to sink.

The specific effects of oil on *Sargassum* depend on the severity of oiling. High to moderate levels of oiling would likely cause complete mortality. Low levels of exposure may result in a range of sublethal effects to the algae and its associated community. Powers et al. (2013) suggest that exposure to oil and/or dispersants can result in direct, sublethal, and indirect effects to *Sargassum*, resulting in death or a decrease in *Sargassum*-related ecosystem services. Sublethal responses in organisms associated with *Sargassum* may occur at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Rogers (1990) documented impacts such as reduced growth, alteration in form, and reduced recruitment and productivity. Other sublethal impacts may include reduced feeding rates, reduced ability to detect food, erratic movement, ciliary inhibition, tentacle retraction, reduced movement, decreased aggression, and altered respiration (Scarlett et al., 2005; Suchanek, 1993). Embryonic life stages of organisms may experience toxicity at lower levels than the adult stages (Fucik et al., 1995; Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989). The algae itself would be less sensitive than many of its associates since the algae produces oils of its own and has a waxy coating that may protect it from physical oiling.

Response efforts aimed at removing oil from the affected area would have minor impacts on *Sargassum* algae as well. Response vessels would impinge a small amount of the algae on their propellers and cooling-water intakes. Cleanup processes such as booming, skimming, and *in-situ* burning would also trap and destroy patches of *Sargassum*; however, these activities would take place in areas of high concentration of surface oil, where *Sargassum* would likely be destroyed by oil contamination even if the cleanup activity were absent.

Phase 3—Onshore Contact

This third phase of a catastrophic blowout focuses on the approach of oil to the shoreline. This involves the possible oiling of coastal resources including beaches, wetlands, SAV and seagrasses, the shallow seafloor, and any resources drifting in the water column (e.g., *Sargassum*). Response efforts can produce additional serious impacts.

There would likely be little additional impact to pelagic *Sargassum* algae as oil approaches a shoreline. Since both the algae and surface oil approaching shore would be guided by the same forces (wind and water currents), they would likely be already traveling together, with the algae already contaminated. Once it is onshore, the *Sargassum* would die, regardless of oil contamination. *Sargassum* that washes ashore has some value to the ecosystem as it provides food and shelter for some organisms as it decays. This value would be mostly lost if the *Sargassum* is oiled when it reaches shore.

Phase 4—Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine the long-term effects. Contaminants biodegrade over time, but they may become sequestered as inert forms (e.g., buried in sediment) until disturbed (by storms) and reactivated, producing renewed impacts.

Sargassum algae has a yearly seasonal cycle of growth and a yearly cycle of migration from the Sargasso Sea, to the Caribbean Sea, and into the GOM (Frazier et al., 2015). A catastrophic spill could affect a large portion of the annual crop of the algae in the vicinity of the spill, but because the Sargasso Sea supplies the GOM, these plants would be replaced with unimpacted individuals in short order (Frazier et al., 2015). However, the effect can be expected to diminish with remoteness from the direct impacts of the spill, both on the algae community itself and on organisms that use the habitat as a nursery, for feeding, as shelter, or for other purposes. While a large spill event could affect a large portion of the standing crop of *Sargassum*, several factors contribute to the quick recovery of the habitat. *Sargassum* algae is predominately found in the open-ocean pelagic habitat. Once the spill event subsides, the pelagic habitat would return to normal. Only part of the *Sargassum* stocks would be affected; algae not affected by the spill event would continue to grow normally and repopulate the habitat. Since *Sargassum* has a seasonal cycle of growth in the summer and reduction in the winter, populations in the winter following a catastrophic event may be similar to populations of any other year. With this pattern, recovery from the effects of a catastrophic event is expected within 1-2 growing seasons. For example, after the *Deepwater Horizon* oil spill, *Sargassum* populations had returned to comparable abundance the following summer (Powers et al., 2013).

Findings from a molecular examination of bacterial communities associated with *Sargassum* in the northern GOM showed that the *Deepwater Horizon* oil spill had little effect on the composition and diversity of these communities (Torralba et al., 2017). Oiled and non-oiled *Sargassum* had an evenly distributed abundance of microbial species. However, the effects of catastrophic oil spills on marine microorganisms are not fully understood.

Overall Summary and Conclusion (Phases 1-4)

Pelagic *Sargassum* algae is one of the most likely habitats to be affected by a catastrophic offshore oil spill; however, because of its ubiquitous distribution and seasonal cycle, recovery is expected within 1-2 years. *Sargassum* algae floats on and near the sea surface and occurs in patches that can be collated into windrows by wind and water currents. Oil from a spill offshore would accumulate in the same waters, making it inevitable that some patches of *Sargassum* would be severely affected.

The initial catastrophic event (Phase 1) could destroy *Sargassum* patches in the immediate vicinity of the accident. Impingement, fire, and the initial concentrated spillage of oil and fuels would destroy local patches. Sediments disturbed by the accident would only affect *Sargassum* if the event occurred in shallow waters.

The duration of the spill event (Phase 2) would have the most effect on floating *Sargassum* algae. Patches of algae within the entire coverage of the oil slick would be subject to severe damage and death. Algae in areas farther from the spill, receiving lower level impacts, may still suffer damage, especially the sensitive invertebrate and fish communities associated with the habitat. Efforts to remove the oil could gather *Sargassum* with the oil, but these algae patches would likely be destroyed by the oil anyway since the collection activities would occur in areas of concentrated oil.

As oil approaches shore (Phase 3), impacts to floating *Sargassum* algae would not increase much, as the algae would likely already be exposed to the oil since wind and water currents drive both the algae and the oil.

The recovery of floating *Sargassum* algae (Phase 4) may occur rapidly because the algae has a yearly cycle of subsidence and re-growth. Not all of the *Sargassum* habitat would be affected, even by a catastrophic spill; healthy algae would continue to grow and replenish the population. Within 1-2 years, the *Sargassum* algae community may have completely recovered from the impacts of a catastrophic spill.

1.3.1.6 Live Bottom Habitats

1.3.1.6.1 Topographic Features

The Gulf of Mexico has a series of topographic features (banks or seamounts) on the continental shelf in shallow-water depths less than 300 m (984 ft). Topographic features are isolated areas of moderate to high relief that provide habitat for hard bottom communities of high biomass and moderate diversity. These features support prolific algae, invertebrate, and fish communities, and they provide shelter and food for large numbers of commercially and recreationally important fish. There are 38 identified topographic features in the Gulf of Mexico, including the Flower Garden Banks, with specific BOEM protections. BOEM has created "No Activity Zones" around topographic features in order to protect these habitats from disruption by OCS oil- and gas-related activities. A No Activity Zone is a protective perimeter drawn around each feature that is associated with a specific isobath (depth contour) surrounding the feature, in which structures, drilling rigs, pipelines, and anchoring are not allowed. These No Activity Zones are areas where activity is prohibited based on BOEM's policy. The NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas," requires that drilling should not occur within 152 m (500 ft) of a No Activity Zone of a topographic feature.

Potentially sensitive biological features (PSBFs) are features that have moderate to high relief, provide hard surface for sessile invertebrates, and attract fish. The PSBFs are frequently located near topographic features. No bottom-disturbing activities that may cause impact to these features are permitted.

Some of these communities include listed coral species, specifically Orbicella species complexes reside in BOEM's planning areas within the Flower Garden Banks. Surveys in the Flower Garden Banks between 2002 and 2006 found that the Orbicella species complex was the dominant coral, comprising between 27 and 43 percent benthic cover (Hickerson et al., 2008). A more recent study (Johnston et al., 2017) found similar results with the Orbicella species complex being the dominant coral in the Flower Garden Banks from 1989 to 2017. Similar to other coral communities in the Gulf of Mexico, the protected coral communities support a diverse community of benthic invertebrates and a wide range of reef fish species (Hickerson et al., 2008).

Any catastrophic oil spill event would likely result in the greatest net negative impacts (primarily direct mortality) to threatened and endangered coral species due to their low population numbers, limited distribution, and potential movement of spilled oil to other areas where species are present. In addition, the short- and long-term presence of spilled oil would result in indirect and potentially long-term effects to threatened and endangered species' habitats and their preferred or required foods. These impacts would be more damaging to Endangered Species Act (ESA) listed species populations because they already have lower population numbers pre-spill.

In general, the potential direct impact (i.e., mortality) to these threatened or endangered species is a function of their presence at the time of a catastrophic oil spill. Indirect effects from a catastrophic oil spill could negatively affect the quality and functional availability of their habitats as well as the availability, distribution, and energetic benefits of their preferred or required foods.

Phase 1—Initial Event

A catastrophic blowout would result in released oil rapidly rising to the sea surface because all known reserves in the GOM have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The oil would likely surface almost directly over the source location. However, if the oil is ejected under high pressure (e.g., deep water), micro-droplets of oil may form and become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy and slowing its rise to the surface (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsea plumes or sinking particulates may contact topographic features.

A catastrophic blowout outside the well casing and below the seafloor or at the seafloor-water interface could resuspend large quantities of bottom sediments and create a large crater, destroying organisms within a few hundred meters of the wellhead (Brooks et al., 1978). If a blowout were to occur near a topographic feature, suspended sediment may impact the organisms living on the lower levels of the topographic feature (since water currents flow around the banks rather than traveling uphill).

A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the seafloor sediment.

Impacts to Topographic Features

Impacts that occur to benthic organisms on topographic features as a result of a blowout would depend on the type of blowout, distance from the blowout, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). The NTL 2009-G39 requires the use of buffers to prevent blowouts in the immediate vicinity of a topographic feature or its associated biota. Much of the oil released from a blowout would rise to the sea surface, therefore minimizing the impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column for extended periods of time may migrate into No Activity Zones that surround the topographic feature. In addition, they may come in contact with PSBFs. Although these small oil droplets would not sink themselves, they may attach to suspended particles in the water column and then be deposited on the seafloor (McAuliffe et al., 1975). The resultant long-term impacts, such as reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment, are discussed in Phase 4. Also, if the blowout were to occur beneath the seabed, suspension and subsequent deposition of disturbed sediment may smother localized areas of benthic communities, possibly including organisms within No Activity Zones or on PSBFs. Benthic communities on a topographic feature or PSBFs exposed to large amounts of resuspended and deposited sediments following a catastrophic, subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light availability. Impacts to corals as a result of sedimentation would vary based on coral species, the height to which the coral grows, degree of sedimentation, length of exposure, burial depth, and the coral's ability to clear the sediment (refer to **Chapter 1.3.1.4**). Impacts may range from sublethal effects such as reduced growth, alteration in form, and reduced recruitment and productivity to slower growth or death (Rogers, 1990). Corals may also experience discoloration or bleaching as a result of sediment exposure, although recovery from such exposure is possible (Wesseling et al., 1999).

The initial blowout impact would be greatest to communities located in clear waters with little suspended sediment that experience heavy sedimentation as a result of the blowout. Reef-building corals are sensitive to turbidity and may be killed by heavy sedimentation (Rogers, 1990; Rice and Hunter, 1992). However, it is unlikely that reef-building corals would experience heavy sedimentation as a result of a blowout because drilling activity is not allowed near sensitive organisms in the No Activity Zones based on the lease stipulations as described in NTL 2009-G39. The most sensitive organisms are also typically elevated above soft sediments, making them less likely to be buried. The lower levels of topographic banks and the PSBFs, which are generally small features with only a few meters of relief, typically experience turbid conditions. Vigorous bottom currents (often generated by storms) frequently resuspend bottom sediments and bathe these features in turbid waters, which results in sedimentation. As a result, the organisms that live in this environment near the seafloor are those best adapted to frequent sedimentation and thus more resilient to sediment-related impacts.

Initial impacts would be much less extreme in a turbid environment (Rogers, 1990). For example, the South Texas Banks exist in a relatively turbid environment (the Nepheloid Zone). They generally have lower relief than the farther offshore banks at the shelf edge, may have a sediment cover, and exhibit reduced biota. Sediment from a blowout, if it occurred nearby, may have a reduced impact on these communities compared with an open-water reef community, as these organisms are more tolerant of suspended sediment (Gittings et al., 1992). Many of the organisms that dominate this community also grow tall enough to withstand the sedimentation that results from their turbid environment or have flexible structures that enable the passive removal of sediments (Gittings et al., 1992).

A portion or the entire rig may sink to the seafloor as a result of a blowout. The benthic features and communities upon which the rig settles would be destroyed or smothered. Encrusting organisms would be crushed by a rig if it lands on a topographic feature or PSBF. A settling rig may suspend sediments, which may smother nearby benthic communities if the sediment is redeposited on sensitive features. The habitats beneath the rig may be permanently lost.

Phase 2—Offshore Spill

A spill from a shallow-water blowout could impact benthic communities on the continental shelf because of the blowout's proximity to these habitats. The scenario (**Table 1-3**) for a catastrophic spill on the continental shelf is assumed to last 1.5-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana mid-range paraffinic sweet crude oil, which would float

(APIº >10), could be released. An anticipated 35,000 bbl of dispersant may be applied to the surface waters.

A spill from a deepwater blowout could also impact shelf communities if surface oil is transported to these areas. The scenario (**Table 1-3**) for a catastrophic spill in deep water is assumed to last 1.5-6 months and to release 30,000-60,000 bbl per day. A total volume of 2.7-7.2 MMbbl of South Louisiana mid-range paraffinic sweet crude oil, which would float (APIº >10), would be released. Oil properties may change as it passes up the well and through the water column, and it may become emulsified. An anticipated 33,000 bbl of dispersant may be applied to the surface waters and 16,500 bbl may be applied subsea. Weathering and dilution of the oil would also occur as it travels from its release point. It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. That oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008). Further, the stratified density layers of water allow the oil/dispersant plume to remain at depth instead of dispersing up into the water column (Joint Analysis Group, 2010; Camilli et al., 2010).

Impacts to Topographic Features

Impacts from Surface Oil

Sensitive reef communities flourish on topographic features and PSBFs in the Gulf of Mexico. Their depth below the sea surface helps to protect these habitats from a surface oil spill. Rough seas may mix the oil into subsurface water layers, where it may impact sessile biota. The longer the amount of time the seas are rough, the greater the amount of oil from a surface slick would be mixed into the water column. Measurable amounts of oil have been documented to mix from the surface down to a 10-m (33-ft) water depth, although modeling exercises have indicated such oil may reach a water depth of 20 m (66 ft). At this depth, however, the oil is found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). None of the topographic features or PSBFs in the GOM are shallower than 10 m (33 ft), and only the Flower Garden Banks are shallower than 20 m (66 ft).

In one extraordinary circumstance with an unusual combination of meteorological and oceanographic conditions, a tropical storm forced a large volume of *Deepwater Horizon* oil spill-linked surface oil/dispersant mixture to as deep as 246 ft (75 m), causing temporary exposure to mesophotic corals in the Pinnacle Trend area and leading to some coral mortality and sublethal impacts (Silva et al., 2015).

Impacts from Subsurface Oil

The presence of a subsurface oil plume on the continental shelf from a shallow-water blowout may affect benthic communities on topographic features and PSBFs. A majority of the oil released is expected to rise rapidly to the sea surface above the release point because of the specific gravity characteristics of the oil reserves in the GOM, thus not impacting sensitive benthic communities. If the oil is ejected under high pressure, oil droplets may become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy and slowing its rise to the surface (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles. Subsurface plumes generated by high-pressure dissolution of oil may come in contact with topographic features and PSBFs. A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column would become diluted or evaporated over time, reducing any localized transport to the seafloor (Vandermeulen, 1982). In addition, microbial degradation of the oil occurs in the water column so that the oil would be less toxic as it travels from the source (Hazen et al., 2010). However, a sustained spill may result in elevated exposure concentrations to benthic communities if the plume reaches them. The longer the spill takes to stop, the longer the exposure time and the higher the exposure concentration may be.

The PSBFs have a greater chance of being impacted by subsea plumes than the topographic features because currents tend to sweep around topographic features (Rezak et al., 1983; McGrail, 1982). The lower relief PSBFs may fall in the path of the plume because those smaller features are not large enough to divert a current. Low-level exposures of corals to oil from a subsea plume may result in chronic or temporary impacts. For example, feeding activity or reproductive ability may be reduced when coral is exposed to low levels of oil. Experimental simulations of exposure indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 parts per million (ppm) oil (Lewis, 1971). In addition, reefs of *Siderastrea siderea* that were oiled in a spill produced smaller gonads than unoiled reefs, resulting in reproductive stress (Guzmán and Holst, 1993).

Elevated concentrations of oil may impact photosynthesis or growth in corals. Photosynthesis of the zooxanthellae in *Diploria strigosa* exposed to approximately 18-20 ppm crude oil for 8 hours was not measurably affected, although other experiments indicate that photosynthesis may be impaired at higher concentrations (Cook and Knap, 1983). Measurable growth of *Diploria strigosa* exposed to oil concentrations up to 50 ppm for 6-24 hours did not show any reduced growth after 1 year (Dodge et al., 1984).

Corals exposed to subsea oil plumes may incorporate petroleum hydrocarbons into their tissue. Records indicate that *Siderastrea siderea*, *Diploria strigosa*, and the protected *Orbicella annularis* accumulate oil from the water column and incorporate petroleum hydrocarbons into their tissues (Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992). Most of the petroleum hydrocarbons are incorporated into the coral tissues, not their mucus (Knap et al., 1982). However, hydrocarbon uptake may also modify lipid ratios of coral (Burns and Knap, 1989). If lipid ratios are modified, mucus synthesis may be impacted, adversely affecting the coral's ability to protect itself from oil through mucus production (Burns and Knap, 1989).

It is unlikely that a subsurface plume from a deepwater blowout would impact shelf communities. The oil is anticipated to remain in deep water and be directed by water currents in the deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts from Dispersed Oil

If dispersants are used at the sea surface, oil may mix into the water column, or if applied subsea, they can travel with currents through the water and may contact or settle on sensitive features. Note that, as indicated above, a deepwater plume would not travel onto the continental shelf, but a plume formed on the continental shelf could impact topographic features and PSBFs. If located near the source, the dispersed oil could be concentrated enough to harm the community. If the oil remains suspended for a longer period of time, it would be more dispersed and exist at lower concentrations. Reports on dispersant usage on surface oil indicate that a majority of the dispersed oil remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (7 ft) (McAuliffe et al., 1981). In one extraordinary circumstance with an unusual combination of meteorological and oceanographic conditions, a tropical storm forced a large volume of *Deepwater Horizon* oil spill-linked surface oil/dispersant mixture to as deep as 246 ft (75 m), causing temporary exposure to mesophotic corals in the Pinnacle Trend area and leading to some coral mortality and sublethal impacts (Silva et al., 2015). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing oil adhering to sediments and traveling to the seafloor (McAuliffe et al., 1981). However, after the *Deepwater Horizon* oil spill, there was the formation of a dense layer of marine snow that aggregated as it fell through the water column and settled on the seafloor (Passow et al., 2012).

Dispersed oil reaching the topographic features and PSBFs in the Gulf of Mexico would generally be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981). Such concentrations would not be life threatening to larval or adult stages at the depth of the features based on experiments conducted with coral. Any dispersed oil in the water column that comes in contact with corals may evoke short-term negative responses by the organisms (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984).

Reductions in feeding and photosynthesis could occur in coral exposed to dispersed oil. Short-term, sublethal responses of *Diploria strigosa* were reported after exposure to dispersed oil at a concentration of 20 ppm for 24 hours. Although concentrations in this experiment were higher than what is anticipated for dispersed oil at depth, effects exhibited included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, and localized tissue rupture (Wyers et al., 1986). Normal behavior resumed within 2 hours to 4 days after exposure (Wyers et al., 1986). *Diploria strigosa* exposed to dispersed oil (20:1, oil:dispersant) showed an 85-percent reduction in zooxanthellae photosynthesis after 8 hours of exposure to the mixture (Cook and Knap, 1983). However, the response was short term, as recovery occurred between 5 and 24 hours after exposure and return to clean seawater. Investigations 1 year after *Diploria strigosa* was exposed to concentrations of dispersed oil between 1 and 50 ppm for periods between 6 and 24 hours did not reveal any impacts to growth (Dodge et al., 1984).

Historical studies indicate dispersed oil to be more toxic to coral species than oil or dispersant alone. The greater toxicity may be a result of an increased number of oil droplets caused by the use of dispersant, resulting in greater contact area between oil, dispersant, and water (Elgershuizen and De Kruijf, 1976). The dispersant causes a higher water-soluble amount of oil to contact the cell membranes of the coral (Elgershuizen and De Kruijf, 1976). The mucus produced by coral, however, can protect the organism from oil. Both hard and soft corals have the ability to produce mucus, and mucus production has been shown to increase when corals are exposed to crude oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Dispersed oil, however, which has very small oil droplets, does not appear to adhere to coral mucus, and larger untreated oil droplets may become trapped by the mucus barrier (Knap, 1987; Wyers et al., 1986). However, entrapment of the larger oil droplets may increase the coral's long-term exposure to oil if the mucus is not shed in a timely manner (Knap, 1987; Bak and Elgershuizen, 1976). Additionally, more recent field studies, using more realistic concentrations of dispersants did not result in the toxicity historically reported (Yender and Michel, 2010).

Although historical studies indicated dispersed oil may be more toxic than untreated oil to corals during exposure experiments, untreated oil may remain in the ecosystem for long periods of time, while dispersed oil might not (Baca et al., 2005; Ward et al., 2003). Twenty years after an experimental oil spill in Panama, oil and impacts from untreated oil were still observed at oil treatment sites, but no oil or impacts were observed at dispersed oil or reference sites (Baca et al., 2005). Long-term recovery of the coral at the dispersed oil site had already occurred as reported in a 10-year monitoring update, and the site was not significantly different from the reference site (Ward et al., 2003).

Impacts from Oil Adhering to Sediments

BOEM's policy, as described in NTL 2009-G39, prevents wells from being placed immediately adjacent to sensitive communities. In the event of a seafloor blowout, however, some oil could be carried to topographic features or PSBFs as a result of oil droplets adhering to suspended particles in the water column. Oiled sediment that settles to the seafloor may affect organisms attached to hard bottom substrates. Impacts may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement in the area. An increase in the number of deformed polyps after metamorphosis also took place because of exposure to oil (Kushmaro et al., 1997).

The majority of organisms exposed to sedimented oil are expected to experience low-level concentrations because as the oiled sediments settle to the seafloor where they are widely distributed. Coral may also be able to protect itself from low concentrations of sedimented oil that settles from the water column. Coral mucus may not only act as a barrier to protect coral from the oil in the water column, but it has also been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). Coral may use a combination of increased mucus production and the action of cilia to rid themselves of oiled sediment (Bak and Elgershuizen, 1976).

Impacts from Oil-Spill Response Activity

Oil-spill response activity may also impact sessile benthic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically impact corals and other sessile benthic organisms, especially when booms are moved around by waves (USDOC, NOAA, 2010d). Vessel anchorage and decontamination stations set up during response efforts may also damage PSBF organisms if their location is unmapped and anchors are set on the features. Injury to coral reefs as a result of anchor impact may result in long-lasting damage or failed recovery (Rogers and Garrison, 2001). Drilling muds may be pumped into a well to stop a blowout. If a "kill" is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on the restrictions described in NTL 2009-G39, a well should be far enough away from a topographic feature to prevent extruded drilling muds from smothering sensitive benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a sensitive community, the muds could smother the existing community. Experiments indicate that corals perish faster when buried beneath drilling mud than when buried beneath carbonate sediments (Thompson, 1980). Burial may lead to the elimination of a live bottom community.

Phase 3—Onshore Contact

There would likely be no adverse impacts to topographic features and PSBFs as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill because the topographic features and PSBFs are located far offshore.

Phase 4—Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine the long-term effects. Contaminants can degrade over time, but they may become sequestered as inert forms (e.g., buried in sediment) until disturbed and reactivated.

Following the *Deepwater Horizon* explosion, oil spill, and response, White et al. (2014) evaluated the possible long-term persistence of oil and the dispersant used during that spill, i.e., the anionic surfactant DOSS (dioctyl sodium sulfosuccinate). Samples were taken from both seafloor sediments and flocculent material in an affected deepwater coral community in Mississippi Canyon Block 294 and were compared with other *Deepwater Horizon* oil spill-derived samples collected on coastal beaches. While this study did not measure or link the toxicity of oil or DOSS to benthic organisms, it noted that DOSS was found to persist for 6 months in the sediment samples taken from the coral community and up to 4 years in the beach samples. These findings contrast the shorter DOSS persistence durations observed in laboratory conditions that mimicked the solar and temperature conditions in surface waters and could present an additional concern if sediments containing DOSS are demonstrated to be toxic.

Another study (Qu et al., 2015) of select macrobenthos species (polychaete annelids) near the *Macondo* wellhead found significantly lower species, abundance, and biodiversity values compared with distant locations with similar depths, which the authors described as a measurable community impact attributed to the *Deepwater Horizon* oil spill. Both of these studies described deepwater impacts and may or may not apply directly to shallower waters. In another study of two banks at depths of 55-80 m (180-262 ft), Felder et al. (2014) sampled both before and after the *Deepwater Horizon* explosion, oil spill, and response, and documented a strong decline in diversity and abundance of decapod crustacean species at Ewing Bank, as well as less severe reductions at Sackett Bank. The authors hypothesized possible mechanisms by which oil could have negatively impacted algal and associated decapod communities, such as through the introduction of oil into porous bedrock that might have stimulated anaerobic sulfate reducers, producing hydrogen sulfide. The resultant loss of seaweed cover could have caused cascading effects, including the observed reduction in resident decapod crustaceans and changes in dominant species. However, as the authors clearly state, they could not definitively attribute the abundance and diversity reductions to the *Deepwater Horizon* explosion, oil spill, and response, owing to the confounding variables of other substantial environmental changes occurring over the same time period, including abnormally high Mississippi River outfalls.

Topographic features and PSBFs exposed to large amounts of resuspended sediments following a catastrophic, subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light penetration. The greatest impacts would occur to communities that exist in clear water with very low turbidity. The consequences of a blowout along, directly on, or near one of these features could be long lasting, although the occurrence of a blowout near such sensitive communities is unlikely because of stipulations described in NTL 2009-G39, which prevents drilling activity near sensitive hard bottom habitats. Impacts to a community in more turbid waters, such as the South Texas Banks, would be greatly reduced, as the species on these features are tolerant of suspended sediments, and recovery would occur more quickly.

Impacts may also occur from low-level or long-term oil exposure. This type of exposure has the potential to impact reef communities, resulting in impaired health. Recovery may be fairly rapid from brief, low-level exposures, but it could be much longer with acute concentrations or long-term exposure to oil, such as in observations from Panama where untreated oil remained in the ecosystem for long periods of time, inhibiting coral recovery (Baca et al., 2005; Ward et al., 2003). Recovery time would therefore depend on recruitment from outside populations that were not affected by oiling and residence time of oil in an ecosystem.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic spill on the continental shelf would have a greater impact on topographic features and PSBFs than a deepwater spill. Surface oil from a deepwater spill would be weathered and diluted by the time it reaches the surface waters over topographic features and PSBFs (if it ever reaches them), and it would be unlikely that it would mix to the depth of active growth in concentrations that could cause toxicity. Subsea plumes formed in deep water would likely not travel onto the continental shelf because deep-sea currents do not typically travel up a slope.

A catastrophic blowout and spill on the continental shelf have a greater chance to impact topographic features and PSBFs. If the blowout occurs close enough to sensitive features, the organisms may be smothered by settling sediment that was displaced by the blowout (Phase 1). The farther the feature is from the blowout, the less its chance of being covered with settling sediment or sediment upon which oil adhered. In addition, distancing OCS oil- and gas-related activities from topographic features prevents the settlement of a sinking rig on top of a topographic feature.

In most cases, impacts from oil during Phase 2 would be sublethal. Surface oil is not generally expected to mix to the zone of active growth, and any oil components that do reach that depth would be in sublethal concentrations. Subsea plumes may contact the features; however, because currents tend to travel around, instead of over, topographic features, the topographic features should be largely protected from subsea plumes, while lower relief PSBFs may be impacted. Overall impacts of dispersed oil would be similar to subsea plumes. Because topographic features are far offshore, there should be no negative impacts during Phase 3. Finally, during Phase 4, spill response activity should not impact topographic features because it is unlikely that vessels would anchor on the features, but they could anchor on unmapped, lower relief PSBFs. Recovery of the habitats would be directly proportional to the distance from the spill, degree of oiling, and if the underlying substrate was damaged.

Overall, a catastrophic spill would have a low probability of impacting topographic features because of the following: the distancing requirements included in leases; the depth of mixing of surface oil compared with the depth of the active growing zone; currents that sweep around the topographic features; and the weathering and dispersion of oil that would occur with distance from the source as it travels toward the features. The PSBFs could have greater impacts from a blowout as OCS oil- and gas-related activities are not distanced as far from them as from topographic features; they have a lower relief than topographic features, which would not divert currents; and the locations of these features are not all known, so accidental anchor impacts may result in damage to the features. The PSBFs would, however, have similar protection as for topographic features from surface oil.

1.3.1.6.2 Pinnacle Trend and Low-Relief Features

The Gulf of Mexico has hard substrate features upon which encrusting and epibenthic organisms often attach (“live bottoms”) on the continental shelf in shallow-water depths less than 300 m (984 ft). Live bottom features occur throughout the Gulf of Mexico, but they are most prevalent in parts of the CPA and EPA where BOEM has enacted the Live Bottom (Pinnacle Trend) and Live Bottom (Low-Relief) Stipulations.

The Pinnacle Trend is an approximately 64 x 16 mi (103 x 26 km) area in water depths of about 200-650 ft (60-200 m). It is in the northeastern portion of the CPA at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. Live bottoms within the Pinnacle Trend area consist of both high-relief outcroppings at the edge of the Mississippi-Alabama Shelf and low-relief hard bottoms on the inner and middle shelf. Live bottom (Pinnacle Trend) features are defined in NTL 2009-G39 as “small, isolated, low to moderate relief carbonate reefal features or outcrops of unknown origin or hard substrates exposed by erosion that provide area for the growth of sessile invertebrates and attract large numbers of fish.” These substrates provide habitat for a large variety of hard and soft corals, sponges, echinoderms, crustaceans, and other invertebrates along with complex fish assemblages (refer to **Chapter 1.3.1.7**). Through site-specific reviews, BOEM distances drilling activities and bottom-disturbing equipment from all known Pinnacle Trend features.

Live bottom (low-relief) features are defined in NTL 2009-G39 as “seagrass communities; areas that contain biological assemblages consisting of sessile invertebrates living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; and areas where hard substrate and vertical relief may favor the accumulation of turtles, fishes, or other fauna.” These features also include reef communities like those found on the Florida Shelf. These communities can include listed coral species. BOEM uses the Live Bottom (Low-Relief) Stipulation and case-by-case plan reviews to protect these features from impacts, including bottom-disturbing activity. This chapter discusses only hard substrates; seagrasses are discussed in **Chapter 1.3.1.3.2**.

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill event. A catastrophic blowout would result in most released oil rapidly rising to the sea surface because all known reserves in the GOM have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site (Environment Canada, 2011; Trudel et al., 2001). The oil would surface almost directly over the source location. However, if the oil is ejected under high pressure, micro-droplets of oil may form and some may become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil’s buoyancy (Adcroft et al., 2010). Large oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may flocculate with particulate matter, promoting sinking of the particles as “marine snow.” Subsea plumes or sinking oil on particulates may contact live bottom features.

Fine sediments could travel up to a few thousand meters before redeposition. If a blowout were to occur close enough to a live bottom feature, suspended sediments may impact the organisms living on the feature. A catastrophic blowout that occurs above the seabed (at the rig, along the riser between the seafloor and sea surface, or through leak paths on the BOP/wellhead) would not disturb the seafloor sediment.

The use of subsea dispersants would increase the exposure of offshore benthic habitats to dispersed oil droplets in the water column, as well as the chemicals used in the dispersants. The use of subsea dispersants is not likely to occur for seafloor blowouts outside the well casing.

Impacts to the Pinnacle Trend and Low Relief Features

Impacts that occur to benthic organisms on Pinnacle Trend and low-relief features as a result of a blowout would depend on the type of blowout, distance from the blowout, relief of the biological feature, and physical characteristics of the surrounding environment (e.g., turbidity and currents). The distancing of bottom-disturbing activities from Pinnacle Trend and live bottom, low-relief features helps to prevent blowouts in the immediate vicinity of a live bottom feature.

Much of the oil released from a blowout would rise to the sea surface, minimizing the impact to benthic communities by direct oil exposure. However, small droplets of oil that are entrained in the water column for extended periods of time may migrate into areas that have pinnacle trend or low-relief features. Although these small oil droplets would not sink themselves, they may attach to suspended particles in the water column and become "marine snow" that may settle on the seafloor (McAuliffe et al., 1975; Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2011; Passow et al., 2012). The resultant long-term impacts, such as reduced recruitment, reduced growth, and reduced coral or other epibenthic cover, are discussed in Phase 4.

Following a catastrophic, subsurface blowout, benthic communities on a pinnacle trend or low-relief feature exposed to large amounts of resuspended and then deposited sediments could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light availability. Sedimentation impacts to fauna found on hard bottoms would vary based on species, the height to which the organism grows, degree of sedimentation, length of exposure, burial depth, and the organism's ability to remove the covering sediment. Impacts may range from sublethal effects (such as reduced or slower growth, alteration in form, and reduced recruitment and productivity) to death (Rogers, 1990; Fucik et al., 1980). Some live bottom organisms, such as flexible sea fans, are naturally adapted to turbid conditions and may not be as negatively affected as others without such adaptations (Gittings et al., 1992).

The initial blowout impact due to sedimentation would be greatest to communities located in clear waters. The most sensitive organisms are typically elevated above the seafloor, making them less likely to be buried. Corals located in Live Bottom (Pinnacle Trend) and Live Bottom (Low-Relief) Stipulations' blocks would likely not experience heavy sedimentation because they are distanced from bottom-disturbing activities by the requirements of NTL 2009-G39. In addition, BOEM conducts case-by-case reviews of plans submitted by operators to ensure that the proposed activity would not impact other sensitive seafloor features. However, it is possible for some live bottoms to experience impacts resulting from turbidity or sedimentation due to a blowout if they are downstream from the blowout in currents transporting sediment. Corals may experience discoloration or bleaching as a result of sediment exposure, although recovery from such exposure may occur within a relatively short time period (i.e., 1 month as noted in Wesseling et al., 1999).

Initial impacts would be less extreme in a naturally turbid environment (Rogers, 1990). The Pinnacle Trend community exists in a relatively turbid environment, starting just 65 km (40 mi) east of the mouth of the Mississippi River and trending to the northeast. Many low-relief live bottoms are frequently covered with a thin sand veneer that moves with waves and bottom currents, intermittently exposing and covering up areas (Phillips et al., 1990; Gittings et al., 1992). Sediment from a nearby blowout may have a reduced impact on such communities compared with open-water reef communities, as organisms in turbid environments have a higher tolerance to suspended sediment (Gittings et al., 1992). Many of the organisms that dominate in this community (such as sea fans) also grow tall enough to withstand some sedimentation or have flexible structures that enable the passive removal of sediments (Gittings et al., 1992). Many organisms present in low-relief, live bottom habitats are motile, can burrow in the sediment, or have other mechanisms for dealing with turbidity that provide some tolerance of short-term, high turbidity events. For example, bivalves can reduce their filtration rates if the suspended sediment concentrations become elevated and can reject excess sediment through pseudofeces (Clarke and Wilber, 2000). Many crustaceans are able to tolerate high levels of suspended sediment (Wilber et al., 2005). These organisms are also able to move away from turbid areas (Clarke and Wilber, 2000; Wilber et al., 2005). Oysters, on the other hand, are not able to move but are somewhat turbidity tolerant due to living near the mouths of rivers that deposit sediment into their habitat (Wilber et al., 2005). Severely impacted organisms may also rapidly repopulate an area affected by sedimentation (Fucik et al., 1980).

As with the *Deepwater Horizon* explosion, oil spill, and response, a rig may sink to the seafloor as a result of a blowout. Destruction of the oil drilling rig and associated equipment could have an acute negative effect on any live bottom organisms and/or hard substrates caught under the direct impact of falling equipment. The benthic features and communities upon which the rig settles would likely be destroyed or smothered. Encrusting organisms would be crushed. A settling rig would also likely suspend sediments, which may smother nearby benthic communities if the sediment is redeposited on sensitive features. The habitats beneath the rig may be permanently lost if sediments cover them. The benthic communities that were smothered by sediment could eventually repopulate from nearby stocks through spawning recruitment and immigration. The distancing requirements of NTL 2009-G39 somewhat mitigate the risk that a rig would sink directly on sensitive habitat.

Phase 2—Offshore Spill

A spill from a shallow-water blowout could impact benthic communities on the continental shelf because of the blowout's proximity to these habitats. The scenario (**Table 1-3**) for a catastrophic spill on the continental shelf is assumed to last 1.5-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana mid-range paraffinic sweet crude oil, which would float (API° >10), could be released. An anticipated 35,000 bbl of dispersant may be applied to the surface waters.

A spill from a deepwater blowout could also impact shelf communities if surface oil is transported to these areas. The scenario (**Table 1-3**) for a catastrophic spill in deep water is assumed to last 1.5-6 months and to release 30,000-60,000 bbl per day. A total volume of 2.7-7.2 MMbbl of South Louisiana midrange paraffinic sweet crude oil, which would float (API° >10), would be released. Oil properties may change as it passes up the well and through the water column, and it may become emulsified. An anticipated 33,000 bbl of dispersant may be applied to the surface waters and

16,500 bbl may be applied subsea. Weathering and dilution of the oil would also occur as it travels from its release point. It is unlikely that large amounts of oil from a subsurface plume from a deepwater blowout would impact shallow-water shelf communities. Most such oil would be anticipated to remain in deep water. These currents do not typically transit from deep water up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts to Pinnacle Trend and Low-Relief Features

Impacts from Surface Oil

Sensitive live bottom communities can flourish on hard bottoms in the Gulf of Mexico. The eastern Gulf of Mexico contains scattered, low-relief live bottoms, including areas of flat limestone shelf rock and the Pinnacle Trend area, located on the Mississippi-Alabama continental shelf, which includes low- and high-relief features that are 60-120 m (197-394 ft) below the sea surface. The depth of the Pinnacle Trend features and most live bottom, low-relief features helps to protect them from a surface oil spill. Rough seas may mix the oil into subsurface water layers, where it may impact sessile biota. Silva et al. (2015) hypothesize that Tropical Storm Bonnie in July 2010 may have submerged injurious amounts of surface oil from the *Deepwater Horizon* oil spill and contributed to documented coral pathologies in the Pinnacles Trend area. The longer the seas are rough, the greater the amount of oil from a surface slick would be mixed into the water column. Measurable amounts of oil have been documented to mix from the surface down to a 10-m (33-ft) depth, although modeling exercises have indicated such oil may reach a depth of 20 m (66 ft). At this depth, however, the oil is found at concentrations several orders of magnitude lower than levels shown to have an effect on corals and other benthic organisms (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985; Scarlett et al., 2005; Hemmer et al., 2010; George-Ares and Clark, 2000). In one extraordinary circumstance with an unusual combination of meteorological and oceanographic conditions, a tropical storm forced a large volume of *Deepwater Horizon* oil spill-linked surface oil/dispersant mixture to as deep as 246 ft (75 m), causing temporary exposure to mesophotic corals in the Pinnacle Trend area and leading to some coral mortality and sublethal impacts (Silva et al., 2015).

Low-relief, live bottom habitats located in shallow coastal waters may be at greater risk of surface oil mixing to contact depths. However, most OCS oil- and gas-related activities do not occur in those shallower, nearshore waters, and therefore, spilled surface oil would be more dispersed and diluted by the time it reaches waters above those shallow-depth live bottoms.

Impacts from Subsurface Oil

The presence of a subsurface oil plume on the continental shelf caused by a shallow-water blowout may affect pinnacle trend and/or low-relief features. A majority of oil released is expected to rise rapidly to the sea surface above the release point because of the specific gravity characteristics of the oil reserves in the GOM and thus not substantially impact sensitive benthic communities. However, if oil is ejected under high pressure, oil droplets may become entrained in the water column (Boehm and Fiest, 1982; Adcroft et al., 2010). The upward movement of the oil may be reduced if methane mixed with the oil is dissolved into the water column, reducing the oil's buoyancy (Adcroft et al., 2010). Larger oil droplets would rise to the sea surface, but smaller droplets, formed by vigorous turbulence in the plume or the injection of dispersants, may remain neutrally buoyant in the water column, creating a subsurface plume (Adcroft et al., 2010; Joint Analysis Group, 2010). Dispersed oil in the water column begins to biodegrade and may attach to particulate matter and sink as “marine snow.” A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column would become diluted or evaporated over time, reducing localized transport to the seafloor (Vandermeulen, 1982). In addition, microbial degradation of the oil occurs in the water column so that the oil becomes less toxic over time (Hazen et al., 2010). However, subsurface plumes generated by the high-pressure dissolution of oil may come in contact with pinnacle trend and/or low-relief features, and a sustained spill may result in elevated exposure concentrations to benthic communities if the plume reaches them. The longer the spill, the longer the possible exposure time and the greater the exposure concentration.

Live bottom, low-relief features have a greater chance of being impacted by subsea plumes than some Pinnacle Trend features because currents may sweep around the larger features, as they do with topographic features (Rezak et al., 1983; McGrail, 1982). The lower relief live bottoms (including low-relief features within the Pinnacle Trend) may fall in the path of the plume because those features are not large enough to divert a current. Low-level exposures of organisms to oil from a subsea plume may result in chronic or temporary impacts. For example, oil exposure can reduce the feeding activity of coral, and oiled reefs may experience reproductive stress (Lewis, 1971; Guzmán and Holst, 1993). In addition, photosynthesis and growth may be reduced with oil exposure, and petroleum may be incorporated into coral tissue including *Siderastrea siderea*, *Diploria strigosa*, and *Orbicella annularis* (Cook and Knap, 1983; Dodge et al., 1984; Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992). Most of the petroleum hydrocarbons are incorporated into the coral tissues, not their mucus (Knap et al., 1982). However, hydrocarbon uptake may also modify lipid ratios of coral (Burns and Knap, 1989). If lipid ratios are modified, mucus synthesis may be impacted, adversely affecting the coral’s ability to protect itself from oil through mucus production (Burns and Knap, 1989). Coral larvae can also be negatively affected by oil and dispersants, resulting in settlement failure or larval mortality (Goodbody-Gringley et al., 2013). Other marine invertebrates on live bottom habitats may experience sublethal impacts that could result in population-level changes (Suchanek, 1993) at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Sublethal impacts may include reduced feeding rates, reduced ability to detect food, erratic movement, ciliary inhibition, tentacle retraction, reduced movement, decreased aggression, and altered respiration (Scarlett et al., 2005; Suchanek, 1993). Embryonic life stages of benthic organisms may experience toxic effects at lower levels than adult stages (Fucik et al., 1995; Suchanek, 1993; Beiras and Saco-Álvarez, 2006; Byrne, 1989).

It is unlikely that a subsurface plume from a deepwater blowout would impact live bottom shelf communities since most of these plumes would be anticipated to remain in deep water. Deepwater currents do not typically transit up onto the shelf (Pond and Pickard, 1983; Inoue et al., 2008).

Impacts from Dispersed Oil

If dispersants are used at the sea surface, oil may mix into the water column. If applied subsea, they can travel with currents through the water, and they may contact or settle on sensitive features. Note that, as indicated above, a deepwater plume would likely not travel onto the continental shelf, but a plume formed on the continental shelf could impact Pinnacle Trend and low-relief features. If near the source, the dispersed oil could be concentrated enough to harm the community. If the oil remains suspended for a longer period of time, it would be present at lower concentrations. Reports on dispersant usage on surface oil suggest that a majority of the dispersed oil usually remains in the top 10 m (33 ft) of the water column, with 60 percent of the oil in the top 2 m (7 ft) (McAuliffe et al., 1981). However, Silva et al. (2015) present evidence that unusually rough seas associated with Tropical Storm Bonnie in July 2010 may have submerged large amounts of oil at the surface and in the upper water column from the *Deepwater Horizon* oil spill. The authors conclude that this mechanism may have led to acute toxic exposure of oil to several species of octocorals at two mesophotic coral communities in the Pinnacle Trend area, causing the documented lethal and sublethal impacts.

Dispersant usage may reduce oil's availability to stick to particles in the water column, minimizing oil adhering to sediments and traveling to the seafloor (McAuliffe et al., 1981). However, after the *Deepwater Horizon* oil spill, there was the formation of a dense layer of marine snow that fell through the water column and settled on the seafloor (Passow et al., 2012), and this may have been responsible for documented lethal and sublethal impacts to deepwater coral (White et al., 2012). Any dispersed oil in the water column that comes in contact with live bottoms may evoke short-term negative responses by the organisms (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984; Scarlett et al., 2005; Renzoni, 1973).

The impact of dispersants on benthic organisms is dependent on the type of dispersant, length of dispersant exposure, and the physical barriers the organism has to protect itself from the dispersant. Coral larvae can suffer reduced settlement and survival following exposure to dispersants, as shown for *Orbicella faveolata* by Goodbody-Gringley et al. (2013). Organisms with shells may be better protected from dispersant-related impacts than those with only a tissue barrier (Scarlett et al., 2005). Organisms that produce mucus may have an elevated tolerance for oil exposure (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). In one experiment, larvae were exposed to an oil-dispersant mixture, and concentrations of 100-ppm and 1,000-ppm oil plus dispersant in a ratio of 4:1 were necessary to reduce oyster and mussel fertilization and development (Renzoni, 1973). After 48 hours of exposure to dispersants, the blue mussel (*Mytilus edulis*) died at dispersant concentrations of 250 ppm; reduced feeding rates were observed at 50 ppm (Scarlett et al., 2005). The snakelocks anemone (*Anemonia viridis*), which does not have a protective shell, retracted its tentacles and failed to respond to stimuli after 48 hours of exposure to 40-ppm dispersant (Scarlett et al., 2005). Reductions in feeding and photosynthesis could occur in corals exposed to dispersed oil. Short-term, sublethal responses of *Diploria strigosa* were reported after exposure to dispersed oil at a concentration of 20 ppm for 24 hours. Although concentrations in this experiment were higher than anticipated for dispersed oil at depth, effects exhibited included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, localized tissue rupture, and reduced photosynthesis

(Wyers et al., 1986; Cook and Knap, 1983). Respiratory damage to organisms may not be reversible; however, if exposure is short enough (noted as <48 hours in Scarlett et al., 2005) and in low concentrations, nervous system damage may be reversed and organisms may recover (Scarlett et al., 2005). Investigations 1 year after *Diploria strigosa* was exposed to varying concentrations of dispersed oil and for varying periods of time found no negative growth impacts (Dodge et al., 1984).

Concentrations used in experiments are generally greater than likely exposure levels in the field (Renzoni, 1973; George-Ares and Clark, 2000). Although historical experiments suggest oil toxicity increases with the concentration of dispersant, the toxicity of the oil actually remains the same as it was when it was not dispersed, but exposure increases due to the dispersed components of the oil (George-Ares and Clark, 2000). However, the increase of oil into the water column with the addition of dispersants is temporary, as dispersed oil is diluted by seawater and biodegraded by bacteria (George-Ares and Clark, 2000). Therefore, concentrated dispersants are generally not anticipated to reach live bottoms in substantial amounts, and in most cases, impacts that do occur should be sublethal and temporary.

Impacts from Oil Adhering to Sediments

BOEM's policy, described in NTL 2009-G39, prevents wells from being placed immediately adjacent to sensitive communities. In the event of a seafloor blowout, some oil could be carried to live bottoms by oil droplets adhering to suspended particles in the water column. Oiled sediment may settle on the seafloor and affect organisms attached to hard bottom substrates. Impacts may include reduced recruitment success, reduced growth, and reduced benthic cover as a result of impaired recruitment. Experiments have shown that the presence of oil on available substrate for larval coral settlement has inhibited larval metamorphosis and larval settlement in the area. Oil exposure also increased the number of deformed polyps after metamorphosis occurred (Kushmaro et al., 1997). In addition, exposure to oiled sediment has also been shown to reduce the growth rate of clams (Dow, 1975).

The majority of organisms exposed to oiled sediments are expected to experience only low-level concentrations, particularly because oiled sediments would have been widely dispersed before settling to the seafloor. Many organisms on live bottoms would be able to protect themselves from low levels of oiled sediment that may settle out of the water column. Organisms with shells would not experience direct contact with the oil, and mobile organisms would be able to move away from areas where oiled sediment has accumulated. Corals may be somewhat protected from mucus that can act as a protective barrier and which has also been shown to aid in the removal of oiled sediment on coral surfaces (Bak and Elgershuizen, 1976). In addition, because many organisms in live bottom habitats are tolerant of naturally occurring levels of turbidity and sedimentation, the addition of slight amounts of sediment by itself may not result in severe impacts.

Impacts from Oil-Spill Response Activity

Oil-spill response activity may also impact sessile benthic features. Booms anchored to the seafloor are sometimes used to control the movement of oil at the water surface. Boom anchors can physically impact sessile benthic organisms, especially when boom anchors are moved by waves (USDOC, NOAA, 2010d). Vessel anchorage and decontamination stations set up during response efforts may also damage unmapped live bottoms if anchors are set on the habitat. Injury to live bottom habitat as a result of anchor impact may result in long-lasting damage or failure to recover (Rogers and Garrison, 2001).

Drilling muds may be pumped into a well to stop a blowout. If such a "kill" is not successful, the mud (possibly tens of thousands of barrels) may be forced out of the well and deposited on the seafloor near the well site. Any organisms beneath the extruded drilling mud would be buried. Based on restrictions described in NTL 2009-G39, a well should be located far enough away from a live bottom feature to prevent extruded drilling muds from smothering sensitive benthic communities. However, if drilling muds were to travel far enough or high enough in the water column to contact a sensitive community, the fluid would smother the existing community. Burial may lead to the elimination of a live bottom community.

Phase 3—Onshore Contact

Because pinnacle trend and low-relief features are located far offshore, there would likely be no adverse impacts as a result of the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill.

Phase 4—Post-Spill, Long-Term Recovery and Response

The final phase of a catastrophic blowout is the long-term response of the ecosystem and its recovery. Both the natural rate of recovery and the persistence of oil in natural habitats over time determine the long-term effects. Contaminants can degrade over time, but they may become sequestered as inert forms (e.g., buried in sediment) until disturbed and reactivated.

Following the *Deepwater Horizon* explosion, oil spill, and response, White et al. (2014) evaluated the possible long-term persistence of oil and the dispersant used during that spill, the anionic surfactant DOSS (dioctyl sodium sulfosuccinate). Samples were taken from both seafloor sediments and flocculent material in an affected deepwater coral community in Mississippi Canyon Block 294 and compared with other *Deepwater Horizon* oil spill-derived samples collected on coastal beaches. While this study did not measure or link the toxicity of oil or DOSS to benthic organisms, it noted that DOSS was found to persist for 6 months in the sediment samples taken from the coral community and up to 4 years in the beach samples. These findings contrast the shorter DOSS persistence durations observed in laboratory conditions that mimicked the solar and temperature conditions in surface waters and could present an additional concern if sediments containing DOSS are demonstrated to be toxic.

Another study (Qu et al., 2015) of select macrobenthos species (polychaete annelids) near the *Macondo* wellhead found significantly lower species, abundance, and biodiversity values compared with distant locations with similar depths, which the authors described as a measurable community impact attributed to the *Deepwater Horizon* oil spill. Both of these studies described deepwater impacts and may or may not apply directly to shallower waters. In another study of two banks at depths of 55-80 m (180-262 ft), Felder et al. (2014) sampled both before and after the *Deepwater Horizon* explosion, oil spill, and response, and documented a strong decline in diversity and abundance of decapod crustacean species at Ewing Bank, as well as less severe reductions at Sackett Bank. The authors hypothesized possible mechanisms by which oil could have negatively impacted algal and associated decapod communities, such as through the introduction of oil into porous bedrock that might have stimulated anaerobic sulfate reducers, producing hydrogen sulfide. The resultant loss of seaweed cover could have caused cascading effects, including the observed reduction in resident decapod crustaceans and changes in dominant species. However, as the authors clearly state, they could not definitively attribute the abundance and diversity reductions to the *Deepwater Horizon* explosion, oil spill, and response, owing to the confounding variables of other substantial environmental changes occurring over the same time period, including abnormally high Mississippi River outfalls.

Pinnacle trend and low-relief features exposed to large amounts of resuspended sediments following a catastrophic, subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light penetration. The greatest impacts would occur to communities that exist in clear water with very low natural turbidity. The consequences of a blowout near one of these features could be long-lasting, although the occurrence of a blowout near such sensitive communities is unlikely because of stipulations described in NTL 2009-G39, which distances bottom-disturbing activity from live bottom features. In addition, BOEM conducts case-by-case reviews of submitted plans and pipelines so that sensitive seafloor habitat is avoided. Impacts to a community in more turbid waters, such as those on the Mississippi-Alabama Shelf, may be reduced, as many of these species are more tolerant of suspended sediments. Recovery time from sediment exposure would depend on the amount of sediment to which organisms were exposed and the extent of lethal and sublethal impacts to the local populations.

Impacts may also occur from low-level or long-term oil exposure. This type of exposure has the potential to impact live bottom communities, resulting in impaired health. Long-term impacts could include reduced recruitment success, reduced growth, and reduced organism cover. Recovery from brief, low-level exposures could be rapid, but it could take longer for greater exposures. Recovery time would then depend on recruitment from outside populations that were not affected by oiling.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic spill on the continental shelf would have a greater impact on live bottom features than a deepwater spill. Surface oil from a deepwater spill would be weathered and diluted by the time it reaches the surface waters over live bottom features, and it would be unlikely, except in shallow coastal waters (e.g., Silva et al., 2015), that oil or oil/dispersant mixtures would mix to the depth of the live bottoms in concentrations that could cause toxicity.

If a blowout on the continental shelf occurs close enough to sensitive features, the organisms may be smothered by settling sediment displaced by the blowout. The farther a feature is from the blowout, the lower its chance of being covered with settling sediment or sediment upon which oil adhered. The distancing of OCS oil- and gas-related activity from live bottom features helps to prevent heavy sedimentation and also reduces the chance of features being crushed by a sinking rig.

In most cases, the impacts from oil would be sublethal. Surface oil is not generally expected to mix to the zone of active growth, and any oil components that do reach that depth would likely be at sublethal concentrations. Subsea plumes may contact the live bottom features; however, because currents tend to travel around instead of over large seafloor features, the Pinnacle Trend features may be more protected from subsea plumes than lower relief live bottoms. Current OCS oil- and gas-related activity in the GOM, however, is distanced from low-relief live bottoms because no live bottom, low-relief blocks are currently leased. Overall impacts of dispersed oil would be similar to the impacts of subsea plumes. Spill response activities such as anchoring may impact low-relief, live bottom features if they are unmarked on nautical charts and vessels anchor on the features.

Overall, a catastrophic spill would have a fairly low probability of impacting live bottom features during a blowout and near the wellsite because the bottom-disturbing activities of OCS oil- and gas-related activities are distanced from live bottom features because BOEM conducts site-specific reviews of all plans to ensure that activities do not impact these seafloor features. Live bottom features are also protected by the limited mixing depth of surface oil compared with the depth of the live bottom features, by currents sweeping around larger features, and by the weathering and dispersion of oil that would occur over distance.

1.3.1.7 Fishes and Invertebrate Resources

Phase 1—Initial Event

Depending on the blowout type and proximity to marine life, an eruption of gases and fluids may generate toxic effects, pressure waves, and noise significant enough to injure or kill local biota. Within a few thousand meters of the blowout, re-suspended sediments (i.e., turbidity) may initially impair biologically important behaviors (e.g., foraging success and predator avoidance) and could result in respiratory stress, altered metabolism, and displacement or mortality of local marine organisms over time (Miner and Stein, 1996; Kielland et al., 2015). However, the effects of increased turbidity are species-specific and can be beneficial in some cases (e.g., increased food availability, increased feeding efficiency, and enhanced predator avoidance) (Wilbur and Clarke, 2001; Johnson, 2018). Sedimentation of the re-suspended particles may then smother invertebrates or interfere with their respiration. Some habitats in the vicinity of the blowout could be adversely impacted by the initial event, having indirect impacts to fish and invertebrates relying on these habitats for shelter and foraging opportunities. These resources are discussed in the following chapters: water quality (**Chapter 1.3.1.2**); coastal habitats (**Chapter 1.3.1.3**); deepwater habitats (**Chapter 1.3.1.4**); *Sargassum*-associated communities (**Chapter 1.3.1.5**); and live bottom habitats (**Chapter 1.3.1.6**).

Phase 2—Offshore Spill

The majority of volatile compounds in spilled oil would be expected to evaporate within 24 hours of reaching the surface. Oil that is not volatilized has the potential to affect fishes through direct coating, ingestion of hydrocarbons, or ingestion of contaminated prey (Murawski et al., 2014; Milleman et al., 2015; Snyder et al., 2015 and 2019). However, adult fishes are mobile and generally able to avoid adverse conditions (Beyer et al., 2016), reducing the potential of exposure to concentrated oil. Less mobile species or planktonic larvae are more susceptible to impacts from oil and dispersants due to their reduced ability to avoid contact. In addition, early life stages of animals are usually more sensitive to oil than adults (Boesch and Rabalais, 1987; NRC, 2005; Pulster et al., 2020). Continued research under controlled laboratory conditions has resulted in gross malformations, genetic damage, and even mortality in fish embryos exposed to low PAH concentrations for several hours post-hatch (Carls et al., 1999; Incardona et al., 2014; Mager et al., 2014; Esbaugh et al., 2016). Marine fishes and invertebrates whose eggs and larvae are found at or near the surface are most at risk from the fraction of spilled oil that rises to the surface. Therefore, the eggs and larvae of species whose spawning periods coincide with the timing and location of the highest oil concentrations would be at the greatest risk of interaction and any subsequent physiological effects.

For many fish species, adults are less likely than earlier life stages to concentrate at the surface and may avoid contact with floating oil. However, the use of dispersants may increase the risk of oil exposure for fishes and invertebrates throughout the water column because they increase the water solubility of petroleum hydrocarbons, making them more bioavailable for uptake (Wolfe et al., 2001). Consequently, filter-feeding organisms such as Gulf menhaden (*Brevoortia patronus*) have an increased risk of exposure (Millemann et al., 2015; Pena et al., 2015). Dispersed oil droplets also readily adhere to inorganic (e.g., minerals) and organic (e.g., plankton) particulates in the water column and contribute to the creation of “marine snow,” which is eventually sedimented to the seafloor (Daly et al., 2016; Suja et al., 2019). This creates an important pathway for oil to enter benthic ecosystems, resulting in greater long-term exposures for benthic and demersal (i.e., organisms living and feeding on, within, or near the bottom) fishes and invertebrates (Snyder et al., 2015; Eenennaam et al., 2018; Snyder et al., 2019).

Depending on the sea state, the rate at which oil breaks into droplets and becomes mixed with the water column can be increased significantly through the application of dispersants (Venosa et al., 2014). However, as the spilled oil mixes with greater volumes of seawater, the concentration of contaminants to which organisms are exposed becomes more dilute. Although concentrated dispersants and dispersant-oil mixes may be more toxic than similar concentrations of crude oil to some marine organisms (USEPA, Office of Research and Development, 2010; Goodbody-Gringley et al., 2013; Lively and McKenzie, 2014; Laramore et al., 2016; Jasperse et al., 2018), the probability of exposure to high concentrations of contaminants is less likely. The combined toxic effects of the oil and any dispersants or dispersant-oil mixes would not be realized unless a significant portion of a year-class were absent from the following year’s fishery (e.g., shrimps, crabs, and snapper). The effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes, sublethal damage to sensitive organs and/or tissues, increased metabolic stress, effects from direct coating by oil, accumulation of hydrocarbons in the food chain, and changes to habitat (Moore and Dwyer, 1974; Murawski et al., 2014; Millemann et al., 2015; Snyder et al., 2019; Pulster et al., 2020). The extent of the impacts would depend on many factors, including the properties of the oil, timing and duration of the event, and the species exposed.

Threatened and endangered fish and invertebrate species would likely experience the greatest net negative impacts (primarily direct mortality) due to their low population numbers, limited distributions, and potential movement of spilled oil to other areas where species are present. In addition, the short- and long-term presence of spilled oil would result in indirect and potentially long-term effects to threatened and endangered species' habitats and their preferred or required foods. These impacts would be more damaging to ESA-listed species populations because they already have lower population numbers pre-spill.

In general, the potential direct impact (i.e., mortality) to these threatened or endangered species is a function of their presence at the time of a catastrophic oil spill. Indirect effects from a catastrophic oil spill could negatively affect the quality and functional availability of their habitats as well as the availability, distribution, and energetic benefits of their preferred or required foods.

Open-water organisms, such as phytoplankton and zooplankton, are essential to marine food webs and are an important source of nutrients for mesopelagic and benthic habitats. Although there is some degree of vulnerability year-round, impacts to planktonic organisms from Phase 2 of a catastrophic oil spill would vary by season (Hernandez et al., 2010). Because phytoplankton abundance is typically greater in the warmer months, a catastrophic blowout resulting in an offshore oil spill occurring in the spring and summer could cause greater harm to fish populations than one occurring during colder months. Therefore, if phytoplankton in the affected area suffered a long-term population-level mortality event, there could be cascading, indirect effects that would impact species beyond those included in the initial mortality event. However, such a circumstance is unlikely because phytoplankton are short-lived and rapidly reproduce while currents and mixing would resupply the area with phytoplankton from outside the contaminated zone. A more likely scenario is that the rapid consumption of contaminated phytoplankton could serve to transfer contaminants into higher trophic levels (Buskey et al., 2016).

The microbial community can also be affected by an offshore oil spill. The microbial loop is an essential part of the marine ecosystem. Changes in the microbial community due to an offshore oil spill could have significant impacts on the rest of the marine ecosystem. However, several laboratory and field experiments and observations have shown that impacts to planktonic and marine microbial populations are generally short-lived and do not affect all groups equally, and in some cases actually stimulated growth of important species (González et al., 2009; Graham et al., 2010; Liu and Liu, 2013; Joye et al., 2014).

Phase 3—Onshore Contact

As oil from an offshore spill moves closer to shore, it has the potential to impact estuarine-dependent fishes and invertebrates, many of which are recreationally and commercially valuable (e.g., penaeid shrimp, blue crab, red drum, and speckled trout). It is assumed that the

National Marine Fisheries Service (NMFS) would close large portions of the GOM as oil from a catastrophic spill nears the coast. This would occur as a precautionary measure to ensure public safety and to assure consumer confidence in Gulf of Mexico seafood (e.g., NMFS issued several fishery closures in 2010 and 2011 following the *Deepwater Horizon* explosion, oil spill, and response in the Gulf of Mexico) (For more information, refer to **Chapter 1.3.1.10**, Commercial Fishing, and **Chapter 1.3.1.11**, Recreational Fishing.) Large fishery closures may help mitigate any oil-related, population-level impacts to fishes and invertebrates due to subsequent decreases in fishing pressure. For example, Shaefer et al. (2016) compared data from 109 near-coastal and estuarine fish assemblages (>45,000 individuals) in Mississippi before and after the *Deepwater Horizon* explosion. They found that, in contrast to predicted oil-induced mortalities, post-spill assemblages were characterized by high abundances in 2011, which then returned to pre-oil spill abundance levels after commercial and recreational fishing resumed (2012, 2013, and 2014) (Shaefer et al., 2016). Similarly, Able et al. (2014) found no consistent differences in species composition, abundance, and size for several juvenile and adult marsh fishes (*Fundulus* sp.) in heavily oiled locations along the Louisiana coast 2-3 years after the Deepwater Horizon explosion, oil spill, and response. Although research following the *Deepwater Horizon* oil spill failed to detect long-term, population-level impacts to many estuarine-dependent species (Fodrie et al., 2014; Glitz and Taylor, 2017), assessment of impacts and recovery may be obscured by confounding environmental and biological factors (e.g., storms, hypoxia, and reproductive success). Nevertheless, impacts to coastal and estuarine fishes and invertebrates at the organismal level can be expected after a catastrophic oil spill. For example, studies in the Gulf of Mexico identified acute impacts to eastern oysters (*Crassotrea virginica*) as a result of the *Deepwater Horizon* oil spill, freshwater diversions, and cleanup efforts (Grabowski et al., 2017), and research suggests that recovery varied across the affected region (Dietl and Durham, 2017). Sublethal exposures could also result in physiological effects in fishes and invertebrates such as decreased growth rates, gill damage, cardiovascular defects, and skin lesions (Brewton et al., 2013; Dubansky et al., 2013; Rozas et al., 2014; Pulster et al., 2020).

Phase 4—Post-Spill, Long-Term Recovery and Response

In addition to the effects described under Phases 2 and 3, a catastrophic spill could affect fish and invertebrate populations in the long-term. Oil deposited on the shore and seafloor can persist for long periods in the sediments. Benthic filter feeders, infauna, and other demersal species may be subject to long-term, intimate exposure to oil if settled on the seafloor. Although mobile adult fishes are assumed to generally avoid relatively fresh oil (Beyer et al., 2016), there is evidence that lower concentrations of weathered oil and oil-contaminated sediments may not be avoided by some species (Martin, 2017; Snyder et al., 2015 and 2019). Such behavior may have implications for the long-term growth and reproduction of exposed fishes (Brown-Peterson et al., 2015 and 2017b) that do not exhibit avoidance behavior. In addition, bioturbation and large-scale, bottom-disturbing events (e.g., storms, dredging, and trawling) could reintroduce contaminants into the water column. Chronic exposure to even low concentrations of spilled oil could have population-level impacts, particularly for species that are long-lived, have low reproductive output, and have limited distributions. However, following a review of available literature, a range of factors could obscure (i.e., spatiotemporal variability, fishery closures, and off-setting effects) or dampen (i.e., avoidance behavior, dilution, and compensatory processes) potential population-level impacts to fish (Fodrie et al., 2014). Furthermore, some effects may be undetectable without improved long-term environmental baseline data; improved population-level genomic, physiological, and demographic response information; and improved information on early life history and ecology of estuarine fishes (Fodrie et al., 2014). In addition, healthy fish and invertebrate resources, as well as fishery stocks, depend on various habitat types for spawning, breeding, feeding, and growth to maturity. If a necessary habitat became unavailable for the long-term or the quality of available habitat was poor, stocks or populations of dependent species may be adversely impacted.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic event is assumed to occur in Phases 1-4, i.e., initial event; offshore spill; onshore contact; and post-spill, long-term recovery and response. The direct impacts to fishes and invertebrates as a result of Phase 1, while likely minor, would depend on the blowout type, proximity to marine life, timing, and other factors. A prolonged release of oil that is directly impacting broad areas of sensitive habitat (e.g., estuaries, deepwater corals, and topographic features) would generate the greatest risk of population-level impacts in the short- or long-term. Phase 2 would affect marine organisms and life stages with limited mobility in the vicinity of spilled oil. For many species, early life stages are more likely to concentrate at the surface; thus, they are most vulnerable due to their inability to avoid adverse conditions. Eggs and larvae are generally most susceptible to the effects of oil exposure, which can include lethal toxicity, sub-lethal disruption of physiological processes, impaired function due to oil coating, and increased stress. Phase 3 could affect important nursery habitat and potentially expose large portions of estuarine dependent-species' populations to harmful concentrations of spilled oil. The long-term effects of chronic sublethal oil exposure during Phase 4 would not be immediately evident but could result in a population-level impacts (Phase 4). Potential long-term effects may be masked by many factors and detection would depend on the availability of long-term environmental baseline data and improved information on species' demographics and life history.

1.3.1.8 Birds

Migratory passerines (also commonly known as songbirds or perching birds) and shorebirds may use offshore platforms or rigs (either or both terms are referred to as offshore structures below) as potential stopover sites during their over-water migrations during the spring and fall. Additionally, it has been well documented that seabirds are attracted to offshore structures for a myriad of reasons, e.g., facilitate the concentrations of baitfish, roost sites, and shelter during extreme weather (Tasker et al., 1986, Wiese et al., 2001, Burke et al., 2012). Birds may also be attracted to the artificial night lighting and other visual cues present at the offshore platforms (Wiese et al., 2001). Passerines, such as swallows and flycatchers, may feed on insects attracted to offshore structures at night.

Any catastrophic oil spill event would likely result in the greatest net negative impacts (primarily direct mortality) to threatened and endangered bird species due to their low population numbers, limited shoreline distribution, and potential movement of spilled oil inland to other habitats during Phase 3, where most of these species reside. In addition, the short- and long-term presence of spilled oil would result in indirect and potentially long-term effects to threatened and endangered bird species' habitats and their preferred or required foods because ESA-listed species already have lower population numbers pre-spill.

In general, the potential direct impact (i.e., mortality) to these threatened or endangered species is a function of their presence at the time of a catastrophic oil spill. Indirect effects from a catastrophic oil spill could negatively affect the quality and functional availability of their habitats as well as the availability, distribution, and energetic benefits of their preferred or required foods. For more information on catastrophic oil spills on coastal habitats and fishes and invertebrates, refer to **Chapters 1.3.1.3 and 1.3.1.7**, respectively.

As the *Deepwater Horizon* explosion, oil spill, and response is the only historic catastrophic oil spill to occur in U.S. waters in the GOM, the information obtained from the *Deepwater Horizon* explosion, oil spill, and response relative to avian mortality may be reasonably relevant for any future catastrophic spills, recognizing of course the variation and uncertainty associated with individual oil spills. Of the threatened and endangered avian species considered, only a single, unoiled piping plover was collected as part of the post-*Deepwater Horizon* explosion, oil spill, and response monitoring program (**Table 1-5**). There were 106 least terns (*Sterna antillarum*) collected (n = 106), but these individuals were considered as members of the coastal breeding population and not the ESA-listed population (interior or noncoastal population). No other carcasses of currently listed threatened and endangered species were collected as part of the post-*Deepwater Horizon* explosion, oil spill, and response monitoring efforts (**Table 1-5**; USDOI, FWS, 2011).

Phase 1—Initial Event

Of the four phases considered herein, bird mortality associated with Phase 1 is expected to be much lower than bird mortality associated with either Phase 2 or Phase 3. However, this anticipated result is highly dependent on the location of the platform and the timing of the blowout event. Birds tend to be present at offshore structures that are closer to shore at a higher rate, particularly during drilling operations (Baird, 1990). Birds resting on the drilling rig or platform during a catastrophic blowout at the surface (like the *Deepwater Horizon* explosion) are more likely to be killed by the explosion. It is possible that the light from the fire could interfere with nocturnal migration, especially during poor visibility conditions, e.g., fog, rain, or cloudy skies. It has been documented that seabirds are attracted to natural gas flares at rigs and platforms (Russell, 2005; Wiese et al., 2001). When other cues are distorted, e.g., during storms, birds would often spiral in towards objects. Therefore, additional bird fatalities could result from the fire, if present, following the blowout, especially if the event occurs during adverse weather (Wiese et al., 2001). A blowout during a spring or fall migration would potentially result in a greater number of bird fatalities as the number of birds present in areas overlapping with offshore platforms would potentially have increased.

The only scenario considered here is the case where a blowout and explosion occurred at the surface. If the catastrophic event, in this case a blowout and explosion at the surface, occurs more proximal to the coast during the breeding season or a peak migration period (late March to late May and mid-August to early November) for passerines, long-legged waders, waterfowl, or shorebirds, then the level of bird mortality is expected to be higher. If the blowout event did not overlap temporally with either the breeding season or either of the trans-Gulf migrations, then it is expected to result in lower bird mortalities.

While the species composition and species-specific mortality estimates would be dependent on the blowout location and time of year, the initial mortalities would not be expected to result in population-level impacts for species present at the blowout and resulting fire (Arnold and Zink, 2011). If the event occurred during the breeding season or wintering period, species of seabirds or diving birds would have the greatest potential to be affected. If the event occurred during either the spring or fall migration, species of passerines might be equally or more affected because they would only travel over the OCS while migrating (Rappole and Ramos, 1994; Lincoln et al., 1998; Russell, 2005). Of the threatened and endangered species considered, only the roseate tern (*Sterna dougallii dougallii*) would potentially be impacted during Phase 1. The other species are restricted to the nearshore, coastal, salt-, and brackish habitats, which would not be impacted during Phase 1.

Phase 2—Offshore Spill

Total seabird mortality offshore (>40 km [25 mi] from the shoreline) (Phase 2) due to the *Deepwater Horizon* explosion, oil spill, and response was estimated at 200,000 birds (Haney et al., 2014a), though others have disputed the methods used for these estimates, suggesting overestimations (Sackmann and Becker, 2015). Zimmerman et al. (2020) also demonstrated in their study that models estimating acute bird mortalities from spills using carcass detection rates can lead to uncertainty in the results. Using mark-recapture methods, other researchers estimated that only 14 percent of birds killed at sea would have washed onshore during the *Deepwater Horizon* oil spill (Boor and Ford, 2020). Mortality rates from catastrophic oil spills may be relatively higher for smaller bird populations as they are often more likely to be decimated or become extinct. For example, four procellariiform (shearwaters and related) species had breeding population size estimates between 60,000 and 15,000,000 (Haney et al., 2014a).

During Phase 2 of a catastrophic spill, the primary concern for marine and migratory birds would be their vulnerability to oiling or ingesting oil, which is primarily a function of their behavior and diets. Wading birds (e.g., herons, egrets, etc.), plunge-divers (e.g., pelicans, gannets, terns, gulls, pelagic birds), and birds that rely on water as a primary means of locomotion, foraging (e.g., black skimmers), or resting and preening (e.g., diving ducks, cormorants, pelicans, etc.) are highly vulnerable to becoming oiled and to ingesting oil. Seabirds tend to feed and concentrate in convergence zones, eddies, upwellings, and near *Sargassum* mats (Haney, 1986a, 1986b, and 1986c; Moser and Lee, 2012). In addition to concentrating prey, these areas are also known to aggregate oil (Unified Incident Command, 2010d). Oiling interferes with the birds’ ability to fly (thus to obtain food and nesting material, migrate, escape predators, find mates, and commute between habitats) and compromises the insulation and buoyancy characteristics of down and contour feathers, making it difficult to regulate body temperature and float on the water. Recent research suggests that oil contamination can lead to feather fouling, which reduces a bird’s flight ability. This can lead to longer flight times and decreased migration speeds, causing late arrivals to wintering ground, breeding grounds, or stopover sites. Late arrival to any of these locations can result in less access to quality resources, thus poorer body conditions and negative effects on reproductive success (Perez et al., 2017). Oiling also increases energy costs and difficultly of locomotion necessary for foraging, avoiding predators, defending territories, courtship, chick provisioning, and short- and long-distance flights (Maggini et al., 2017). Attempts by oiled birds to remove the oil via preening result in the ingestion of oil (Harr et al., 2017b) and may result in mortality. Ingestion of contaminated prey can ultimately result in physiological impairment and even death. This was experimentally simulated in oral dosing studies (Horak et al., 2017; Alexander et al., 2017; Dean et al., 2017; Harr et al., 2017a, 2017b, and 2017c; Pritsos et al., 2017) discussed in Phase 4. Other recent studies have shown the physiological effects of oiling events on birds as discussed in Phase 3.

Spilled oil may affect nearby seabird colonies, or the oil may move hundreds of kilometers to affect distal colonies (Michel, 2013). It is probable that representative species of seabirds would be impacted by Phase 2 (i.e., an offshore spill) at a higher rate than they would during Phase 3 because they have a higher species richness offshore than inshore (Marine Data Analysis Team, 2018). During Phase 2 seabirds may encounter oil while feeding or roosting on the water surface. In contrast, small migratory songbirds and shorebirds stopping over on offshore platforms may not encounter oil under Phase 2 because they would not roost or feed on the water. The species composition and species-specific mortality estimates associated with Phase 2 are unknown and would be primarily dependent on the blowout location, as well as the spilled oil's distribution, coverage, and proximity to the shoreline.

Bird mortalities for Phase 2 would likely not result in population-level impacts for species affected by the offshore spilled oil. However, many species of seabirds and diving birds have life-history strategies (i.e., K-selection species) that do not allow subpopulations to recover quickly from major mortality events or perturbations (Ricklefs, 1983 and 1990; Russell, 1999; Saether et al., 2004). K-selection bird species have responded to natural selection with slow recruitment and a long period before their first breeding; in contrast, mutually exclusive r-selection species have reacted to natural selection with rapid recruitment and a short period before their first breeding. Of the threatened and endangered species considered, only the roseate tern would be potentially impacted during Phase 2. The other species are restricted to the nearshore, coastal, salt-, and brackish habitats, which would not be impacted during this phase given the scenario.

Overall, bird mortality estimates are unknown and are difficult to predict given the uncertainty (Conroy et al., 2011; Williams, 2011) associated with the scenario and specific characteristics associated with the spill (refer to **Chapter 1.2**), as well as environmental conditions that are a function of spill location and timing. Even recognizing the uncertainty associated with the scenario, spill characteristics, and the environmental conditions at the time of the spill, Phase 2 would likely be second only to Phase 3 in total bird mortality. Phase 3 would include greater avian species diversity and abundance due to the oil reaching nearshore, coastal beach/dune, salt- and brackish marsh habitats.

Phase 3—Onshore Contact

Gulf coastal habitats are essential to the annual cycles of many species of breeding, wintering, and migrating diving birds, seabirds, shorebirds, passerines, marsh and wading birds, and waterfowl. For example, the northern Gulf Coast supports a large proportion of populations of several beach-nesting bird species (USDOI, FWS, 2010b). During Phase 3, oil is expected to contact beaches, nearshore environment, and tidal freshwater, brackish, and salt marsh habitats where these species are overall more abundant than they are offshore and have a higher overall species richness (except for seabirds). Therefore, the potential impacts and total bird mortality from Phase 3 would be greater than any of the other phases considered herein. Like Phases 1 and 2, the timing and location of the spill are important factors in determining the severity of impacts to the bird community in Phase 3. In addition, the duration of potential oil exposure to various species of birds is an important factor in determining the level of impact. Some impacts discussed in Phase 2 are also expected to occur in Phase 3. For example, birds exposed in Phase 3 can face similar negative impacts to flight ability as in Phase 2.

While recognizing the variation and uncertainty associated with individual oil spills, information obtained from the catastrophic oil spills in U.S. waters (e.g., *Deepwater Horizon* explosion, oil spill, and response; and the *Exxon Valdez* oil spill) pertaining to bird mortality may be reasonably relevant for any future catastrophic spills. Despite the smaller oil-spill volume and size of the *Exxon Valdez* oil spill (compared to the *Deepwater Horizon* explosion, oil spill, and response), the nearshore location of the *Exxon Valdez* resulted in a large bird mortality event. The impacted area contained high bird diversity and abundance where oil was released suddenly, thus impairing cleanup, and oil accumulated rapidly (Piatt et al., 1990a and b; Piatt and Ford, 1996; Flint et al., 1999; Castège et al., 2007; Byrd et al., 2009; Ford and Zafonte, 2009).

Mortality from the *Deepwater Horizon* explosion, oil spill, and response was enough to cause a small negative shift in baseline abundances for seabirds. Total bird mortality onshore (0-40 km [25 mi] from shoreline) was estimated using two models, culminating in estimates of 600,000 birds using one model and 800,000 birds using the other (Haney et al., 2014b). Estimated losses due to the *Deepwater Horizon* explosion, oil spill, and response in three analyzed seabird species were 12 percent or more of the total estimated northern GOM population (Haney et al., 2014b). Paruk et al. (2020) sought to estimate the mortality rates post-*Deepwater Horizon* oiling and found that several factors can affect these estimations and likely underestimate oil exposure rates. As such, they suggest that, to convert data to population decline estimates, researchers need to estimate oil exposure rates throughout the blowout event and conduct post-event field studies to estimate seabird mortality.

The most impacted (based on number collected) avian species from the *Deepwater Horizon* explosion, oil spill, and response represented all seabird groups. Recovery (Natural Resource Damage Assessment, or NRDA) data have become available since the analyses by Haney et al. (2014a and 2014b). Total nearshore mortality was determined in six recent NRDA final reports on the *Deepwater Horizon* explosion, oil spill, and response as 54,099-100,134 waterbirds (USDOI, FWS, 2015a, 2015b, 2015c, 2015d, and 2015e; Industrial Economics, Incorporated, 2015a). Total offshore mortality was determined in one NRDA final report on the *Deepwater Horizon* explosion, oil spill, and response as 2,317-3,141 birds (Industrial Economics, Incorporated, 2015b). These NRDA reports did not include estimates of lost bird-years used in NRDAs of some previous spills as discussed in Zafonte and Hampton (2005).

For other noted outcomes, Franci et al. (2014) found no confirmed impacts of oil on the endocrine status, and no evidence of exposure to oil, of northern gannets that migrated to eastern Canada after overwintering in the northern Gulf of Mexico in the winter of 2010-2011. Seegar et al. (2015) found evidence in the fall of 2010 of PAH contamination of blood of migrant Tundra Peregrine Falcons that probably were exposed to *Deepwater Horizon* PAHs in oil. However, blood of migrant Tundra Peregrine Falcons found in the spring of 2011 had a small amount of PAHs that were not from *Deepwater Horizon* oil. Blood in migrants in the fall of 2011 could have had moderate levels of PAHs from a petroleum source, but it was probably not *Deepwater Horizon* oil (Seegar et al., 2015). In a preliminary study, Martin et al. (2016) found no detectable PAHs in waterfowl (scaup, redhead, and bufflehead) in northern GOM estuaries in the winter following the spill (in 2011). However, the authors recommend further study. Fallon et al. (2018) found evidence of oxidative injury in birds that displayed no visible evidence of oil exposure, which can cascade into muscle fatigue, decreased energy availability for metabolic processes, and adverse reproductive impacts. Another recent study demonstrated that repeat sublethal exposure to even weathered oil can have negative impacts on exposed double-crested cormorants' (*Phalacrocorax auratus*) plasma and liver metabolome (the complete set of metabolites within a biological sample) (Dorr et al., 2019), which can affect thermoregulation, multiple organ systems, cardiac function, and hematologic parameters (Bursian et al., 2017, Dean et al., 2017, Harr et al., 2017a and 2017b). Seaside sparrows (*Ammodramus maritimus*) also experienced several molecular changes after exposure to spilled oil from the Deepwater Horizon (Bonisoli-Alquati et al., 2020), which concurred with previous observations that oil contamination can cause liver hypertrophy (Albers, 2006; Miller et al., 1978; Peakall et al., 1989) and energy homeostasis changes (Xu et al., 2016 and 2017).

It should be noted that oil from the *Deepwater Horizon* explosion reached the shoreline less than 14 days after the blowout occurred (National Audubon Society, 2010). The OSRA does not take into account or consider the following with respect to birds and their habitats: (1) species-specific densities; (2) species-specific habitat preferences, food habits, or behavior; (3) relative vulnerabilities to oiling among the bird species groups or among species within each of the groups (refer to Williams et al., 1995; Camphuysen, 2006); and (4) species-specific life-history strategies, their demography, or a species' recovery potential.

A worst-case scenario for Phase 3 of a catastrophic oil spill would be a co-occurrence with a hurricane that has the strength or magnitude similar to Hurricanes Katrina (2005), Rita (2005), Ike (2008), or Laura (2020) during the breeding season. Such an overlap of two low-probability events during the breeding season (late spring to early summer) could potentially push spilled oil even farther inland, as well as distribute oil vertically into the vegetation. Such an event would negatively impact diving birds, seabirds, shorebirds, marsh and wading birds, and waterfowl. It would also negatively impact more terrestrial bird species groups, including passerines and raptors. The effects would most likely be long-term due to direct mortality of individuals (as well as major habitat destruction) and could potentially result in population-level impacts to several avian species. Threatened and endangered birds would likely be the most severely impacted by a catastrophic oil spill coinciding with a strong hurricane, depending on the spatial and temporal aspects of both.

In summary, Phase 3 of a catastrophic oil spill has the greatest potential for negative impacts (i.e., direct mortality) to bird resources due to (1) its contact with the shoreline and inundation of other habitats and (2) those habitats being occupied by a much greater diversity and abundance of birds, particularly during the breeding season. Avian mortality estimates are presently unknown and are difficult to predict with any level of precision, given the uncertainty associated with the following: the scenario; specific characteristics associated with the spill; spatial and temporal variation in environmental conditions; and species diversity, distribution, and abundance affecting the likelihood for birds to be oiled.

Phase 4—Post-Spill, Long-Term Recovery and Response

There is a high probability of underestimating the impacts of oil spills on birds potentially encountering oil. Data from numerous oil spills worldwide indicate acute lethal impacts for heavily oiled birds (Burger, 1993). Despite being oiled, some birds are capable of flight and may later succumb to the oiling for a myriad of reasons. Lesser impacts are from short-term (acute) sublethal exposure to oil. Often overlooked and understudied are the long-term (chronic) sublethal effects due to oil exposure (Butler et al., 1988; Alonso-Alvarez et al., 2007; Pérez et al., 2010). Also, individuals oiled in the GOM from a catastrophic oil spill during the overwinter period or while staging in the GOM could exhibit carry-over effects to the northern breeding grounds. Affected individuals in poor body condition may arrive at their breeding grounds later than nonaffected individuals, which could negatively affect habitat-use decisions, territory establishment, and pairing success, and which ultimately could lead to reduced reproductive success (Norris, 2005; Harrison et al., 2011). Some oiled individuals may forego breeding altogether (Zabala et al., 2010). If oil-affected, long-distance migrants represent important prey items for various species of raptors, then the ingestion of affected individuals could also negatively affect individual birds of prey (Zuberogoitia et al., 2006; Henkel et al., 2012). Shoreline and wetland intertidal oil from the *Deepwater Horizon* explosion, oil spill, and response may persist and affect overwintering and/or breeding shorebirds or birds stopping over during migration (Henkel et al., 2012). Spatiotemporally, the impact may be extended to breeding grounds to the north of the GOM, recurring for migrant shorebirds for years (Henkel et al., 2012).

Long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response are hard to separate from other oiling events (i.e., anthropogenic and natural events) of the Gulf Coast. The long-term impacts of potential food-induced stress for bird species from an altered ecosystem due to a catastrophic spill are unknown, but disturbances to the ecosystem can cause long-term sublethal impacts, including reduced food intake, prey switching, increased energy expenditures, decreased reproductive success, and decreased survival. Reduction in primary fish prey may cause prey switching to secondary prey and reduced reproductive success. Decreases in reproductive success and/or survival could result in population-level effects as was observed for certain bird species more than 10 years after the *Exxon Valdez* catastrophic oil spill (Esler et al., 2002 and 2010; Golet et al., 2002). Long-term, sublethal, and chronic effects may exceed immediate, acute losses (i.e., direct mortality of oiled birds) if residual effects influence a significant proportion of the population or disproportionately impact an important aspect of the population demography, i.e., breeding-age females (Croxall and Rothery, 1991; Oro et al., 2004). Depending on the effects and the life-history strategy of impacted species, some populations could take years or decades before reaching pre-spill population numbers and age-sex structure, while some populations for individual species may never recover (Peterson et al., 2003; Wiens et al., 2010).

In general, the potential effects associated with Phase 4 should be limited to short-term disturbance effects (personnel and equipment) and potential indirect effects to various avian species groups due to possible habitat loss, alteration, or fragmentation from restoration efforts. These avian groups would include threatened and endangered species. There may be cases whereby incubating individuals are flushed from nests, exposing their eggs or young to either weather-related mortality or depredation by avian or mammalian predators (American Bird Conservancy, 2010; National Audubon Society, Inc., 2010). However, efforts to minimize the potential effects of post-oil spill monitoring and restoration efforts, particularly during the breeding season, should be sufficient to protect nesting birds as a function of the immediate and continuous oversight by Federal and State agencies charged with the conservation of migratory bird resources during and after the oil spill.

Seabirds may not always experience the greatest impacts from a spill, but it may take longer for populations to recover because of their unique population ecology (demography). Some species of seabirds, such as gulls and cormorants, have larger clutches (laughing gulls usually have 3 eggs per clutch, except in the tropics; and double-crested cormorants [*Phalacrocorax auritus*] average 4 eggs per clutch) and may recover quite quickly. Many seabird species can have a clutch size of just one egg, relatively long life spans, and often have delayed age at first breeding (Hamer et al., 2002). This can prolong the recovery period from a catastrophic spill.

A group of recent 2017 Deepwater Horizon Natural Resource Damage Assessment studies covered laughing gulls (Horak et al., 2017) and double-crested cormorants (Alexander et al., 2017; Dean et al., 2017; Harr et al., 2017a, 2017b, and 2017c; Pritsos et al., 2017). Seabirds were exposed orally and/or dermally to short-term low to moderate levels of artificially weathered *Deepwater Horizon* oil. Findings included mostly sublethal clinical endpoints of organ weight changes (Harr et al., 2017b; Horak et al., 2017), gross organ lesions (Harr et al., 2017b), biochemical changes (Alexander et al., 2017; Dean et al., 2017; Horak et al., 2017), tissue disorders (Harr et al., 2017b; Horak et al., 2017), oxidative stress (including hemolytic anemia) (Pritsos et al., 2017; Horak et al., 2017), as well as heart and blood cell count changes (Harr et al., 2017a and 2017c; Dean et al., 2017). There were few birds with an endpoint of death.

Dispersants might be used to move some of the oil from the surface to the water column, but the dispersants may also be toxic. For example, hatching success was significantly decreased among mallard eggs treated with Corexit 9500 dispersant compared with controls (Wooten et al., 2012). Finch et al. (2012) found that the ratio of dispersant relative to weathered crude oil affected the toxicity to the mallard embryos. Treatment of mallard eggs with weathered crude oil alone had less toxicity than a mixture with high oil-to-dispersant ratio but more toxicity than a mixture with a lower ratio (Finch et al., 2012). In summary, depending on the ratios of dispersant to oil, the level of toxicity of dispersed weathered oil in the natural environment (not a laboratory-based study) could be less or greater than untreated weathered oil.

A recent study on gulls suggests that rehabilitation of exposed birds may be successful. Researchers found that feathers from rehabilitated birds were indistinguishable from unexposed birds after 3 weeks. Oiled birds were shown to have the capacity to clean their feathers and reduce feather clumping. However, these birds were still showing signs of significant clumping when compared to unexposed birds a month after exposure. These results suggest that focusing rehabilitation practices (i.e., washing the birds) on moderate to heavily oiled birds may enhance their long-term survival. However, these results may vary depending on the bird group, foraging behavior, and the level of oil exposure. More research is needed to assess if the stress from rehabilitation efforts would outweigh the negatives of oil exposure for birds only lightly oiled (Horak et al., 2020). Another study on rehabilitation found that gulls affected by sublethal external oiling may be good targets for rescue and rehabilitation (Dannemiller et al., 2019).

In general, the potential effects associated with Phase 4 should be limited to short-term disturbance effects (cleanup personnel and equipment) and potential indirect effects to various bird species groups due to possible habitat loss, alteration, or fragmentation from restoration efforts. These birds include threatened and endangered species. There may be cases whereby incubating individuals are flushed from nests, exposing their eggs or young to either weather-related mortality or predation by other birds or mammalian predators (American Bird Conservancy, 2010; National Audubon Society, Inc., 2010). However, Federal and State agency oversight of post-oil spill monitoring and restoration efforts, particularly during the breeding season, should be enough to protect and observe nesting birds.

Overall Summary and Conclusion (Phases 1-4)

While the species composition and species-specific mortality estimates are unknown and would be dependent on the blowout location and time of year, the mortalities for the initial event (Phase 1) would almost certainly not result in population-level impacts for those species present at the time of the blowout and resulting fire. Many seabirds and diving birds are highly vulnerable to becoming oiled and to ingesting oil during Phase 2 (the offshore spill). Even recognizing the uncertainty associated with the scenario, spill characteristics, and the environmental conditions at the time of the spill, Phase 2 would likely be second only to Phase 3 (onshore contact) in total bird mortality. Phase 3 would have a greater impact than Phase 2 because it could produce impacts to birds in the nearshore and shoreline area. This area has greater overall abundance and (except for seabirds) greater overall species richness (for seabirds and diving birds, refer to the Marine Data Analysis Team report [2018]). Under Phase 3, oil would reach inshore habitats, including the following: nearshore, coastal beaches and dunes; and tidal freshwater, brackish, and salt marshes. In general, the potential effects associated with Phase 4 (long-term recovery and response) should be limited to short-term disturbance effects (by cleanup personnel and equipment) and potential indirect effects to various bird species groups from possible habitat loss, alteration, or fragmentation from restoration activities.

1.3.1.9 Sea Turtles

Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout incident. Impacts, response, and intervention depend on the spatial location of the blowout and leak. For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1-2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month. The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. Regardless of water depth, the immediate response would be from search-and-rescue vessels and aircraft, such as USCG cutters, helicopters, and rescue planes, and firefighting vessels. The potential impacts reflect the explosion, subsequent fire for 1-30 days, and the sinking of the platform in the immediate vicinity and up to 1 mi (1.6 km) from the well.

Five species of sea turtles are found in the waters of the Gulf of Mexico: green (*Chelonia mydas*); leatherback (*Dermochelys coriacea*); hawksbill (*Eretmochelys imbricata*); Kemp's ridley (*Lepidochelys kempii*); and loggerhead (*Caretta caretta*). All species are protected under the ESA, and all but loggerhead and green turtles are currently listed as endangered. Depending on the type of blowout, an eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. A high concentration of response vessels could place sea turtles at a greater risk of fatal injuries from vessel collisions. All sea turtle species and life stages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and prey.

Further, mitigation by burning puts sea turtles at risk because they tend to be gathered up in the corralling process necessary to concentrate the oil in preparation for the burning. Trained observers should be required during any mitigation efforts that include burning. The scenarios for each phase, including cleanup methods, can be found in **Table 1-3**.

Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. A catastrophic spill would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. The potential impacts reflect spill and response in Federal and State offshore waters. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

Sea turtles are more likely to be affected by a catastrophic spill in shallow water than in deep water because not all sea turtles occupy a deepwater habitat. For example, Kemp's ridley sea turtles are unlikely to be in water depths of 160 ft (49 m) or greater. Hawksbill sea turtles are commonly associated with coral reefs, ledges, caves, rocky outcrops, and high energy shoals. Green sea turtles are commonly found in coastal benthic feeding grounds, although they may also be found in the convergence zones of the open ocean. Convergence zones are areas that also may collect oil. Leatherback sea turtles are commonly pelagic and are the sea turtle species most likely to be affected by a deepwater oil spill. As the spilled oil moves toward land, additional species of sea turtles are more likely to be affected.

While all of the pathways that an oil spill or the use of dispersants can affect sea turtles is poorly understood, some pathways may include the following: (1) oil or dispersants on the sea turtle's skin and body can cause skin irritation, chemical burns, and infections; (2) inhalation of volatile petroleum compounds or dispersants can damage the respiratory tract and lead to diseases; (3) ingesting oil or dispersants may cause injury to the gastrointestinal tract; and (4) chemicals that are inhaled or ingested may damage internal organs.

The *Ixtoc I* well blowout and spill in the Bay of Campeche, Mexico, on June 3, 1979, resulted in the release of 500,000 metric tons (140 million gallons) of oil and the transport of this oil into the Gulf of Mexico (ERCO, 1982). Three million gallons of oil impacted Texas beaches (ERCO, 1982). Of the three sea turtles found dead in the U.S., all had petroleum hydrocarbons in the tissues examined, and there was selective elimination of portions of this oil, indicating chronic exposure (Hall et al., 1983). The effects of the *Ixtoc I* well blowout and spill on sea turtles in waters off Texas are still unknown.

The *Deepwater Horizon* explosion, oil spill, and response impacted sea turtles that came into contact with oil and remediation efforts (including use of dispersants). A study by Ylitalo et al. (2017) showed external and internal exposure to oil from the *Deepwater Horizon* spill in samples of sea turtles in the northern GOM from 2010 through 2011, supporting visual observations of oiling. There was limited evidence of sea turtle exposure to dispersants. Based on other observations during the *Deepwater Horizon* explosion, oil spill, and response, oiling, in addition to capture and transport associated with rescue efforts, contributed to adverse physiological effects in sea turtles resulting from stress, exertion, physical exhaustion, and dehydration (Stacy et al., 2017). Sea turtles exposed to the *Deepwater Horizon* oil spill may have experienced substantial biological perturbation, decreased fitness, and subsequent mortality (Mitchelmore et al., 2017).

The OSRA model catastrophic runs (**Chapter 2**) indicate that the environmental resources closest to the spill offshore typically had the greatest risk of contact. The OSRA for this analysis was conducted for the trajectories of oil spills from seven hypothetical spill locations in the GOM to various onshore and offshore environmental resources. As the model run duration increased (3, 10, 30, and

60 days), more resources offshore and onshore had meaningful conditional probabilities (**Chapter 2**). For 30-day OSRA trajectories, offshore waters including State waters often had higher conditional probabilities during spring (April, May, June) from all launch points. Spring is the start of sea turtle onshore nesting, with prior mating offshore and hatching until the end of October. For some launch points and for the travel times greater than 30 days, the probability of contact to land decreases very slowly or remains constant because the early contacts to land have occurred within 30 days, and the trajectories that have not contacted land within 30 days would remain at sea for 60 days or more.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response, and on oil initially reaching the shoreline during the spill event or while the oil still persists in the offshore environment once the spillage has been stopped. It is likely that Phases 2 and 3 could occur simultaneously. The duration of the initial shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. The re-oiling of already cleaned or previously impacted areas could be expected during Phase 3. In addition to the response described in Phase 2, nearshore and onshore efforts would be introduced in Phase 3 as oil entered coastal areas and contacted shore. The potential impacts reflect the spill and response in very shallow coastal waters and once along the shoreline. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various life cycle stages.

Out of the five species of sea turtle that occur in the Gulf of Mexico, only four nest in the GOM. The largest nesting location for the Kemp's ridley sea turtle is in Rancho Nuevo, Mexico, but they also nest in Texas and Alabama. Loggerhead sea turtles nest in all states around the Gulf of Mexico. Green sea turtles have been cited nesting in Texas, Alabama, and Florida. Leatherback sea turtles mostly nest on the east coast of Florida but are recorded in Texas. Kemp's ridley and loggerhead sea turtles would most likely be affected by a low-probability catastrophic oil spill when there is onshore and/or offshore contact.

Female sea turtles seasonally emerge during the warmer summer months to nest on beaches. Thousands of sea turtles nest along the Gulf Coast, and turtles could build nests on oiled beaches. Nests could also be disturbed or destroyed by cleanup efforts. Untended booms could wash ashore and become a barrier to sea turtle adults and hatchlings (USDOC, NOAA, 2010d). Hatchlings, with a naturally high mortality rate, could traverse the beach through oiled sand and swim through oiled water to reach preferred habitats of *Sargassum* floats. Response efforts could include mass movement of eggs from hundreds of nests or thousands of hatchlings from Gulf Coast beaches to the east coast of Florida or to the open ocean to prevent hatchlings entering oiled waters (Jernelöv and Lindén, 1981; USDOI, FWS, 2010c). As a preventative measure during the *Deepwater Horizon* explosion, oil spill, and response, and a measure that would be expected during a catastrophic spill event, NMFS and the U.S. Fish and Wildlife Service (FWS) translocated a number of sea turtle nests and eggs that were located on beaches affected or potentially affected by spilled oil. Due to poorly understood mechanisms that guide female sea turtles back to the beaches where they hatched, it is uncertain if relocated hatchlings would eventually return to the Gulf Coast to nest (State of Florida, Fish and Wildlife Conservation Commission, 2010). Therefore, shoreline oiling and response efforts may affect future population levels and reproduction (USDOI, NPS, 2010). Sea turtle hatchling exposure to, fouling by, or consumption of tarballs persisting in the sea following the dispersal of an oil slick would likely be fatal (USDOI, NPS, 2010).

In addition to the impacts from contact with hydrocarbons, spill-response activities could adversely affect sea turtle habitat and cause displacement from suitable habitat to inadequate areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings because of predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The strategy for cleanup operations should vary, depending on the season and extent of the spill.

A study by Lauritsen et al. (2017) found that the *Deepwater Horizon* oil spill and spill-response activities (i.e., highly mechanized beach cleanup efforts) affected loggerhead nesting on northwest Florida beaches in 2010. Nest densities were decreased by 43.7 percent relative to expected nesting rates in the absence of the *Deepwater Horizon* oil spill and spill-response activities. Additional studies and future nesting season monitoring are needed to assess whether this decreased nesting would have population-level effects.

Phase 4—Post-Spill, Long-Term Recovery and Response

Phase 4 focuses on long-term recovery once the well has been capped and the spill has stopped. During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and that cleanup activities are concluding. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill. On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms. The potential impacts reflect long-term persistence of oil in the environment and residual and long-term cleanup efforts.

Sea turtles take many years to reach sexual maturity. Green sea turtles reach maturity between 20 and 50 years of age; loggerheads may be 35 years old before they are able to reproduce; and hawksbill sea turtles typically reach lengths of 27 in (69 cm) for males and 31 in (79 cm) for females before they can reproduce (USDOC, NMFS, 2010). Declines in the food supply for sea turtles, which include invertebrates and sponge populations, could also affect sea turtle populations. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick would result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity and increased vulnerability to disease) to sea turtles. Other possible internal impacts might include harm to the liver, kidney, and brain function, as well as causing anemia and immune suppression, or they could lead to reproductive failure or death. The deaths of subadult and adult sea turtles may drastically reduce the breeding population. A study by Kocmoud et al. (2019) found that Kemp's ridleys in the GOM may be resilient to large mortality events of short duration, including the *Deepwater Horizon* explosion, oil spill, and response.

Findings from multiple studies analyzing exposed sea turtle populations (Lauritsen et al., 2017; Mitchelmore et al., 2017; Stacy et al., 2017; Wallace et al., 2017; Ylitalo et al., 2017; Kocmoud et al., 2019; Frasier et al., 2020) further support that the *Deepwater Horizon* explosion, oil spill, and response contributed to the adverse health effects described in the *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), including adrenal insufficiency, which can result in reduced reproduction and, in some cases, death.

Overall Summary and Conclusion (Phases 1-4)

Accidental catastrophic blowouts, oil spills, and spill-response activities resulting from OCS oil- and gas-related activities have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and time of accidents, and various meteorological and hydrological factors. During Phase 1, sea turtles could be affected by an eruption of pressure and associated noise and an increased possibility of collision with response vessel traffic. Sea turtles could have an increased probability of direct contact with oil or dispersants if used during offshore spill and response (Phase 2). Direct contact through the skin, eyes, or digestive system would cause adverse physiological effects and potential mortality. Onshore contact (Phase 3) could affect nesting turtles and eggs from direct contact with oil or disturbance from spill-response activities. Potential effects from post-spill, long-term recovery and response (Phase 4) include a decline in food supply and sublethal impacts, reproductive failure, or death from exposure to remaining hydrocarbons.

Each catastrophic event is unique with the conditions in space and time. The *Ixtoc* and *Deepwater Horizon* explosion, oil spill, and response are examples of catastrophic events that provided information on the potential impacts from a catastrophic spill in the GOM. For low-probability catastrophic spills, this analysis concludes that there is a potential for a catastrophic event to result in significant effects on sea turtle species, potentially with or without existing unknown toxicological influences in the environment.

1.3.1.10 Beach Mice

Phase 1—Initial Event

There would likely be no adverse impacts to beach mice as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because Phase 1 is the initiation of a catastrophic blowout incident, and initiation would occur well offshore from beach mouse habitat.

Phase 2—Offshore Spill

There would likely be no adverse impacts to beach mice as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event because Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters well away from beach mouse habitat.

Phase 3—Onshore Contact

Five subspecies of old field mouse, collectively known as beach mice, live along the Gulf Coast. Four subspecies of beach mice (i.e., Alabama, *Peromyscus polionotus ammobates*; Perdido Key, *Peromyscus polionotus trissyllepsis*; Choctawhatchee, *Peromyscus polionotus allophrys*; and St. Andrew, *Peromyscus polionotus peninsularis*) are listed as State and federally endangered. Beach mice discussed here are restricted to the coastal barrier sand dunes along the Gulf Coasts of Alabama and Florida and the Atlantic Coast of Florida. Erosion caused by the loss of vegetation because of oiling would impact beach mice because of the degradation or loss of habitat. Direct oiling also could cause impacts. A recent study (Ramesh et al., 2018) evaluated behavioral and toxicological impacts to laboratory mice from *Deepwater Horizon* oil and Corexit dispersant. The study reaffirmed that oil and Corexit dispersant individually have the potential to induce toxic effects on mammals and showed relatedness of kidney and liver function and immune response to the combined mixture, resulting in an increased toxic effect. In addition, vehicular traffic and activity associated with cleanup can trample or bury beach mice nests and burrows or cause displacement from their preferred habitat. Improperly trained personnel and vehicle and foot traffic during shoreline cleanup of a catastrophic spill would disturb beach mouse populations and would degrade or destroy preferred habitat.

The Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice are designated as protected species under the Endangered Species Act, mostly because of the loss and fragmentation of coastal habitat (*Federal Register*, 1989; USDOI, FWS, 2007). Some of the subspecies have coastal habitat that is designated as their critical habitat. For example, the endangered Alabama beach mouse's designated critical habitat is 1,211 acres (490 hectares) of frontal dunes covering just 10 mi (16 km) of shoreline (USDOI, FWS, 2007). Critical habitat includes the specific geographic areas that are essential for the conservation of a threatened or endangered species.

All designated critical habitat for beach mice officially extends landward from the mean high water line (*Federal Register*, 2006; USDOI, FWS, 2007). Therefore, spilled oil could contact critical habitat even without a concurrent storm surge; contact would require only that the water level would be at mean high tide. However, a concurrent storm surge of considerable height would be required to oil the portion of the critical habitat substantially landward of the mean high water line (over the tops of the primary, secondary, and tertial dunes). With the potential oiling of over 1,000 mi (1,609 km) of shoreline that could result from a catastrophic spill event and a concurrent storm surge of considerable height that were to occur within a close proximity to the critical habitat, there would be the potential for the entire critical habitat for a subspecies of beach mice to be completely oiled. Ramesh et al. (2018) affirmed that exposure to both oil and the dispersant Corexit have the potential to induce toxic effects on mammals. Thus, destruction of critical habitat because of a catastrophic spill, a concurrent storm surge of considerable height and over a considerable length of shoreline, and cleanup activities and associated exposure to oil would increase the threat of extinction of several subspecies of beach mice.

The catastrophic OSRA provides estimated conditional probabilities (expressed as percent chance) of a hypothetical spill occurring at different locations and then contacting the coastline that includes the Alabama, Perdido Key, Choctawhatchee, and St. Andrew beach mouse critical habitat. The condition associated with these conditional OSRA probabilities is that a spill is assumed to have occurred at the given location. The probabilities are for contact with the seaward border of beach mouse habitat (the mean high water line). They are not probabilities for contact with the entire critical habitat, which would be much lower and are not available. Further details on the catastrophic OSRA run can be found in **Chapter 2**.

There are usually low conditional probabilities for a summer and fall catastrophic spill contacting beach mice during part of a period of high beach mouse breeding activity along the Gulf Coast (in late fall and early winter [November to mid-January]) (*Federal Register*, 1989). Therefore, during part of the period of high breeding activity in the Gulf, in late fall, the probability of a catastrophic spill contacting beach mice would be generally diminished.

This same seasonal period of low oil-spill probabilities of a catastrophic spill contacting beach mice occurs during the hurricane season (summer and fall). Therefore, during a period of high hurricane probability (including a period of relatively high probability of successive hurricanes), the probability of a catastrophic spill contacting beach mouse habitat would be generally diminished. Even so, the potential is still present for synergistic impacts on beach mice from (1) a catastrophic spill, and (2) a hurricane or two or more successive hurricanes. It is precisely such synergistic impacts that are the most likely route to extinction for subspecies of beach mice. Seasonal and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in potential exposure of the resources throughout various beach mice life cycle stages.

Phase 4—Post-Spill, Long-Term Recovery and Response

Within the last 30-40 years, the combination of habitat loss because of beachfront development, the isolation of the remaining beach mouse habitat areas and populations, and the destruction of the remaining habitat by tropical storms and hurricanes has increased the threat of extinction of several subspecies of beach mice. On sandy beaches, oil can sink deep into the sediments and become exposed again after the erosion of sand by wave action and persist until it degrades or is removed. The destruction of the remaining habitat and potential for re-exposure following a catastrophic spill and cleanup activities would increase the threat of extinction.

Overall Summary and Conclusion (Phases 1-4)

Impacts to beach mice would vary according to the severity of the oiling and environmental conditions that may exacerbate the dispersal of oil along the beach. The OSRA conditional probabilities can vary greatly depending on duration, season, and location. The potential is present for synergistic impacts on beach mice from (1) a catastrophic spill, and (2) a hurricane or successive hurricanes. The phases associated with a catastrophic oil spill that may impact beach mice is the onshore contact phase (Phase 3) and post-spill phase (Phase 4). Due to the proximity of beach mouse distribution along the coast of Alabama and the Florida panhandle, there is a low probability of a catastrophic spill directly affecting the beach mouse. A catastrophic spill along with successive hurricanes that lead to direct onshore contact and repeated contact during oil re-exposure with beach mouse habitat may lead to the extinction of the subspecies of the affected beach area as described in Phases 3 and 4 of this section. Timing, magnitude, and location of a spill would determine the post-spill, long-term recovery and response impacts. If beach mouse critical habitat was directly affected by onshore contact from a catastrophic spill, the implications of effects from a long-term response would be more severe. Further detail on the catastrophic OSRA run is contained in **Chapter 2**.

1.3.1.11 Marine Mammals

Phase 1—Initial Event

Phase 1 of the scenario is the initiation of a catastrophic blowout event. Impacts, response, and intervention depend on the spatial location of the blowout and leak. For this analysis, an explosion and subsequent fire are assumed to occur. If a blowout associated with the drilling of a single exploratory well occurs, this could result in a fire that would burn for 1 or 2 days. If a blowout occurs on a production platform, other wells could feed the fire, allowing it to burn for over a month. The drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deep water, the rig or platform could land a great distance away, beyond avoidance zones. Regardless of water depth, the immediate response would be from search-and-rescue vessels and aircraft, such as USCG cutters, helicopters and rescue planes, and firefighting vessels. The potential impacts reflect the explosion, subsequent fire for 1-30 days, and the sinking of the platform in the immediate vicinity and up to 1 mi (1.6 km) from the well.

Depending on the type of blowout, the pressure waves and noise generated by the eruption of gases and fluids would likely be significant enough to harass, injure, or kill marine mammals, depending on the proximity of the animal to the blowout. A high concentration of response vessels could result in harassment or displacement of individuals and could place marine mammals at a greater risk of vessel collisions, which would likely cause fatal injuries. The scenarios for each phase, including cleanup methods, can be found in **Table 1-3**.

Any catastrophic oil spill event would likely result in the greatest net negative impacts (primarily direct mortality) to threatened and endangered marine mammal species due to their low population numbers, limited distribution, and potential movement of spilled oil to other areas where species are present. In addition, the short- and long-term presence of spilled oil would result in indirect and potentially long-term effects to threatened and endangered species' habitats and their preferred or required foods. These impacts would be more damaging to ESA-listed species populations because they already have lower population numbers pre-spill.

In general, the potential direct impact (i.e., mortality) to these threatened or endangered species is a function of their presence at the time of a catastrophic oil spill. Indirect effects from a catastrophic oil spill could negatively affect the quality and functional availability of their habitats as well as the availability, distribution, and energetic benefits of their preferred or required foods.

Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters. A catastrophic spill would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. The potential impacts reflect spill and response in Federal and State offshore waters. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in the potential exposure of the resources throughout various life cycle stages.

An oil spill and related spill-response activities can impact marine mammals that come into contact with oil and remediation efforts. The impacts of an oil spill on marine mammals depend on many variables, such as the location and size of the spill, oil characteristics, weather and water conditions, time of year, and types of habitats affected, as well as the behavior and physiology of the marine mammals themselves (Wilkin et al., 2015). The range of toxicity and the degree of sensitivity to oil hydrocarbons on most marine mammal species are largely unknown due to ethical concerns regarding dosage experiments on marine mammals. There are few published accounts of wild cetaceans in oiled water and few necropsies of cetaceans that have been oiled (Helm et al., 2015). Most of the information on the effects of oil on marine mammals comes as a result of the *Exxon Valdez* oil spill, *Deepwater Horizon* oil spill, and some limited exposure experiments (Geraci and St. Aubin, 1990; Venn-Watson et al., 2015a; Schwake et al., 2014; Helm et al., 2015). The increased human presence after an oil spill (e.g., vessels) would likely add to changes in behavior and/or distribution, thereby potentially stressing marine mammals further and perhaps making them more vulnerable to various physiologic and toxic effects. In addition, the large number of response vessels could place marine mammals at a greater risk of vessel collisions, which could cause fatal injuries.

The resident marine mammal species in the GOM include a baleen whale, toothed whales, delphinids, and a sirenian. Oil spills can affect marine mammals through a variety of direct and indirect pathways that may ultimately affect the survivability of an individual or a population (Helm et al., 2015). Direct pathways may include inhalation, ingestion, and dermal exposure via mucous membranes, while indirect pathways may include short-term reductions in prey availability, long-term injury to prey habitats and populations, and cumulative effects on the ecosystem. The long-term impacts to marine mammal populations are poorly understood but could include decreased survival and lowered reproductive success (Matkin et al., 2008). In any case, the impact could negatively impact a marine mammal population or stock.

Marine mammal species that inhabit offshore waters may have direct contact with oil by swimming through oil on the surface and/or subsurface. Surfacing behavior exposes eyes, nares, and other mucus membranes to volatile hydrocarbons. This contact with oil may result in sublethal impacts, including (1) decreased health, reproductive fitness, longevity, and increased vulnerability to disease or other natural factors; (2) some soft tissue irritation to eye tissues, potentially leading to ulcers, conjunctivitis, or blindness; (3) respiratory stress from inhalation of toxic fumes; (4) immune suppression from food reduction or contamination; (5) immune suppression from direct ingestion of oil and/or tar; (6) fouling of baleen plates from direct ingestion of oil and/or tar; and (7) temporary displacement from preferred habitats or migration routes (Geraci and St. Aubin, 1990). Baleen whales may be at highest risk because of their small populations, their specialized feeding patterns and structures (baleen), and their selected localized habitats for feeding and reproduction (Helm et al., 2015). Geraci and St. Aubin (1990) suggested that baleen whales are particularly vulnerable to direct impacts from oil, causing fouling of baleen plates, which could impact feeding behavior. However, the authors acknowledged that this study used dry baleen to determine the impacts of oil and that baleen from living whales could yield different results (Geraci and St. Aubin, 1990). Further, a more recent publication found many differences in properties of dry baleen and hydrated baleen, and suggested that baleen's high levels of hydration probably affect its interaction with non-polar, hydrophobic waterborne substances, especially oil from anthropogenic point sources, and that more research needs to be done to understand this interaction (Werth et al., 2016). The Bryde's whale (*Balaenoptera edeni*) is the only resident baleen whale that regularly occurs in the GOM. However, there are currently no data on habitat use and migration patterns nor are there sufficient data to determine their population trends (Waring et al., 2016), making it difficult to analyze how a hypothetical catastrophic spill may impact this species.

Cetacean diets and feeding locations within the water column contribute to defining potential exposure to oil (Würsig, 1990). Cetaceans with limited diets or that take advantage of seasonally abundant or geographically restricted food would be most affected by an overlapping oil spill. The occurrence and magnitude of nutritional effects would depend on the intensity and spread of the oil and its impact on possible alternative prey. The trophic level of cetacean food also might affect their exposure to oil and dispersants, with some feeding on aggregations of small invertebrates such as krill, copepods, and mysids or schools of small fish, and others preying on larger fish, squid, and mammals. Each trophic level has a specific potential to retain and transfer petroleum hydrocarbon residues. Some benthic invertebrates concentrate these compounds in their tissues, whereas teleost fishes and most other invertebrates metabolize and rapidly excrete them (Würsig, 1990),

Few surveys have evaluated the presence and nature of petroleum constituents in cetaceans (O'Hara and O'Shea, 2001). Based on findings from harbor seals during the *Exxon Valdez* oil spill, marine mammals probably metabolize hydrocarbons rapidly and efficiently, and mediated through the induction of mixed-function oxidases (O'Hara and O'Shea, 2001). This is supported by the absence of firm evidence of tissue contamination or toxicological effects for cetaceans from the *Exxon Valdez* oil spill (Loughlin, 1994). In addition, no clinical, hematological, or biochemical effects were noted in a captive bottlenose dolphin dosed daily with 5 milliliters of machine oil for 99 days, suggesting captive dolphins can tolerate small amounts of ingested oil (Geraci and St. Aubin, 1990).

Oil does not readily penetrate cetacean skin, which is characterized by tight intercellular bridges and an unusually thick epidermis that is 10-20 times that of humans (O'Hara and O'Shea, 2001). Experimental direct application of various petroleum fractions to dolphin skin resulted only in subtle histological changes, which were reversed within a week of exposure (Geraci and St. Aubin, 1990). The absence of hairs and the frequent sloughing of skin cells provide little opportunity for oil to adhere to cetacean bodies. Insulation is provided by a layer of blubber rather than hair or fur; therefore, it is unlikely oil would compromise the thermoregulatory system of cetaceans (Helm et al., 2015). However, if contact with oil were to result in overall decreased health, there is the potential for the blubber layer to decrease in response.

Several authors suggest that the threat of most immediate concern to cetaceans is inhalation of volatile toxic fractions at the air-water interface rather than from ingesting contaminated prey or absorbing oil through skin (Geraci, 1990; Geraci and St. Aubin, 1982; Smultea and Würsig, 1995). This risk is greatest near the source of a fresh spill because concentrated volatile toxic vapors disperse relatively quickly. Therefore, when concentrated vapors are inhaled near the source of a fresh spill, mucous membranes may become inflamed, lungs can become congested, and pneumonia may ensue (Hansen, 1985). Inhaled fumes from oil may accumulate in blood and other tissues, leading to possible liver damage and neurological disorders (Geraci and St. Aubin, 1982). Respiratory intervals vary between cetacean species, ranging from minutes to more than an hour, but all intervals have the potential to expose cetaceans to toxic fumes from oil spills. One researcher concluded the following: "...it is clear that for the short time they persist, vapors are one feature of an oil spill that can threaten the health of a cetacean" (Geraci, 1990).

In general, exposure to oil is likely to be most problematic for species inhabiting restricted habitats or those with restricted ranges that could result in prolonged exposure if the oil lingers in these habitats. Many cetacean species inhabiting offshore or open coastal waters are highly mobile and range widely; therefore, their contact with an oil spill may be relatively brief. In contrast, some species have very specific habitat requirements for feeding and/or reproduction, and annually move between specific locations (Würsig, 1990; Wells et al., 1999). The prospect of oil disrupting reproductive behavior is remote for offshore species, but it is more of a concern for inshore reproducers such as resident populations of dolphins (Würsig, 1990).

Avoidance by cetaceans of oil at the water's surface requires that they be able to detect the oil and that the spill is not so large that it cannot be avoided (Helm et al., 2015). Because groups of toothed whales are constantly communicating, enhanced sensory integration may allow them to more efficiently detect oil and therefore avoid it as a group (Würsig, 1990). Experiments with captive bottlenose dolphins showed they avoided detected oil on the surface of the water by hesitating to swim beneath it, as well as eliciting a startle response in their few contacts with the oil (Smith et al., 1983). Subsequent experiments found that these dolphins avoided oil during both day and night, but the response broke down when the oil was a thin sheen, particularly at night, suggesting a threshold for the dolphins' ability to detect oil or their inclination to avoid it (St. Aubin et al., 1985). The most detailed observations published to date of the behavior of wild dolphins near oil come from the 1990 *Mega Borg* spill off Galveston, Texas (Smultea and Würsig, 1995). Surface oil was classified as sheen, slick, or mousse, with dolphins apparently detecting the latter two, but not the sheen. In contrast to the consistent avoidance demonstrated in the captive dolphin experiments described earlier, wild dolphins hesitated and milled briefly upon encountering an oil slick, but eventually they dove under or in small oil patches and swam through more extensive areas of oil. However, these free-ranging dolphins consistently avoided mousse by swimming under or around it, and group integrity was altered. Although marine mammals may (or may not) avoid oil spills or slicks, it is highly likely that they would encounter spill residuals in their environment at some point in their lifetime. Consequently, the probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern GOM would likely be exposed to residuals of spilled oil throughout their lifetime.

An oil spill and related spill-response activities have the potential to affect the population of certain marine mammal species, depending on many variables of both the oil spill (e.g., the location and size of the spill, oil characteristics, weather and water conditions, time of year, types of habitats affected, etc.) and the marine mammal species affected (i.e., the number of individuals exposed to oil, toxicity of oil, pathway of exposure, and population size of species affected). The NMFS is the Federal agency tasked with managing marine mammal stocks inhabiting waters within U.S. jurisdiction and determining the abundance and potential biological removal (PBR) for these stocks. The Marine Mammal Protection Act of 1972 defines the PBR level as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. Although the PBR is mostly associated with fishery activities, it can be used as a conservative tool to manage marine mammal stocks. However, in the Gulf of Mexico, many marine mammal species have unknown PBRs or PBRs with outdated abundance estimates that are considered undetermined. The biological significance of any injury or mortality would depend, in part, on the population size and reproductive rates of the affected stocks, as well as the number, age, and size of the individual marine mammals affected.

Some research suggests that exposure to oil spills is a combined stress factor that can reduce the health condition of dolphins, making them more susceptible to pathogens and to cold-water stunning (Schwake et al., 2014; Carmichael et al., 2012; Venn-Watson et al., 2015), which has the potential to become an unusual mortality event (UME) for marine mammals. An UME is defined under the Marine Mammal Protection Act as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response." Most UMEs that have been declared by NMFS in the northern GOM have either been due to infectious diseases and/or biotoxins, ecological factors, or were declared "undetermined" (USDOC, NMFS, 2016a). An UME that was declared about 2 months before the *Deepwater Horizon* oil spill closed in May 2016 and suggested that adrenal and lung disease, overall poor health and body condition, bacterial pneumonia, and reproductive failure observed in two bottlenose dolphin stocks was most likely due to exposure to petroleum products from the spill (Schwake et al., 2014; Venn-Watson et al., 2015). Many of the serious health conditions found during assessments of these dolphin stocks are suggestive of exposure to oil, but comparative health data on these stocks from before the spill are not available. Therefore, it is possible that environmental conditions in the habitats of these stocks before the spill increased the vulnerability of the resident dolphin population to the oil spill or these dolphins were already unhealthy prior to the spill (Helm et al., 2015). Furthermore, other natural factors that have the potential to cause many of these observed health conditions occurred during this UME and warrant more research to determine their contribution to health of these stocks (Colegrove et al., 2016; Venn-Watson et al., 2015; Carmichael et al., 2012). Although most of the aforementioned data observed weathered oil-spill impacts on nearshore and coastal marine mammal species, which exhibit various behavioral and physiological differences that can contribute to the degree and type of oil spill impacts, it could be assumed that offshore marine mammal species may experience similar impacts depending on many variables of both the oil spill (e.g., the location and size of the spill, oil characteristics, weather and water conditions, time of year, types of habitats affected, etc.) and the marine mammal species affected (i.e., the number of individuals exposed to oil, toxicity of oil, pathway of exposure, and population size of species affected).

Based on the OSRA model's catastrophic run data presented in **Chapter 2**, it is reasonable to assume that a catastrophic oil spill lasting up to 90 days could have population-level effects on many offshore species of marine mammals (e.g., sperm whales, Bryde's whales, etc.). However, it should be noted that data collected from a potential catastrophic spill occurring in the GOM would be very limited in determining the degree of impact to all exposed marine mammal species due to the lack of baseline data to compare as a control for new data (Venn-Watson et al., 2015), as well as the low detection rates of carcasses (Williams et al., 2011). Further details on this catastrophic OSRA run can be found in **Chapter 2**.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response, and on oil initially reaching the shoreline during the spill event or while the oil still persists in the offshore environment once the spillage has been stopped. It is likely that Phases 2 and 3 could occur simultaneously. The duration of the initial shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining oil dissipates offshore. Re-oiling of already cleaned or previously impacted areas could be expected during Phase 3. In addition to the response described in Phase 2, nearshore and onshore efforts would be introduced in Phase 3 as oil entered coastal areas and contacted shore. The potential impacts reflect the spill and response in very shallow coastal waters and once along the shoreline. Season and temperature variations can result in different resource impacts due to variations in oil persistence and oil and dispersant toxicity and because of differences in the potential exposure of the resources throughout various life cycle stages.

A high-volume oil spill lasting 90 days could directly impact over 22 species of marine mammals. If a spill enters coastal waters, it would most likely affect manatees and coastal and estuarine dolphins.

Manatees are in the order Sirenia and primarily inhabit open coastal (shallow nearshore) areas and estuaries, and they are also found far up in freshwater tributaries. Florida manatees have been divided into four distinct regional management units:

- the Atlantic Coast Unit that occupies the east coast of Florida, including the Florida Keys and the lower St. Johns River north of Palatka, Florida;
- the Southwest Unit that occurs from Pasco County, Florida, south to Whitewater Bay in Monroe County, Florida;
- the Upper St. Johns River Unit that occurs in the river south of Palatka, Florida; and
- the Northwest Unit that occupies the Florida Panhandle south to Hernando County, Florida (Waring et al., 2012).

During warmer months (June to September), manatees are common along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida. Although manatees are less common farther westward, manatee sightings increase during the warmer summer months and can be found as far west as Texas; however, most sightings still occur in the eastern GOM (Fertl et al., 2005). Winter habitat use is primarily influenced by water temperature as animals congregate at natural (springs) and/or artificial (power plant outflows) warm water sources (Alves-Stanley et al., 2010). Manatees are infrequently found as far west as Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998). If a catastrophic oil spill were to reach the Florida coast when manatees were in or near coastal waters, the spill could have population-level effects.

The types of impacts to manatees from contact with oil may include (1) asphyxiation because of inhalation of hydrocarbons; (2) acute poisoning because of contact with fresh oil; (3) lowering of tolerance to other stress because of the incorporation of sublethal amounts of petroleum components into body tissue;, (4) nutritional stress through damage to food sources; (5) abscesses in the lungs and areas of necrosis, hemorrhage, and gas accumulation in the bowel walls correlated with the ingestion and aspiration of hydrocarbons; and (6) inflammation or infection and difficulty eating because of oil sticking to the sensory hairs around their mouths (Preen, 1989, in Sadiq and McCain, 1993; Figueroa-Oliver et al., 2000). There have been no experimental studies and only a few observations suggesting that oil impacts have harmed any manatees (St. Aubin and Lounsbury, 1990). Therefore, immediate, long-term chronic and sublethal effects of exposure to oil are unknown for manatees (Helm et al., 2015).

Several publications suggest that toxic effects of oil and associated vapors on the eyes and respiratory system of manatees would likely be similar to those seen in other marine mammals (Geraci and St. Aubin, 1990; St. Aubin and Lounsbury, 1990; Dierauf and Gulland, 2001). Manatee skin has a thick dermis on top of their blubber layer, which may suggest that oil compounds would not adhere to their skin (Helm et al., 2015). Direct contact with discharged oil likely does not impact adult manatees' thermoregulatory abilities because they use blubber for insulation. However, an initial examination of a live, newborn Antillean manatee (*Trichechus manatus manatus*) observed in an area affected by a diesel fuel spill found shedding skin and diesel fuel residues on its body (Figueroa-Oliver et al., 2000). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980), as well as cause lung abscesses that may become positive for certain bacteria such as *Pseudomonas* and *Klebsiellas* (Figueroa-Oliver et al., 2000). Other published data by Wetzel et al. (2008) examined sirenian tissues for the presence of PAHs and related compounds did not find any of those chemicals and stated that it was not surprising as vertebrates are known to efficiently metabolize aromatic hydrocarbons (Varanasi et al., 1989; Neff, 2002). However, the study by Wetzel et al. (2008) was not conducted during a large spill and did not involve sirenians that were suspected of being exposed to oil.

Manatees exhibit no grooming behavior that would contribute to the ingestion of hydrocarbons from residues on their bodies (USDOI, FWS, 2006); however, they are nonselective, generalized feeders that might consume tarballs along with their normal food, although such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). Manatees feed on shoreline vegetation and spend considerable time with their muzzles in the sediment while feeding (Marsh et al., 2011); therefore, ingestion of residual oil and associated dispersants would be expected in areas impacted by oil. However, the effects of oil ingestion on manatees are poorly studied (Helm et al., 2015). An oil spill could have a substantial impact on manatees by reducing the abundance and quality of their food. Oil has been experimentally shown to cause mortality and sublethal harmful effects on freshwater aquatic vegetation that has been known to be consumed by manatees in the Amazon and elsewhere (Lopes et al., 2009). However, the effects of oil on sirenian food resources in tropical climates may not persist for long periods, as evidenced by the substantial recovery of seagrasses in the Gulf of Arabia 1 year after the Gulf War spill (Kenworthy et al., 1993).

Manatees share the waterways with watercraft and have historically sustained injuries due to interactions with vessels (Lightsey et al., 2006); therefore, it is possible that manatees could occur in coastal areas where vessels traveling to and from the spill site could affect them. A manatee present where there is vessel traffic could be injured or killed by a vessel strike (Wright et al., 1995). Due to the large number of vessels responding to a catastrophic spill both in coastal waters and traveling through coastal waters to the offshore site, manatees would have an increased risk of collisions with boats. A study assessing dead manatees recovered in the State of Florida between 1993 and 2003 found as much as 24 percent of these manatees were killed by watercraft-induced trauma, making it a significant contributor to Florida manatee mortality (Lightsey et al., 2006). Therefore, if a catastrophic spill and response vessel traffic occurred near manatee habitats in the eastern Gulf of Mexico, population-level impacts could occur because the possibility exists for the number of mortalities to exceed the potential biological removal.

Oil spills that may occur from OCS oil- and gas-related activities that reach the coast or the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could further endanger local populations. When manatees experience prolonged exposure to water temperatures below 68 °F (20 °C), they can develop a condition called cold-stress syndrome, which can be fatal. The effects of cold stress may be acute, when manatees succumb rapidly to hypothermia, or longer-lasting as chronic debilitation. Chronic cold-stress syndrome is a complex disease process that involves metabolic, nutritional, and immunologic factors

(State of Florida, Fish and Wildlife Conservation Commission, 2015b). The physiological costs of animals moving to colder waters to escape oiled areas may result in thermal stress that would exacerbate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). For a population that is already under great pressure from other mortality factors (e.g., vessel strikes and cold-stress), even a localized incident could be significant (St. Aubin and Lounsbury, 1990).

Certain species of cetaceans that typically show strong site fidelity to restricted nearshore habitats would likely be impacted by oil spills that reach the shoreline of these habitats. If these habitats were to become oiled, these types of species could experience both acute and chronic exposure through both their respiratory system and ingestion of contaminated prey (Helm et al., 2015). Studies of nearshore resident bottlenose dolphin stocks that were exposed to an oil spill that reached the shoreline observed adrenal and lung disease, overall poor health and body condition, bacterial pneumonia, and reproductive failure (Schwake et al., 2014; Venn-Watson et al., 2015). Many of the serious health conditions found during assessments of these dolphin stocks are suggestive of exposure to oil, but comparative health data on these stocks from before the spill are not available. Therefore, it is possible that environmental conditions in the habitats of these stocks before the spill increased the vulnerability of the resident dolphin population to the oil spill or these dolphins were already unhealthy prior to the spill (Helm et al., 2015). Furthermore, other natural factors that have the potential to cause many of these observed health conditions occurred during an oil spill and warrant more research to determine their contribution to the health of these stocks (Colegrove et al., 2016; Venn-Watson et al., 2015; Schwake et al., 2014).

Phase 4—Post-Spill, Long-Term Recovery and Response

Phase 4 focuses on long-term recovery once the well has been capped and the spill has stopped. During the final phase of a catastrophic blowout and spill, it is presumed that the well has been capped or killed and cleanup activities are concluding. While it is assumed that the majority of spilled oil would be dissipated offshore within 1-2 months (depending on season and temperature) of stopping the flow, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill. On sandy beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms. The potential impacts reflect long-term persistence of oil in the environment and residual and long-term cleanup efforts.

Even after the spill is stopped, oilings or deaths of marine mammals would still likely occur because of oil and dispersants persisting in the water, past marine mammal/oil or dispersant interactions, and ingestion of contaminated prey. The animals' exposure to hydrocarbons persisting in the sea may result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) and some soft tissue irritation, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. A catastrophic oil spill could lead to increased mortalities, resulting in potential population-level effects for some species/populations (USDOC, NMFS, 2015). Evidence indicates that odontocete populations diminished by a catastrophic oil spill can be slow to recover and often do not meet recovery goals (Schwacke et al., 2017). Findings from Smith et al. (2017) showed that bottlenose dolphins inhabiting areas affected by the *Deepwater Horizon* oil spill were more likely to exhibit adverse health implications, such as lung disease, compared to areas not affected.

Findings from multiple studies analyzing the Barataria Bay and Mississippi Sound bottlenose dolphin populations (Schwacke et al., 2017; Smith et al., 2017; Takeshita et al., 2017; Frasier et al., 2020) further support that the *Deepwater Horizon* explosion, oil spill, and response contributed to the adverse health effects described in the *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), including impaired stress responses, high prevalence of lung and adrenal lesions, persistent lung and pulmonary disease, and reproductive failure, though other factors specific to these less than pristine areas continuously and historically contribute to these stresses. Takeshita et al. (2017) stated that “while many of these studies have now been published, a true understanding of the long-term effects of the *Deepwater Horizon* oil contamination (and the associated response activities) on northern GOM marine mammals would require sustained investigation and monitoring.”

Overall Summary and Conclusion (Phases 1-4)

Catastrophic blowouts, oil spills, and spill-response activities have the potential to impact small to large numbers of marine mammals in the GOM. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-response capabilities and timing; and various meteorological and hydrological factors. Impacts that may affect an individual or group of individuals include vessel collisions, soft tissue irritation, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, fouling of baleen plates, increased vulnerability to disease, temporary displacement from preferred habitats or migration routes, and decreased health, reproductive fitness, and longevity. The pressure waves and noise generated by the eruption of gases and fluids during the initial blowout (Phase 1) would likely harass, injure, or kill marine mammals, depending on the proximity of the animal to the blowout. However, marine mammals are wide-ranging and the chance that a marine mammal would be in the vicinity of a low-probability catastrophic blowout would be unlikely. The initial offshore spill (Phase 2) may impact an individual or group of individuals depending on the proximity of the individual(s) to the spilled oil and the amount and characteristics of the spilled oil, which may cause soft tissue irritation, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, fouling of baleen plates, increased vulnerability to disease, temporary displacement from preferred habitats or migration routes, and decreased health, reproductive fitness, and longevity. Potential exposure to any chemical dispersants that may be used during spill-response activities may cause similar impacts as spilled oil to marine mammals. In addition, the large number of response vessels could place marine mammals at a greater risk of vessel collisions, which could cause fatal injuries. Even after the spill is stopped, oilings or deaths of marine mammals would still likely occur because of oil and dispersants persisting in the water, past marine mammal/oil or dispersant interactions, and ingestion of contaminated prey (Phase 3). However, the long-term effects (Phase 4) of chronic sublethal oil exposure may not be immediately evident, may be difficult to separate from other toxicological influences, and could result in a population-level impact.

1.3.1.12 Commercial Fisheries

Phase 1—Initial Event

The initial explosion and fire could endanger commercial fishermen in the immediate vicinity of the blowout. Although commercial fishing vessels in the area would likely aid in initial search-and-rescue operations, vessels would subsequently avoid the area so as to not interfere with response activities. This could lead to reduced seafood landings and revenues in the affected area, which would negatively impact commercial fishermen. The extent of the economic impact on the fishing community would depend largely on the season during which the blowout occurred, the depth of water in which it occurred, and its distance from shore because these factors determine the species affected as well as the scale of fishing activity in an area.

Phase 2—Offshore Spill

A catastrophic oil spill would likely lead to fishing closures for large parts of the Gulf of Mexico. The negative impacts to commercial fishing would be proportional to the intensity of fishing activity that would typically occur in the closed areas. The impacts would also depend on the duration and time of year of the closures. Finally, the impacts would depend on the extent to which fishermen could find substitute fishing sites, which would be difficult subsequent to a catastrophic spill because the closure areas would potentially be large. The *Deepwater Horizon* explosion, oil spill, and response led to a peak fishing closure of 37 percent of Federal waters (USDOC, NMFS, 2016b), which negatively impacted various commercial fisheries (Carroll et al., 2016).

The impacts to commercial fishing would also depend on the biological impacts to affected species (refer to **Chapter 1.3.1.7**, Fishes and Invertebrate Resources). Oil has the potential to affect finfish through direct ingestion of hydrocarbons or ingestion of contaminated prey. The effects on commercial species may also include the tainting of flesh or the perception of tainting in the market. Commercial species occupy many different habitats throughout the area, and many commercial species occupy different habitats during different life stages. Most commercial species spend at least part of their life cycles in productive shelf and estuarine habitats, and thus would be particularly susceptible to oiling of these areas. Adult finfish are mobile and generally able to avoid adverse conditions (Beyer et al., 2016). Less mobile species, juveniles, and planktonic larvae are more susceptible to the effects of oil and dispersants.

Declines in fisheries landings subsequent to a catastrophic spill would negatively impact commercial fishermen, as well as companies and employees in the seafood supply chain. The extent of these impacts would depend on how seafood prices change subsequent to a spill. The decline in landings would tend to increase seafood prices. However, concerns about seafood safety could decrease seafood prices, which would negatively impact income in the seafood supply chain. Carroll et al. (2016) provides information regarding the short-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on the seafood industry. This report analyzes, both quantitatively and qualitatively, how the reductions in fisheries landings due to the *Deepwater Horizon* explosion, oil spill, and response affected the supply chain for each fishery. Finally, the impacts to commercial fishing from a catastrophic oil spill would depend on the effectiveness of the damage payment system and restoration activities subsequent to the spill.

Phase 3—Onshore Contact

If the spill were to reach shore, the fishing closures, biological impacts, and supply chain impacts discussed for Phase 2 would be similar. However, there would likely be greater impacts to species that are harvested close to shore, such as oysters and blue crab. In addition, as mentioned above in **Chapter 1.3.1.3** (Coastal Habitats), fisheries would be particularly harmed by any damage to estuarine habitat. Shoreline contact would also lead to impacts to fish and invertebrate populations arising from shoreline protection and response activities. For example, following the *Deepwater Horizon* explosion, oil spill, and response, freshwater diversions to slow the approaching oil affected the oyster fishery (Janasie, 2013). Shoreline oil contact may also damage infrastructure supportive of the commercial fishing industry. Finally, onshore contact could exacerbate the perceptions of fish tainting, which would reduce the demand for seafood. The combination of these various impacts could cause severe negative impacts to the commercial fishing industry.

Phase 4—Post-Spill, Long-Term Recovery and Response

The long-term impacts of a catastrophic spill would depend on how fish populations respond, as well as on the recovery of the people, infrastructure, and market conditions that support the commercial fishing industry. Following the 1979 *Ixtoc I* blowout and spill, the commercial fishing industry of Texas did not sustain measurable direct or indirect economic effects (Restrepo et al., 1982), although there is a documented phenomenon that, long after an incident, the perception of tainted fish and shellfish from the impacted area persists (Keithly and Diop, 2001). Innovative Emergency Management, Inc. (2010) combines biological and economic information to estimate the impacts of the *Deepwater Horizon* oil spill on various fisheries. This study estimated that impacts for most species would primarily be felt during the 2 years subsequent to a spill. Upton (2011) provides additional details regarding the impacts of a spill to various fisheries, as well as information regarding policies that can mitigate the impacts of a spill. Austin et al. (2014a and 2014b) employed ethnographic methods and data analysis to analyze the impacts of the *Deepwater Horizon* oil spill on various industries, including the seafood industry. This study points out how the impacts of the *Deepwater Horizon* oil spill on the seafood industry were exacerbated by existing trends (such as increasing import competition) and seafood safety concerns. These types of impacts on commercial fishing would likely be felt subsequent to a future catastrophic oil spill.

Overall Summary and Conclusion (Phases 1-4)

The Gulf of Mexico supports a vast and complex commercial fishing industry. The initial impacts (Phase 1) would be on fishing activities in the immediate vicinity of the spill. While the spill is offshore (Phase 2), it would cause fishing closures and could affect fish populations in the affected areas. If the spill were to reach shore (Phase 3), there would be impacts to important fisheries in nearshore waters. The long-term impacts of a catastrophic spill (Phase 4) would depend on the timing and location of the spill, as well as on the evolution of public perceptions of seafood safety.

1.3.1.13 Recreational Fishing

Phase 1—Initial Phase

About 20 percent of recreational fishing and 93 percent of recreational diving in the GOM (excluding West Florida) occurs within 300 ft (91 m) of oil and gas structures (Hiett and Milon, 2002). Therefore, an explosion and fire could endanger recreational fishermen and divers in the immediate vicinity of the blowout, especially if the blowout is located close to shore. Recreational vessels in the area would likely aid in initial search-and-rescue operations, but they would also be in danger during the explosion and subsequent fire. The subsequent fire could burn for up to a month during which recreational vessels would be expected to avoid the area and to not interfere with response activities. If the spill destroyed a production platform, the reef functions of that platform would be lost. It is also possible that recreational fishing could be impacted in areas beyond the immediate area of the event due to the perceptions of the public.

Phase 2—Offshore Spill

If a catastrophic spill were to occur, a substantial portion of ocean waters could be closed. For example, 88,522 mi^2 (229,271 km^2) were closed to recreational fishing activity at the peak of the *Deepwater Horizon* explosion, oil spill, and response (Yitalo et al., 2012). However, the majority of recreational fishing activity occurs fairly close to shore. Therefore, while the spill remains offshore, the impacts would be particularly felt with respect to fishing of offshore species such as king mackerel and red snapper (the impacts of a catastrophic spill on fish populations are discussed in **Chapter 1.3.1.7**). However, even while the spill remains offshore, there could be impacts to inshore recreational fishing due to misperceptions regarding the extent of the spill or due to concerns regarding the tainting of fish species. These misperceptions could also reduce tourism activity, which would impact tourism-based recreational fishing activity.

Phase 3—Onshore Contact

If a catastrophic spill were to reach shore, there would likely be noticeable impacts to recreational fishing activity. Since most recreational fishing activity occurs fairly close to shore, there would be a number of direct impacts to angler activity due to the fishing closures that would likely arise. This is particularly true since anglers would find it more difficult to find substitute fishing sites in the case of a catastrophic spill. The impacts to recreational fishing would also depend on the time of year of the spill. Typically, the highest number of angler trips occur between May and August (Keithly and Roberts, 2017). In addition, fishing tournaments are often scheduled for the summer months and would be difficult to reschedule in the aftermath of a catastrophic spill.

There would also be various economic impacts along the recreational fishing supply chain. Gentner Consulting Group (2010) estimates that recreational fishing activity supports $9.8 million in direct expenditures and $23 million in total sales per day in the Gulf of Mexico. Value added, which represents the contribution of recreational fishing to the gross domestic product of the state (region), was estimated to equal $3.3 billion (Keithly and Roberts, 2017). There could be further impacts if the fishing closures persisted long enough to affect purchases of boats and other durable fishing equipment. There could also be further impacts if the lost opportunities for recreational fishing exacerbated the fall in tourism activity that would arise due to the spill.

Phase 4—Post-Spill, Long-Term Recovery and Response

The long-term impacts of a catastrophic spill on recreational fishing activity would primarily depend on the extent to which fish populations recover (refer to **Chapter 1.3.1.7** for more information). This would be influenced by the resultant restoration plan, as well as by any changes to oil and gas development (since oil and gas structures can serve as artificial reefs). The longer-term impacts of a spill on recreational fishing activity would also depend on the extent to which public perceptions of fish tainting can be assuaged. In addition, the longer-term impacts would depend on the extent to which the various firms that serve the recreational fishing industry would be able to weather the downturn in activity resulting from the spill. In the aftermath of the *Deepwater Horizon* oil spill, recreational fishing activity generally returned to baseline levels the year subsequent to the spill (USDOC, NMFS, 2014).

Overall Summary and Conclusion (Phases 1-4)

Recreational fishing activity could be noticeably impacted in the event of a catastrophic spill. The initial impacts (Phase 1) would be on fishing activities in the immediate vicinity of the spill. While the spill is offshore (Phase 2), recreational fishing of offshore species such as red snapper and king mackerel would be affected by fishing closures and impacts to fish populations. The impacts to recreational fishing would be greater if the spill were to reach shore (Phase 3) because most recreational fishing activity occurs close to shore. The impacts would be particularly noticeable if the spill occurred during peak times and places of recreational fishing activity. The long-term impacts of a catastrophic spill (Phase 4) would depend on the extent to which fish populations recover and the length of time it would take to convince the public that it was again safe to fish in the affected areas.

1.3.1.14 Recreational Resources

Phase 1—Initial Event

The most immediate impacts of a catastrophic spill would be on the recreational fishing and recreational diving activity in the vicinity of the blowout. About 20 percent of the recreational fishing activity and 93 percent of the recreational diving activity in the GOM from Alabama to Texas occurs within 300 ft (91 m) of oil and gas structures (Hiett and Milon, 2002). The impacts on recreational fishing and recreational diving would be greater the closer the blowout occurred to shore. The immediate response activities could also impact ocean-based recreational activity. Finally, there could be impacts to tourism activity since a catastrophic spill would likely receive a large amount of media attention. Tourism in the immediate vicinity of the spill would likely decrease while tourism farther away from the spill could either decrease (due to misperceptions of the extent of the spill) or increase (due to substitution behaviors of tourists).

Phase 2—Offshore Spill

While the spill is still offshore, there could be some ocean-dependent recreation that is affected (e.g., fishing, diving, and boating), as mentioned in Phase 1. In addition, there may be some effects due either to perceived damage to onshore recreational resources that has not yet materialized or to general hesitation on the part of travelers to visit the overall region because of the spill. A Congressional hearing into this matter (U.S. House of Representatives, 2010) provides a broad overview of some of the effects that were felt along the Gulf Coast subsequent to the *Deepwater Horizon* explosion, oil spill, and response. The Deepwater Horizon Natural Resource Damage Assessment Trustees (2016) estimate that shoreline recreation in the Florida Peninsula was negatively impacted for 9 months following the *Deepwater Horizon* explosion, oil spill, and response. This type of effect could be due to misperceptions about the spill, uncertainty about the future of the spill, or concerns about whether a tourism experience would be affected even if the destination is only within close proximity to a spill.

Phase 3—Onshore Contact

A catastrophic spill has the potential to noticeably impact the Gulf Coast recreation and tourism industries. The water-dependent and beach-dependent components of these industries would be particularly vulnerable. Environmental Sensitivity Indexes (ESIs) provide overall measures of the sensitivity of a particular coastline to a potential oil spill. The ESIs rank coastlines from 1 (least sensitive) to 10 (most sensitive). Marshes and swamps are examples of resources that have ESIs of 10 due to the extreme difficulty of removing oil from these areas; marsh and swamp areas are particularly prevalent in Louisiana. The ESIs for beach areas generally range from 3 to 6, depending on the type of sand and the extent to which gravel is mixed into the beach area; beach areas are particularly prevalent in Texas, Mississippi, Alabama, and Florida. The ESI maps for any coastline along the Gulf of Mexico can be viewed using NOAA’s Environmental Response Management Application (ERMA) mapping system (USDOC, NOAA, 2020a; USDOC, NOAA, Office of Response and Restoration, 2019). The ERMA also includes maps of important parks along the Gulf Coast (such as Gulf Islands National Seashore), as well as point indicators for other recreational resources (such as boat ramps, campgrounds, and dive sites).

A catastrophic spill would also raise a number of issues regarding recreational activity that is based on tourism. One important point is that a spill of the *Deepwater Horizon* oil spill’s dimensions can influence a much broader range of individuals and firms than can a smaller spill. For example, a small, localized spill may lead some travelers to seek substitute recreational opportunities in nearby areas. However, a large spill is more likely to dissuade travelers from visiting a broader economic region. Similarly, small- and mid-sized restaurant chains and hotels may be able to find other customers or to simply weather a smaller spill. However, a spill the size of the *Deepwater Horizon* oil spill is more likely to affect these types of firms since they are less able to diversify their customer base. These effects can be seen in the makeup of those who filed damage claims with BP (Gulf Coast Claims Facility, 2012). For example, the bulk of the claims by individuals have been made in the food, beverage, and lodging sector and in the retail, sales, and service sector. Claims have also been made by individuals and firms in a broad range of geographic regions, many of which were not directly impacted by oil.

Murtaugh (2010) provides data on the changes in hotel and sales tax receipts for individual Gulf Coast counties and parishes in the months immediately following the *Deepwater Horizon* explosion, oil spill, and response. During the summer of 2010, the spill caused substantial declines in hotel receipts in the following counties: Baldwin, Alabama (33.2% decline); Santa Rosa, Florida (24.8% decline); Okaloosa, Florida (24.1% decline); Walton, Florida (12.3% decline); and Bay, Florida (7.4% decline). However, coastal counties west of Baldwin, Alabama (as far west as St. Mary, Louisiana), generally experienced noticeable increases in hotel receipts. This was particularly true in Mobile, Alabama; Jackson, Mississippi; and in the coastal parishes of Louisiana. For example, in Louisiana, St. Mary, Terrebonne, and Lafourche Parishes each reported increases in hotel tax receipts of over 80 percent in the summer of 2010. These effects are likely due to the influx of oil-spill relief workers to these areas in the immediate aftermath of the *Deepwater Horizon* explosion, oil spill, and response. Overall sales tax receipts in counties from Baldwin, Alabama, eastward also generally fell during 2010, although to a lesser extent than hotel tax receipts. Sales tax receipts in counties and parishes west of Baldwin, Alabama, did not show as clear a pattern as did hotel tax receipts. For example, overall sales tax receipts fell by 12.5 percent in Hancock County (Mississippi), receipts were almost unchanged in Harrison County (Mississippi), and receipts increased by 8.3 percent in Orleans Parish (Louisiana). These results suggest that the impacts of a future catastrophic spill would be influenced by the structure of a particular county/parish's recreational economy, as well as by the extent to which oil-spill response activities would mitigate some of the negative impacts of the spill in certain areas.

There could also be effects on tourist activities in areas far away from the areas directly affected by oil. For example, in Texas subsequent to the *Deepwater Horizon* explosion, oil spill, and response, some tourists may have stayed away from Texas Gulf Coast beaches due to misperceptions regarding the extent to which these beaches were damaged due to the spill. Conversely, there may have been some substitution of beach visitation away from beaches in the eastern Gulf towards the beaches in Texas, which were farther from the spill. While it is difficult to quantify these effects, some anecdotal evidence regarding this substitution effect can be found in Pack (2010). Hotel occupancy data suggest that these two effects may have largely offset each other. Source Strategies Inc. (2010) reports that total hotel occupancy in the three metropolitan regions in Texas closest to the Gulf Coast increased just 1.9 percent during the third quarter of 2010 compared with the third quarter of 2009.

Phase 4—Post-Spill, Long-Term Recovery and Response

The longer-term implications of a catastrophic event on tourism would depend on the extent to which any structural/ecological damage can be repaired and the extent to which economic mitigation actions would occur. The long-term implications of a catastrophic spill would also depend on the extent to which public confidence in the various components of the recreational and tourism economies can be restored. For example, restaurants in the region would be impacted to the extent to which they are perceived to use seafood products caught or raised in contaminated waters. Similarly, although beaches can be decontaminated not long after a spill has been stopped, lingering perceptions can be expected to negatively impact tourism even after a spill has ended.

Oxford Economics (2010) analyzes the impacts of recent catastrophic events on recreational economies. For example, following the *Ixtoc I* well blowout and spill of 1979, it took approximately 3 years for beaches to be cleaned and for recreational activity to return to similar levels as before the spill. Following the *Prestige* oil spill of 2002 off the coast of Spain, recreational activity returned to pre-spill levels in approximately 1 year. Alaska's tourism economy took approximately 2 years to recover from the *Exxon Valdez* spill.

Eastern Research Group (2014) is a study of the impacts of the *Deepwater Horizon* explosion, oil spill, and response on tourism activities in the Gulf region. Eastern Research Group analyzed claims data, reviewed newspaper accounts of the spill, analyzed county-level employment data, and conducted interviews with people involved in the tourism industry. These various methodologies paint a rich picture of the impacts of the *Deepwater Horizon* explosion, oil spill, and response and revealed some broad conclusions. First, the *Deepwater Horizon* explosion, oil spill, and response had a broad geographic reach, partially due to public perceptions of the nature and scope of the spill. In addition, restaurants and hotels were particularly impacted by the *Deepwater Horizon* explosion, oil spill, and response, which led areas with more diversified tourism economies to endure better in the spill's aftermath. Also, tourism generally rebounded strongly after the initial decline, and employment was sustained in most counties and parishes that supported the recovery following the *Deepwater Horizon* explosion, oil spill, and response. Finally, the impacts of the spill on tourism were shaped by the damage payment system, the cleanup processes, and the lessons learned from prior disasters.

The Deepwater Horizon Natural Resource Damage Assessment Trustees (2016) estimated the impacts of the *Deepwater Horizon* explosion, oil spill, and response on shoreline recreation (e.g., beach visitation) and boating recreation (e.g., vessel-based recreational fishing). This analysis entailed surveying recreators, conducting aerial counts, and applying various statistical techniques. This study estimates that the *Deepwater Horizon* explosion, oil spill, and response led to a 23 percent decline in shoreline user days and a 28 percent decline in boating user days during the study period. These declines were valued at $693.2 million (with a range of uncertainty of $527.6-$858.9 million) in lost recreational value. However, these damages are being mitigated by restoration of various recreational resources.

Overall Summary and Conclusion (Phases 1-4)

The most immediate (Phase 1) impacts of a catastrophic spill would be on recreational fishing and recreational diving activities in the vicinity of the blowout. While the spill is still offshore (Phase 2), there could be some ocean-dependent recreation that is affected (e.g., fishing, diving, and boating), as well as some effects due either to perceived damage to onshore recreational resources that has not yet materialized or to general hesitation on the part of travelers to visit the overall region because of the spill. If a spill were to reach shore (Phase 3), it could cause noticeable impacts to recreational resources (such as beaches); it could also have complex effects on recreational activity that depends on tourism. The longer-term implications (Phase 4) of a catastrophic oil spill on recreation and tourism would depend on the extent to which any structural/ecological damage can be repaired, the extent to which economic mitigation actions would occur, and the speed at which public confidence in the various components of the affected recreational and tourism economies would be restored.

1.3.1.15 Archaeological Resources

Phase 1—Initial Event

Offshore Archaeological Resources

BOEM protects potentially historic and precontact archaeological resources on the OCS by requiring surveys and implementing avoidance criteria or directives to investigate these resources in conjunction with agency-permitted activities. Onshore archaeological resources and other historic properties (as defined at 36 CFR § 800.16) would not be immediately impacted during the initial phase of a catastrophic blowout because the distance of a blowout site from shore is at least 3 nmi (3.5 mi; 5.6 km). However, offshore catastrophic blowouts, when compared with spills of lesser magnitude, may initially impact multiple archaeological resources. Resources adjacent to a catastrophic blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during emergency relief well drilling, or contaminated by the spilled hydrocarbons. Contamination of individual artifacts may result in a variety of impacts, including staining and disfiguration of porous objects (e.g., wood, bone, certain ceramics, and deteriorated glass), material degradation from the acidic byproducts of sulfur- and nitrogen-reducing microorganisms that digest hydrocarbons, and toxic exposure to any humans handling the artifacts (USDOI, NPS, 2019).

Based on historical information, over 2,200 potential shipwreck locations have been identified on the Gulf of Mexico OCS (USDOI, BOEM and BSEE, 2020). This number is a conservative estimate and is heavily weighted toward post-19th century, nearshore shipwrecks, where historic records documenting the loss of the vessels were generated more consistently. BOEM currently has confirmed locational data for over 400 potential wreck sites. Eleven of these wrecks are currently listed in the National Register of Historic Places, and approximately 30 more have been identified by BOEM as potentially eligible for listing, although the historic significance for the majority of OCS wreck sites is not yet determined.

BOEM's Regional Director may require the preparation of an archaeological report to accompany the exploration plan, development operations coordination document, or development and production plan, under 30 CFR § 550.194, and BSEE's Regional Director may do likewise under 30 CFR § 250.194 if a potential wreck is encountered during operations. Current BOEM guidance on collecting and reporting archaeological survey data is presented in NTL 2005-G07. As part of the environmental reviews conducted for post-lease activities, available information is evaluated regarding the potential presence of archaeological resources within a proposed project area to determine if additional archaeological resource surveys and mitigations are warranted. Having knowledge of seafloor resources before a spill occurs would enable responders to quickly plan countermeasures in a way that would minimize adverse effects occurring from the spill response.

Phase 2—Offshore Spill

Offshore Archaeological Resources

Due to the potential response methods (i.e., subsea dispersants) and magnitude of the response (i.e., thousands of vessels), a catastrophic blowout and spill have a greater potential to impact offshore archaeological resources than other accidental events.

Deep Water

In contrast to smaller spills or spills in shallow water, large quantities of subsea dispersants could be used for a catastrophic subsea blowout in deep water. Such an event could impact archaeological resources at significant distances from the wellhead and for extended periods of time. Data collected for a BOEM-funded study in 2014 (4 years after the *Deepwater Horizon* explosion, oil spill, and response) confirmed moderate-to-heavy impacts from oil and/or dispersant contamination of at least five known historic wood- or steel-hulled shipwrecks located at distances up to approximately 100 km (62 mi) from the Mississippi Canyon Block 252 blowout location (Hamdan et al., 2018). Oiling of these sites occurred during massive sedimentation events triggered by “marine oil snow sedimentation and flocculent accumulation”. By collecting sediment samples up to 200 m (656 ft) from the five impacted wrecks and two unimpacted control wrecks, Hamdan et al. (2018) found that shipwrecks that were exposed to deposited oil within the *Deepwater Horizon* oil spill plume displayed differences in their microbiomes and reduced biodiversity relative to unimpacted sites. Additionally, metal loss on experimental carbon steel disks placed at the study sites was increased at those sites within the spill plume, and time-series imagery indicates that the rate of metal loss on the wreck of the German U-boat U-*166* has accelerated since the spill (Mugge et al., 2019).

As part of the same study, Salerno et al. (2018) document that the release of hydrocarbons and chemical dispersant in marine environments may affect the structure of benthic microbial communities and biofilms found on artificial substrates, including historic shipwrecks. Lab experiments were performed to determine separately the impacts of crude oil, dispersant, and chemically dispersed crude oil on the community structure and function of microorganisms in seawater and on biofilms formed on carbon steel, which is a common ship hull construction material. Steel corrosion was also monitored to illustrate how oil spills may impact the preservation of steel shipwrecks. The study revealed a decrease in genes associated with hydrocarbon degradation in dispersant-treated biofilms. This indicates that exposure to oil and dispersant could disrupt the composition and metabolic function of biofilms colonizing metal hulls, potentially compromising the environmental equilibrium of the shipwreck and accelerating corrosion processes (Salerno et al., 2018).

A separate experimental study has suggested that the biodegradation of wood is initially retarded by contamination with crude oil, but it is accelerated at later stages of contamination (Ejechi, 2003). That study focused on terrestrial environments and, while there are different constraints that affect the degradation of wood in terrestrial versus waterlogged environments, soft-rot fungal activity, one of the primary wood-degrading organisms in submerged contexts, was shown to be increased in the presence of crude oil (Ejechi, 2003). There is a possibility that oil from a catastrophic blowout could come in contact with wooden or iron shipwrecks and artifacts on the seafloor and accelerate their deterioration.

Ancillary damages from vessels associated with oil-spill response activities (e.g., anchoring) in deep water are unlikely because of the expected use of dynamically positioned vessels responding to a deepwater blowout. If response and support vessels were to anchor near a deepwater blowout site, the potential to damage undiscovered vessels in the area would be high because of the required number and size of anchors and the length of mooring chains needed to safely secure vessels.

Shallow Water

In shallow water, the risks to archaeological sites from exposure to crude oil and/or dispersant are similar to those described above. However, the risk of impacts from bottom-disturbing activities associated with spill response are increased. Most of the damage to archaeological resources in shallow waters would likely be associated with oil cleanup and response activities. Potentially, thousands of vessels may respond to a shallow-water blowout and would likely anchor, potentially damaging both known and undiscovered archaeological sites. Additionally, multiple offshore vessel decontamination stations would likely be established outside of ports or entrances to inland waterways, as was done for the *Deepwater Horizon* explosion, oil spill, and response. The potential to impact archaeological resources increases as the density of anchoring activities in these areas increases.

Regardless of water depth, shipwrecks may be subject to colonization by micro- and macrofauna, including coral species, thereby becoming an essential component of the marine ecosystem. These organisms often form a protective layer over the shipwreck, which may decrease the rate of deterioration of a shipwreck as it reaches a relative state of equilibrium with its surrounding environment over time. Certain species of sessile fauna have been observed to induce localized artifact preservation (Etnoyer, official communication, 2016). If these fragile ecosystems are disrupted as a result of the oil spill and the protective layer is removed, the shipwreck may then be exposed to increased degradation until it reaches a new level of relative equilibrium with its surroundings.

Phase 3—Onshore Contact

Onshore Archaeological Resources

Onshore precontact and historic sites would be impacted to some extent by a high-volume spill from a catastrophic blowout that reaches shore. Sites on barrier islands could suffer the heaviest impact (refer to **Chapter 1.3.1.3.3**), and sites located inland from the coastline, in the marsh, and along bayous (refer to **Chapter 1.3.1.3.1**) could also experience oiling. A major onshore impact from an oil spill would be visual and chemical contamination of a coastal site, such as a shell midden, historic fort, or lighthouse. Though such impacts may be temporary and reversible, cleaning oil from historic structures can be a complex and expensive process (Chin and Church, 2010).

Coastal archaeological surveys during the *Deepwater Horizon* spill response identified 77 sites with evidence of oiling between Louisiana, Mississippi, Alabama, and Florida. A BOEM study revisited six of these sites and two unimpacted control sites along the Louisiana coast to assess their post-spill and cleanup oiling impacts (Rees et al., 2019). Crude oil and dispersant were detected in redeposited shoreline middens and intact archaeological contexts. The proximate impacts to the archaeological record include contamination of artifacts, ecofacts, and samples, with the potential to distort the results of certain archaeometric dating techniques, including radiocarbon dating and pottery residue analysis. Rees et al. (2019) found that erroneous radiocarbon dating resulted from applying standard pretreatment techniques to organic artifacts exposed to prolonged oil contamination. Conversely, pretreatment by solvent extraction was successful in mitigating the adverse impacts. Similarly, trace element analysis of absorbed pottery sherd residues was adversely affected when using gas chromatography-mass spectrometry but was unaffected when using other techniques such as neutron activation analysis or laser-ablation inductively coupled plasma-mass spectrometry (Rees et al., 2019). Adverse effects increased when hydrocarbon contamination was combined with dispersants. Furthermore, field and laboratory research on oiled sites would likely result in increased costs and time expenditures due to the safety protocols required to protect human health. One estimate suggests a 21 percent increase in the total direct cost for a Phase 3 investigation of an oiled coastal site (Rees et al., 2019).

Important lessons were learned from the *Exxon Valdez* spill in Alaska in 1989, in which the greatest damage to archaeological sites was related to cleanup activities and looting by cleanup crews rather than from the oil itself (Bittner, 1996). As a result, cultural resources were recognized as significant early in the *Deepwater Horizon* explosion, oil spill, and response. Archaeologists were embedded in Shoreline Cleanup Assessment Teams and consulted with cleanup crews. Historic preservation representatives were present at both the Joint Incident Command as well as each Area Command under the general oversight of the National Park Service to coordinate response efforts (Odess, official communication, 2010).

Phase 4—Post-Spill, Long-Term Recovery and Response

Onshore Archaeological Resources

As discussed above, impacts to onshore archaeological resources would include visual and chemical contamination of the resources and a reduction in the accuracy of certain archaeometric dating techniques. The most significant damage to archaeological sites would be related to cleanup and response efforts. Long-term recovery could prove difficult and expensive. Historic structures such as coastal forts that are exposed to oiling are generally constructed of brick or other porous, friable materials that are difficult to clean without causing further damage (Chin and Church, 2010). Funding for any sort of archaeological recovery is problematic outside of Federal lands because of existing laws and regulations (Varmer, 2014). For example, most coastal prehistoric sites in Louisiana are on private lands where there is no mechanism to recover damages. Section 106 of the National Historic Preservation Act is triggered by a Federal undertaking, which in the case of a spill, would be the response and not the actual spill. The NRDA process, codified by the Oil Pollution Act of 1990, is a legal process to determine the type and amount of restoration needed to compensate the public for harm that occurs to natural resources as a result of an oil spill, but it does not cover cultural, archaeological, or historic properties.

Overall Summary and Conclusion (Phases 1-4)

Archaeological resources are finite, unique, irreplaceable, nonrenewable records of mankind's past, which, once destroyed or damaged, are gone forever. During Phase 1, resources adjacent to a catastrophic blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during emergency relief well drilling, or contaminated by the spilled hydrocarbons. Phase 2 may include large quantities of subsea dispersants to be used for a catastrophic subsea blowout in deep water. This could result in alterations of the microbiological communities inhabiting the site, which, in turn, could accelerate the degradation of artifacts. In shallow waters, additional bottom-disturbing activities associated with spill-response operations increase the risk of direct contact and physical disturbance of archaeological resources. Phase 3 extends the risk of oil contamination to onshore archaeological sites. The most damaging effects of a catastrophic oil spill may occur due to response efforts during Phase 4. Additionally, in the event of a catastrophic oil spill, the most likely source of irreversible impact is from the response to any of the above phases, and the risk increases as the response approaches the shoreline, thereby increasing access to archaeological resources making them more vulnerable to impacts due to response efforts. This damage can, to a large extent, be mitigated by the early integration of archaeologists and State and Tribal historic preservation officers in the response to protect sites from impact. Mitigation of impacts from the oil itself is likely to meet with varied success depending upon the type of site and availability of funding.

1.3.1.16 Human Resources and Land Use

1.3.1.16.1 Land Use and Coastal Infrastructure

Phase 1—Initial Event

There would likely be no adverse impacts to land use and coastal infrastructure as a result of the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event because of the long distance (>3 nmi; 3.5 mi; 5.6 km) from shore and the short duration of the initial event, fire, and/or explosion.

Phase 2—Offshore Spill

Impacts to tourism and recreational resources are addressed in **Chapter 1.3.1.14**. Possible fisheries closures are addressed in **Chapters 1.3.1.12 and 1.3.1.13**. As cleanup and remediation efforts evolve, there would be increased activity at ports and coastal cities from all of the workers, vessels, planes, and helicopters responding to the event, leading to increased traffic on road infrastructure and at port facilities. Waste disposal activities associated with boom deployment and retrieval would increase demand at waste disposal facilities. Also, vessel decontamination sites would be set up offshore and the staffing/maintenance of these sites would contribute to increased activity at port facilities and traffic congestion on coastal waterways and highways (USEPA, 1999).

Phase 3—Onshore Contact

In the event of a catastrophic spill, impacts on land use and coastal infrastructure would be temporary and variable in nature. The scale of impact would depend on the nature of the event and whether it occurs in shallow or deep water. These impacts would include land use in staging areas, waste disposal locations and capacities, and potential delays because of vessel decontamination stations near ports.

For a shallow-water event, several staging areas would be established, many skimmers would be utilized, and numerous responders would be involved in the effort. BOEM expects a further increase in traffic congestion and some possible competing land-use issues near the staging areas, depending on the real estate market at the time of the event. Some infrastructure categories (such as vessels, ports, docks, and wharves) would likely become very engaged in response activities and this could result in a shortage of space and functionality at infrastructure facilities if ongoing drilling activities were simultaneously occurring. However, if drilling were to be suspended, conflicting demands on infrastructure facilities would likely be avoided.

In the category of waste disposal, the impacts would be more visible as thousands of tons of oily liquid and solid wastes from the oil-spill cleanup would be disposed of in onshore landfills. As was the case in the *Deepwater Horizon* explosion, oil spill, and response, USEPA, in consultation with USCG, would likely issue solid-waste management directives to address the issue of contaminated materials and solid or liquid wastes that are recovered as a result of cleanup operations (USEPA, 2010a and 2010b).

For navigation and port use, there would also be the potential for delays in cargo handling and slow vessel traffic because of decontamination operations at various sites along the marine transportation system (USDOT, 2010). However, vessel decontamination activities most likely would be complete within a year of the event, so impacts would be expected to be limited in duration.

Phase 4—Post-Spill, Long-Term Recovery and Response

Based on the rapid recovery of infrastructure that was heavily damaged by the catastrophic 2005 hurricane season (Louisiana State University, 2015) and the region’s experience since the *Deepwater Horizon* explosion, oil spill, and response, BOEM would not expect any long-term impacts to land use and coastal infrastructure as a result of a catastrophic oil-spill event. However, if a catastrophic oil spill were to occur, BOEM would monitor the post-spill, long-term recovery phase of the event for any changes that indicate otherwise.

A catastrophic spill could generate several thousand tons of oil-impacted solid materials disposed in landfills along the Gulf Coast. This waste may contain debris, beach, or marsh material (sand/silt/clay), vegetation, and personal protection equipment collected during cleanup activities. BOEM does not expect that landfill capacity would be an issue at any phase of the oil-spill event or the long-term recovery. In the case of the *Deepwater Horizon* explosion, oil spill, and response, USEPA reported that existing landfills receiving oil-spill waste had plenty of capacity to handle waste volumes; the *Deepwater Horizon* explosion, oil spill, and response's waste that was disposed of in landfills represented less than 7 percent of the total daily waste normally accepted at these landfills (USEPA, 2012).

It is not expected that any long-term, land-use impacts would arise from properties that are used for response activities and would somehow have their future economic use compromised. The rise or fall of property values would not be solely a function of some kind of economic impact from a catastrophic oil-spill event. There are many other factors that influence the value of property and its best economic use. It is not clear from past experiences whether vegetation loss or erosion created by a spill could result in changes in land use onshore, but nearshore oyster beds damaged by oil could take years to recover (refer to **Chapter 1.3.1.6.2**, Pinnacle Trend and Low-Relief Features), and **Chapter 1.3.1.12**, Commercial Fisheries, for analyses of impacts to oyster areas). The amount and location of erosion and vegetation loss could be influenced by the time of year the spill occurs, its location, and weather patterns, including hurricane landfalls. However, it may be expected that, outside of the NRDA process, additional restoration efforts likely would be formalized by congressional action, funded by damages recovered from the responsible party, and organized by a governing body such as the Gulf Coast Ecosystem Restoration Council, which was established by the RESTORE Act of 2012 as a result of the *Deepwater Horizon* explosion, oil spill and response (U.S. Dept. of the Treasury, 2012; Gulf Coast Ecosystem Restoration Council, 2013). Restoration efforts would be focused on habitat, water quality, biological coastal and marine resources, onshore community resilience, and regional economic revitalization (Gulf Coast Ecosystem Restoration Council, 2016).

Overall Summary and Conclusion (Phases 1-4)

There would likely be no adverse impacts to land use and coastal infrastructure throughout Phase 1 of a catastrophic spill event. Response efforts in Phases 2 and 3 would require considerable mobilization of equipment and people. While these efforts might temporarily displace typical users of coastal land and infrastructure, these interruptions would not be long lasting. The post-spill, long-term recovery and response efforts during Phase 4 could generate several thousand tons of oil-impacted solid materials disposed in landfills along the Gulf Coast, but this would account for a small percentage of the total daily waste normally accepted in these landfills. Any properties used for response activities throughout Phases 3 and 4 likely would not suffer substantial long-term land use or infrastructure impacts. BOEM expects that potential long-term impacts may be resolved with a formalized effort such as the RESTORE Act, which initiated restoration projects managed by the Gulf Coast Ecosystem Restoration Council after the *Deepwater Horizon* explosion, oil spill, and response.

1.3.1.16.2 Economic Factors

Phase 1—Initial Event

The most immediate economic impacts of a catastrophic spill would be on the oil/gas production and employment associated with the area of the spill. There could also be impacts on commercial fishing (**Chapter 1.3.1.12**), recreational fishing (**Chapter 1.3.1.13**), and recreational resources (**Chapter 1.3.1.14**). However, the primary economic impacts of a catastrophic spill would depend how the spill evolves, which is discussed in subsequent sections.

Phase 2—Offshore Spill

Subsequent to a catastrophic event, some OCS oil- and gas-related activities would likely be suspended. This could impact hundreds of oil-service companies that supply the steel tubing, engineering services, drilling crews, and marine supply boats critical to offshore exploration. An interagency economic report estimated that the suspension arising from the *Deepwater Horizon* explosion, oil spill, and response may have directly and indirectly resulted in up to 8,000-12,000 fewer jobs along the Gulf Coast (USDOC, Economics and Statistics Administration, 2010). Greater New Orleans, Inc. (2012) provides an overview of the impacts of decreased oil and gas industry operations subsequent to the *Deepwater Horizon* explosion, oil spill, and response. This report provides survey evidence regarding the various economic strains felt by businesses in Louisiana due to the *Deepwater Horizon* explosion, oil spill, and response. For example, this report found that 41 percent of the respondents were not making a profit due to the slowdown in operations. Small businesses would be particularly vulnerable due to their difficulty in finding substitute revenue sources. Much of the employment loss would be concentrated in coastal oil-service parishes in Louisiana (i.e., St. Mary, Terrebonne, Lafourche, Iberia, and Plaquemines Parishes) and counties/parishes where drilling-related employment is most concentrated (i.e., Harris County, Texas, in which Houston is located, and Lafayette Parish, Louisiana). There could also be impacts in other Gulf counties/parishes that are home to OCS oil- and gas-related activities, as well as in counties that contain industries further down the supply chain from direct OCS oil- and gas-related activities. There could also be economic impacts due to the impacts on commercial fishing (**Chapter 1.3.1.12**), recreational fishing (**Chapter 1.3.1.13**), and recreational resources (**Chapter 1.2.1.14**).

Phase 3—Onshore Contact

By the end of a catastrophic spill, a large number of personnel would be expected to have responded to protect the shoreline and wildlife and to cleanup vital coastlines. The degree to which new cleanup jobs offset job losses would vary greatly from county to county (or parish to parish). However, in most cases, cleanup jobs are temporary (and personnel are usually paid less), resulting in consumers in the region having reduced incomes overall and thus, spending less money in the economy (Aversa, 2010). In addition, the economic impacts of relief workers would likely vary by county or parish, causing noticeable positive economic impacts to some counties or parishes while having fairly small positive impacts in other counties or parishes (Murtaugh, 2010). However, the influx of relief workers could also cause some negative impacts if it disrupted some of the normal functioning of economies. In addition, if the spill reaches shore, the impacts to commercial fishing (**Chapter 1.3.1.12**), recreational fishing (**Chapter 1.3.1.13**), and recreational resources (**Chapter 1.3.1.14**) would likely be greater.

In the unfortunate event of a future disaster, the creation of a large financial claims administration process, similar to the Gulf Coast Claims Facility, would be likely. This administrative body would be responsible for distributing funds made available by the responsible party to parties financially hurt by the disaster. As demonstrated by the actions of Gulf Coast Claims Facility recipients following the *Deepwater Horizon* explosion, oil spill, and response, funds would likely be used by individuals to pay for necessities such as mortgages or groceries, while businesses who receive funds would likely use them to maintain payroll and current payments on equipment. Data on damage claims arising from the *Deepwater Horizon* oil spill can be found on the *Deepwater Horizon* Claims Center's (2015) website.

Phase 4—Post-Spill, Long-Term Recovery and Response

The long-term economic impacts of a catastrophic spill would depend on the speed at which the various industries that depend on damaged resources can recover; refer to **Chapters 1.3.1.12** (commercial fishing), **1.3.1.13** (recreational fishing), and **1.3.1.14** (recreational resources) for discussions of these industries. The recovery speeds of many industries would depend on the effectiveness of the financial mitigation and damage restoration activities subsequent to the event. The U.S. Department of Justice (2016) provides information regarding the *Deepwater Horizon* damage settlement, and the Deepwater Horizon Natural Resource Damage Assessment Trustees (2016) provide information regarding the corresponding restoration plan. The long-term recovery of the oil and gas industry would depend on the market changes that occur due (directly or indirectly) to the spill. For example, regulatory changes may occur, and oil and gas market participants may adjust their practices. However, in examining the impacts of prior spills, it is difficult to disentangle the impacts of these spills from the numerous external factors that affect the energy market. For example, oil and gas drilling in the Gulf of Mexico declined from mid-2014 through 2016 (Baker Hughes Incorporated, 2021), but this was primarily driven by declines in energy prices.

Austin et al. (2014a and 2014b) is a 2-volume study of the social impacts of the *Deepwater Horizon* explosion, oil spill, and response. This study employed an ethnographic methodology that entailed analyzing data sources, examining various sources of descriptive information, and conducting field interviews with people in Louisiana, Mississippi, and Alabama. This study documents the complex and varied impacts of the *Deepwater Horizon* explosion, oil spill, and response during the 20 months subsequent to the spill. This study found that the impacts of the spill on a particular community depended on a number of factors, such as its proximity to the spill, economic structure, social and political dynamics, organizational structure for dealing with disasters, and ability to adapt to the structures of the oil cleanup and damage claims processes.

Overall Summary and Conclusion (Phases 1-4)

The most immediate (Phase 1) impacts of a catastrophic oil spill would be on oil and gas production and employment associated with the area of the spill. While the spill is offshore (Phase 2), the spill could affect the offshore oil and gas industry, as well as industries that depend on offshore resources, such as fishing and recreation. If the spill were to reach shore (Phase 3), there would be more notable impacts due to cleanup operations and damage claims. The long-term (Phase 4) economic impacts of a catastrophic spill would depend on the speed at which the oil and gas, commercial fishing, recreational fishing, and recreational industries recover.

1.3.1.16.3 Social Factors (Including Environmental Justice)

This chapter focuses on the impacts to people and communities within the 133 counties/parishes that comprise the 23 BOEM-identified Economic Impact Areas in the five Gulf Coast States, i.e., Texas, Louisiana, Mississippi, Alabama, and Florida. This also involves consideration of the impacts to minority and low-income populations, short-term impacts to employment and income levels, possible demographic shifts, and the short-term and potential long-term health impacts of a catastrophic spill event. For a more detailed discussion of specific topics closely related to this analysis, refer to the discussions of commercial fishing (**Chapter 1.3.1.12**), recreational fishing (**Chapter 1.3.1.13**), recreational resources (including tourism) (**Chapter 1.3.1.14**), land use/coastal infrastructure (**Chapter 1.3.1.16.1**), and economic factors (**Chapter 1.3.1.16.2**).

Phase 1—Initial Event

During the initial event, described in **Chapter 1.2.1** as a catastrophic blowout incident with explosion and fire, direct impacts to social factors (people and communities) would be limited to those persons in the immediate vicinity, whether on site at the time of the accident or part of the emergency responder teams. The blowout may occur at the sea surface, along the riser, at the seafloor, or below the seafloor (**Table 1-1**), and in shallow or deep water. During this initial phase, there would be no adverse population impacts to low-income and minority populations because the event would occur at a great distance away (>3 nmi; 3.5 mi; 5.6 km from shore) and because the initial blowout, explosion, and fire would be of short duration. Potential health impacts may occur to first responders and persons present on site, including those of low-income or minority status, though the severity and duration of those health impacts would depend on the nature of the injuries and would occur within the context of the standard safety precautions and procedures for handling such emergencies.

Phase 2—Offshore Spill

The demarcation between Phases 2 and 3 for this analysis is largely obscured because the impacts begun in Phase 2 continue into Phase 3. The social, demographic, economic, and environmental justice impacts would not begin or end as oil reaches the shoreline; the impacts are associated with all phases of response and cleanup. Beginning in Phase 2, social factor impacts would involve the number and types of responders, their housing and support, various response vessels and aircraft, waste disposal protocols and procedures, fishery closures, cancellations of nonessential visits from outsiders including tourists, and possible moratoria or suspension of OCS oil- and gas-related activities in the region.

The offshore phase of a catastrophic spill event would lead to immediate mobilization and organization of people and equipment under the implementation of Area Contingency Plans and would be coordinated by a combination of Federal agencies in conjunction with State and local agencies and the responsible party. After the initial event, and depending on the location (shallow or deep water), responders, vessels, and aircraft would be activated for cleanup (e.g., *in-situ* burning, dispersant application, oil skimming, boom deployment, etc.) in an effort to prevent the spill from reaching shore (Ramseur, 2010). Refer to **Chapter 1.2.2.7** for a detailed discussion of offshore cleanup activities.

Onshore, responders would move into the area, thus providing a temporary boost to local communities by paying for housing, food, and other general services, partially offsetting losses from tourist cancellations and fishing closures. There would also be a negative component to this impact as increased population numbers may strain public municipal services (i.e., water, sewer, and roads) and create a shortage of available hotel/housing accommodations, potentially increasing housing prices, which would cause disproportionate impacts on low-income residents (Austin et al., 2014a). The extent of this economic and demographic influx would depend on the location, size, and duration of the spill event and cleanup effort, and may be limited to areas near where spill responders embark and disembark to go offshore. Disposal of wastes such as used boom materials would be directed and regulated by the USEPA, in coordination with State environmental agencies, most likely with specific directives being issued as was done for the *Deepwater Horizon* explosion, oil spill, and response (USEPA, 2010c and 2010d).

During Phase 2, BOEM anticipates commercial and recreational fishery closures by Federal and State agencies and, depending on the size and location of the spill, closures could affect large areas of the Gulf, potentially causing substantial reductions in landings (USDOC, NOAA, 2010e; Upton, 2011). These closures also may cause disproportionate negative impacts to minority and low-income fishers because of their regular use of offshore and coastal natural resources, thus making them more vulnerable to fishery closures (Hemmerling and Colten, 2003). Phase 2 impacts would not only affect offshore commercial, subsistence, and recreational fishing but also near-to-shore oyster farming and harvesting because authorities would likely open freshwater diversions to help prevent oil intrusion into marshes and wetlands, as was done post-*Deepwater Horizon*. High freshwater influx would severely and negatively impact oyster beds, leading to large-scale die-off. This, in turn, could cause disproportionate negative impacts to minority oyster fishers in places such as lower Plaquemines Parish, Louisiana, where the African-American communities of Phoenix, Davant, and Point à la Hache are home to families with some of the few remaining minority-owned oyster leases in Louisiana. In addition to directly impacting commercial fishermen and oystermen, these closures would indirectly impact shrimp and fish processing facilities and oyster shucking houses, which have historically employed mainly minority populations (Austin et al., 2014a and 2014b; Colton et al., 2012; Mock, 2010; Ravitz, 2010). Depending on how, when, and if short-term assistance were to be provided to injured parties, these impacts may be mitigated or compounded.

It is anticipated that other industries would experience slowdowns or closures, the extent of which would depend on their connection to OCS oil- and gas- or ocean-related activities, as well as the location and timing of the spill. For example, following the *Deepwater Horizon* oil spill, the tourist industry in the coastal Gulf of Mexico region suffered lost business; fears of environmental contamination, coupled with fishing and beach closures, drove away tourists at the height of the summer season (Austin et al., 2014b). The time for tourism recovery would likely depend on the length of cleanup and the level of real or perceived impact to resources or areas accessed by tourists. Refer to **Chapter 1.3.1.14** for a detailed discussion of tourism and recreational resources. In the case of suspension or moratorium of OCS oil- and gas-related activities, industries servicing offshore oil and gas drilling would see a slowdown, which would lead to some workers being laid off, cut to part-time work, or transferred. For example, during the *Deepwater Horizon* explosion, oil spill, and response, many skilled drilling workers were transferred out of the Gulf of Mexico region to work in onshore oil and gas activities (Austin et al., 2014b). Some tourist and oil services businesses would be able to mitigate their losses, and those of their employees, by serving responders or working for the spill response. However, these opportunities would not be equally available. They would privilege service providers close to the debarkation or cleanup sites and vendors who have the capacity to respond quickly to requests for bids and contracts, requirements which may disadvantage small businesses.

Phase 3—Onshore Contact

Phase 3 would see a continuation of the impacts described in Phase 2, with the addition of large-scale deployment of onshore cleanup workers, the increased opportunity for short-term health impacts as more people are exposed to oil that is washed ashore, air quality issues associated with the presence of oil, the likely contamination of coastal areas widely used for subsistence activities, and onshore disposal of waste. The extent of these impacts would be defined and limited by the location and scale of the oil-spill event.

A spill of national significance, such as the *Deepwater Horizon* oil spill, would likely contaminate several hundred miles of coastal habitat and involve tens of thousands of cleanup workers, likely including a high number of local residents and low-income and minority persons (Osofsky et al., 2012; Austin et al., 2014a). For some, this could offset losses from slowdowns or shutdowns in tourism, fishing, and OCS oil- and gas-related activities. People might also move into the area looking for work in the cleanup, increasing competition for residents (Austin et al., 2014a and 2014b). Federal regulations require the wearing of protective gear, and only a small percentage of cleanup workers would be expected to suffer immediate illness and injuries (King and Gibbons, 2011; Middlebrook et al., 2011), but those short-term injuries could be severe. Aguilera et al. (2010) compiled and reviewed existing studies on the repercussions of spilled oil exposure on human health for patterns of health effects and found evidence of a relationship between exposure and "acute physical, psychological, genotoxic, and endocrine effects in the exposed individuals." Acute symptoms from exposure to oil, dispersants, and degreasers include headaches, nausea, vomiting, diarrhea, sore eyes, runny nose, sore throat, cough, nose bleeds, rash, blisters, shortness of breath, and dizziness (Sathiakumar, 2010). Research on the health of cleanup workers following the *Deepwater Horizon* oil spill, however, found health impacts to be more prevalent than in previous studies (D'Andrea and Reddy, 2013). The cleanup workers would also be expected to experience stress and negative psychosocial impacts, as would their spouses and families (King and Gibbons, 2011; Rung and Oral, 2015).

Coastal residents may also suffer acute health impacts similar to those discussed above for cleanup workers, depending on exposure. Research on children in impacted areas found elevated levels of skin, breathing, and mental health problems after the spill, particularly among children with physical or environmental exposure to oil or whose families experienced loss of income or jobs following the spill (Abramson et al., 2010). Findings on the impact of eating seafood from an impacted area vary. After the *Deepwater Horizon* oil spill, extensive seafood testing for PAHs and dispersant compounds established that levels were within the risk assessment protocol established by the

U.S. Food and Drug Administration, NOAA, and the Gulf Coast States (Kang et al., 2012; Dickey, 2012). However, there has been some dispute within the scientific community over the validity of the risk assessment protocol used and concern that the protocol may have underestimated the risk from seafood contaminants among high-volume consumers of seafood, such as many Gulf Coast residents, and vulnerable populations, such as pregnant women and children (Rotkin-Ellman et al., 2012; Rotkin-Ellman and Soloman, 2012; Gohlke et al., 2011). Gulf Coast minority and low-income groups would be particularly vulnerable to the coastal impacts resulting in Phase 3 because of their greater than average dependence on natural resources for traditional subsistence fishing, hunting, trapping, and gathering activities to augment their diets and household incomes (Hemmerling and Colten, 2003). Fisheries closures may have reduced the potential of oil and dispersant exposure by limiting access to subsistence foods, especially since fisheries were not reopened until testing indicated that the waters were safe for fishing.

Mental health impacts would be widespread, as reflected in more reported cases of depression, anxiety, and post-traumatic stress syndrome, among other forms of mental distress, as people try to deal with the enormity of the impact to their way of life (Austin et al., 2014a and 2014b; Goldstein et al., 2011; National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Following the *Deepwater Horizon* oil spill, negative mental health impacts were found to increase with an individual's level of physical or economic exposure to the spill regardless of whether or not they lived in a community that received oil on its shores (Abramson et al., 2013; Blackmon et al., 2016; Fan et al., 2015; Grattan et al., 2011; Rung et al 2016). Studies have also found mental health distress to last longer than previously proposed and, for some populations, to increase over time (Cope et al., 2013; Hansel et al., 2016; Varner et al., 2016). These findings are in contrast to early epidemiological studies of the entire Gulf of Mexico region following the *Deepwater Horizon* oil spill, which found no or minimal changes to mental health (Substance Abuse and Mental Health Services Administration, 2013; Gould et al., 2015). A subsequent review of the large-scale epidemiological and small-scale studies explained this difference as underreporting on the part of the epidemiological studies due to the inability of large-scale studies to track changes within subpopulations and of these studies, in particular, to determine changes in the severity of mental health symptoms (Teich and Pemberton, 2015).

Phase 4—Post-Spill, Long-Term Recovery and Response

The impacts of Phase 4 for people and communities would be a continuation of all the impacts discussed in Phases 2 and 3 but with a longer temporal component and greater uncertainty because catastrophic spill events are very rare and because the long-term impacts would depend greatly on the location, duration, and magnitude of the particular event. Also, variation among and between those factors would most likely produce different results, except perhaps in regard to mental health. Catastrophic spill events understandably and consistently produce negative mental health impacts to people and communities, though mental health impacts are often overlooked or minimized (Goldstein et al., 2011; National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011; Austin et al., 2014b).

Phase 4 would see a very long-term recovery phase with some things taking longer than others to return to pre-spill conditions. While OCS oil- and gas-related activities would recover and regain pre-spill levels within a year or so, damaged marshes and oyster beds that provided valuable habitat for subsistence harvesting would not recover quickly and, in some cases, not at all. Many people who moved into the area to help in the response and cleanup would move back to their homes outside of the region and cause a reduction in economic demand, but this would hopefully be offset by the return of those who left to pursue oil and gas work elsewhere (Austin et al., 2014a and 2014b). Depending on how legal claims against the responsible party were administered, it is likely that low-income and minority residents and small businesses without the ability to handle complex legal proceedings would be at a disadvantage, as occurred after the *Deepwater Horizon* oil spill, and perceived or real discrepancies in the calculation of loss could lead to social conflict among residents and a loss of trust (Austin et al., 2014b).

Research has shown that past oil-spill workers, especially uninformed and poorly informed workers, were at more risk of exposure and symptoms, demonstrating the importance of education and proper training of workers (Sathiakumar, 2010). Additionally, for all populations, exposure could have long-term health impacts (e.g., increased rates of some types of cancer, respiratory and central nervous system problems, and mental health distress) (Savitz and Engel, 2010; Kirkeleit et al., 2008; Peres et al., 2016). In the case of the *Deepwater Horizon* explosion, oil spill, and response, the USEPA's monitoring data have not shown that the use of dispersants resulted in a presence of chemicals that surpassed human health benchmarks (Trapido, 2010). Studies have identified potential long-term negative impacts on lung health from exposure to airborne particles of oil and dispersants (Liu et al., 2016; Majora et al., 2016). Children in the affected areas were found to suffer from physical and mental health distress for as long as 2 years after the *Deepwater Horizon* oil spill (Abramson et al., 2013). Following the *Deepwater Horizon* explosion, oil spill, and response, the National Institute of Environmental Health Sciences is conducting a study known as the "Gulf Long-Term Follow-Up Study" (GuLF STUDY) that should provide a better understanding of the long-term and cumulative health impacts, such as the consequences of working close to a spill and of consuming contaminated seafood. The GuLF STUDY is monitoring oil-spill cleanup workers for 10 years and represents a national effort to determine if the *Deepwater Horizon* explosion, oil spill, and response led to physical or mental health problems. In October of 2013, results from Phase 1 of the GuLF STUDY showed that workers who participated in cleanup activities where 30 percent more likely to suffer from depression than people who were not cleanup workers (U.S. Dept. of Health and Human Services, National Institute of Environmental Health Sciences, 2013 and 2014). If, as was the case in the *Deepwater Horizon* explosion, oil spill, and response, a high percentage of the cleanup workforce consists of minority and low-income workers, these populations may suffer long-term disproportionate impacts from a catastrophic oil-spill, raising environmental justice concerns (Sandler et al., 2014; Osofsky et al., 2012; Austin et al., 2014a).

During Phase 4, environmental justice concerns may arise due to the likely disposal of cleanup-related wastes near minority and/or low-income communities (Schleifstein, 2010) and decisions surrounding coastal restoration. A catastrophic spill in the Gulf of Mexico could generate several thousand tons of oil-soaked solid materials that would be disposed in landfills along the Gulf

Coast. Though construction of new landfills would not be expected, existing environmental justice issues may be exacerbated because many landfills in the Gulf of Mexico region are located near minority and low-income populations (Bullard, 2010; Kubendran, 2011; Osofsky et al., 2012). Depending on the processes put in place following a catastrophic oil spill to develop, select, and administer restoration projects, it is possible that the needs and desires of low-income and minority populations may not be taken into account, potentially creating additional environmental justice impacts.

Overall Summary and Conclusion (Phases 1-4)

During Phase 1, direct impacts to social factors (people and communities) would be limited to those persons in the immediate vicinity of the event, whether on site at the time of the accident or serving as part of the emergency responder teams. Potential health impacts may occur though the severity and duration of those health impacts would depend on the nature of the injuries and would occur within the context of standard safety precautions and procedures for handling such emergencies.

Social factor impacts in Phase 2 would include both offshore and onshore impacts. The impacts would involve the number and types of responders, their housing and support, various kinds of response vessels and aircraft, waste disposal protocols and procedures, fishery closures, and possible moratoria or suspension of OCS oil- and gas-related activities in the region leading to the relocation of some workers who are either being laid off, transferred, or cut to part-time work. Fishery closures and damage to oyster beds from freshwater diversions may cause disproportionate negative impacts to minority and low-income fishers because their regular use of offshore and coastal natural resources.

For Phase 3, the social, demographic, economic, and environmental justice impacts would not begin or end at the shoreline. The primary differences between Phases 2 and 3 would include large-scale deployment of onshore cleanup workers and increased opportunity for short-term health impacts as more people are exposed to oil that is washed ashore, problems associated with waste disposal, air quality issues, and the likely contamination of coastal areas widely used for subsistence activities.

Phase 4 would see a long-term recovery phase with some things taking longer than others to potentially return to pre-spill conditions. While OCS oil- and gas-related activities would recover eventually, damaged marshes and oyster beds that provided valuable habitat for subsistence harvesting would not recover very quickly and, in some cases, not at all. Potential long-term health impacts are not well-understood, though long-term health impact studies are underway for the *Deepwater Horizon* explosion, oil spill, and response and eventually a greater understanding would be accomplished.

The extent of impacts from all four phases would be defined by the magnitude, duration, and location of the oil-spill event. Depending on a number of mainly geographic variables such as the location of fisheries closures and oyster bed contamination and closures, the demographic composition of cleanup workers, and selection of waste disposal facilities and restoration projects, a catastrophic oil-spill event may have disproportionate effects on minority and low-income populations.

2 CATASTROPHIC SPILL EVENT ANALYSIS: BOEM-OSRA CATASTROPHIC RUN

A special Oil Spill Risk Analysis (OSRA) run was conducted in order to estimate the impacts of a possible future catastrophic or high-volume, extended-duration oil spill resulting from a loss of well control. Thus, assuming a hypothetical high-volume, long-duration oil spill occurred, this analysis emphasized modeling a spill that continued for 90 consecutive days, with each trajectory tracked for up to 60 days. The analysis was conducted for only the trajectories of oil spills from seven hypothetical spill locations to various onshore and offshore areas. The probability of an oil spill contacting a specific area within a given time of travel from a certain location or spill point is termed a conditional probability; the condition being that a spill is assumed to have occurred. Each trajectory was allowed to continue for as long as 60 days. However, if the hypothetical spill contacted shoreline sooner than 30 days after the start of the spill, the spill trajectory was terminated, and the contact was recorded. Although overall OSRA is designed for use as a risk-based assessment, for this analysis, only the conditional probability, the probability of contact to coastal and offshore areas, was calculated. The probability of a catastrophic spill occurring was not calculated; thus, the combination of the probability of a spill and the probability of contact from the hypothetical spill locations were not performed. Results from this trajectory analysis provide input to the final product by estimating where spills might travel on the ocean's surface and what geographic areas might be contacted if and when another catastrophic spill occurs, but the results do not provide input on the probability of another catastrophic spill occurring.

2.1 CATASTROPHIC OSRA RUN METHODS

The OSRA model, originally developed by Smith et al. (1982) and enhanced by Ji et al. (2002, 2004a, 2004b, and 2011), is used to predict the possible route, or trajectory, an oil spill might move on the ocean surface. The model calculates the movement of a hypothetical spill by successively integrating time sequences of two spatially gridded input fields, i.e., surface ocean currents and sea-level winds. Thus, the OSRA model generates time sequences of hypothetical oil-spill locations i.e., essentially, oil-spill trajectories. The trajectories are determined by the model-simulated surface ocean currents exerting a shear force on the spilled oil from below and the prevailing winds exerting an additional shear force on the spill from above. The combination of the two forces causes the movement of the oil away from its initial spill location. In the OSRA model, the velocity of a hypothetical oil spill is the linear superposition of the surface ocean current and the wind drift caused by the winds.

In the trajectory simulation portion of the OSRA model, many hypothetical oil-spill trajectories are produced by numerically integrating a temporally and spatially varying ocean current field and an empirical wind-induced drift (Samuels et al., 1982). Collectively, the trajectories represent a statistical ensemble of simulated oil-spill displacements produced by a field of numerically derived winds and ocean currents. Detailed information on ocean currents and wind fields is needed when conducting an oil-spill risk analysis (Ji, 2004). The ocean currents used are numerically computed from an ocean circulation model of the GOM driven by analyzed meteorological forces (the near-surface winds and the total heat fluxes) and observed river inflow into the Gulf of Mexico (Oey, 2005 and 2008). The ocean model calculation was performed by Princeton University (Oey, 2005 and 2008). This simulation covered the 14-year period from 1993 through 2006, and the results were collected at

3-hour intervals. This run included the assimilation of sea-surface altimeter observations to improve the ocean model results. The surface currents were then computed for input into the OSRA model, along with the concurrent wind field. The OSRA model used the same wind field to calculate the empirical wind drift of the simulated spills.

In addition to the trajectory analysis, the OSRA model tabulates contacts to specified geographic areas by the simulated oil spills. At each successive time step, the OSRA model compares the location of the hypothetical spill against the geographic boundaries of onshore and offshore areas. The frequencies of oil-spill contact are computed for designated oil-spill travel times (i.e., 3, 10, 30, or 60 days) by dividing the total number of oil-spill contacts by the total number of hypothetical spills initiated in the model from a given hypothetical spill location. The frequencies of oil-spill contact are the model-estimated probabilities of oil-spill contact. The OSRA model output provides the estimated probabilities of contact from seven launch points (LPs) (**Figure 2-1**). A contact to shore would stop the trajectory of an oil spill; no re-washing is assumed to occur. After each of the specified periods of time, the OSRA model would divide the total number of contacts to the specified areas by the total number of simulated oil spills from each of the LPs. These ratios are the estimated probabilities of oil-spill contact from OCS oil- and gas-related activities at that geographic location, assuming spill occurrence. The winds and currents are assumed to be statistically similar to those that would occur in the GOM during future offshore activities. In other words, the oil-spill risk analysts assume that the frequency of strong wind events in the wind field is the same as what would occur during future offshore activities. By inference, the frequencies of contact by the simulated oil spills are the same as what could occur from actual oil spills during future offshore activities.

The trajectories simulated by the OSRA model represent only hypothetical pathways of oil slicks; they do not involve any direct consideration of response activities, dispersion, or weathering processes that could alter the quantity or composition of oil. However, an implicit analysis of weathering and spill degradation can be considered by choosing a travel time for the simulated oil spills that represent the likely persistence of the oil slick on the water surface. Oil-spill runs with weathering were performed using the Spill Impact Model System (SIMAP) software (Applied Science Associates, Inc., 2012) in order to determine a reasonable length of time for simulating the trajectories for the catastrophic OSRA runs. Based on the SIMAP spill scenario runs, 60 days was chosen as the longest spill travel time for the catastrophic OSRA runs. For each scenario run, SIMAP was used to simulate surface oil trajectories from input current and wind fields and weathering processes, including evaporation, dispersion, dissolution, and natural degradation. To compute the weathering assumption for the catastrophic OSRA run, 12 different scenarios were performed (1 in each season from 1993 through 1995), using a spill size of 60,000 bbl, a spill duration of 24 hours, and a South Louisiana Crude (light) oil. Based on these runs, a conservative estimate of 60 days was chosen as the length of time that oil would likely persist floating on the surface following a catastrophic spill. For comparison, 19 days was the calculated persistence time of *Deepwater Horizon* oil on the water's surface, and a 30-day catastrophic OSRA run has previously been used to simulate that particular spill event (Ji et al., 2011).

The statistics for the contacts by the trajectories forced by the currents and winds were combined for the average probabilities. Trajectories of hypothetical spills were initiated once per day from each of the launch points over the 14-year simulation period of January 1, 1993, to December 31, 2006. The chosen number of trajectories per site was small enough to be computationally practical and large enough to reduce the random sampling error to an insignificant level. Also, the weather-scale changes in the winds are at least minimally sampled with simulated spills started every day.

The methodology used for launch point selection is not part of the OSRA model in the manner it has been typically run for BOEM's spill analyses. The seven launch point locations were determined based on the approximate areas, with the possibility of finding the largest oil volume within each planning area. The New Orleans Office's geologists and engineers used the following methodology to select launch point locations. BOEM's Office of Resource Evaluation applied their Undiscovered Resource Distribution Methodology to identify a location within the proposed lease sale area where the potential for a large undiscovered oil volume may exist. For each geologic play, the undiscovered technically recoverable resource volume is distributed throughout the play using a statistical allocation process that is based on the likelihood of future oil discovery potential. The probability factors used to allocate undiscovered oil volumes to specific areas within the geologic play is based on the pool density of existing discoveries, the density of undrilled prospects on leased acreage, and the results from recent exploration drilling activity. In areas where the potential for undiscovered technically recoverable resource volume exists for more than one geologic play, the oil volumes are aggregated. Results from the aggregation were used to identify geographic areas of high potential for future oil discoveries in the Gulf of Mexico: three in the CPA; two in the WPA; and two in the EPA. Although these areas may encompass hundreds of square miles, the coordinates for the five launch points in the WPA and CPA were selected qualitatively to correspond with the centroid of these areas. Due to the very limited number of OCS blocks available in the EPA, the statistical analysis described above was supplemented by an area-specific subsurface geological and geophysical data reconnaissance and interpretation in order to identify LP 6. The LP 7 was specifically chosen to estimate the increased effects of the Loop Current on trajectories at the southern extreme of the planning area. The seven LP locations are as follows:

Description	Longitude (DD)	Latitude (DD)	Launch Point (LP)
Central Planning Area (west of Mississippi River)	-92.17851	28.98660	1
Central Planning Area (east of Mississippi River)	-88.15338	29.91388	2
Central Planning Area (slope area)	-90.22203	27.31998	3
Western Planning Area (shelf area)	-96.76627	27.55423	4
Western Planning Area (slope area)	-94.51836	27.51367	5
Eastern Planning Area (based on oil resource potential)	-86.75761	27.95762	6
Eastern Planning Area (southernmost point)	-86.70000	26.90000	7

DD = decimal degrees; LP = launch point.

2.2 CATASTROPHIC OSRA RESULTS

Based on the weathering analyses (described above), OSRA model trajectories were analyzed for up to 60 days, and any spill contacts occurring during this elapsed time are reported in the probability tables (**Tables 2-1 through 2-14**). Conditional probabilities of contact with onshore and offshore areas within 60 days of travel time were calculated for each of the hypothetical spill sites. The probability estimates were tabulated as 90-day groupings for the 60-day trajectories, as averages for the 14 years of the analysis from 1993 to 2006. The groupings were treated as seasonal probabilities that corresponded with quarters of the year: Winter, (January, February, and March), spring (April, May, and June), summer (July, August, and September), and fall (October, November, and December). These 3-month probabilities can be used to estimate the average contact with onshore and offshore areas during a spill, treated as one spill occurring each day for 90 days, within the quarter. The seasonal quarterly groupings take into account the differing meteorological and oceanographic conditions (i.e., wind and current patterns) during the year (**Figures 2-1 through 2-7**). As well, annualized conditional probabilities provide a useful single picture of average probabilities across the entire year from each launch point (**Figures 2-8 through 2-14**).

As one might expect, environmental resources closest to the spill sites typically have the greatest risk of contact. It should be reiterated that these are conditional probabilities; the condition being that a spill is assumed to have occurred. The longer transit times up to 60 days allowed by the model enable hypothetical spills to reach the shoreline from more distant spill locations. With increased travel time, the complex patterns of winds and ocean currents produce eddy-like motions and multiple opportunities for a spill to make contact with shoreline segments. Monthly climatologies of wind stress for the Gulf of Mexico demonstrate that winds are generally out of the east for most of the year (Rhodes et al., 1989). However, predicting spill drift by evaluating wind patterns alone is difficult because of the accompanying effects of surface currents. For example, during the spring, winds shift toward the northwest yet spill trajectory simulations predict increased movement of surface oil toward the eastern Gulf. In addition, the LPs located farther offshore are more heavily influenced by offshore winds and currents, and the LPs in the EPA are more likely to be influenced by the Loop Current. As noted, LP 7 was specifically chosen to estimate the increased effects of the Loop Current on trajectories at the southern extreme of the EPA. It should also be noted that the study area only extends part way into the Atlantic Ocean, where oil spills in the Gulf of Mexico might be transported via the exiting Loop Current.

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5 FIGURES

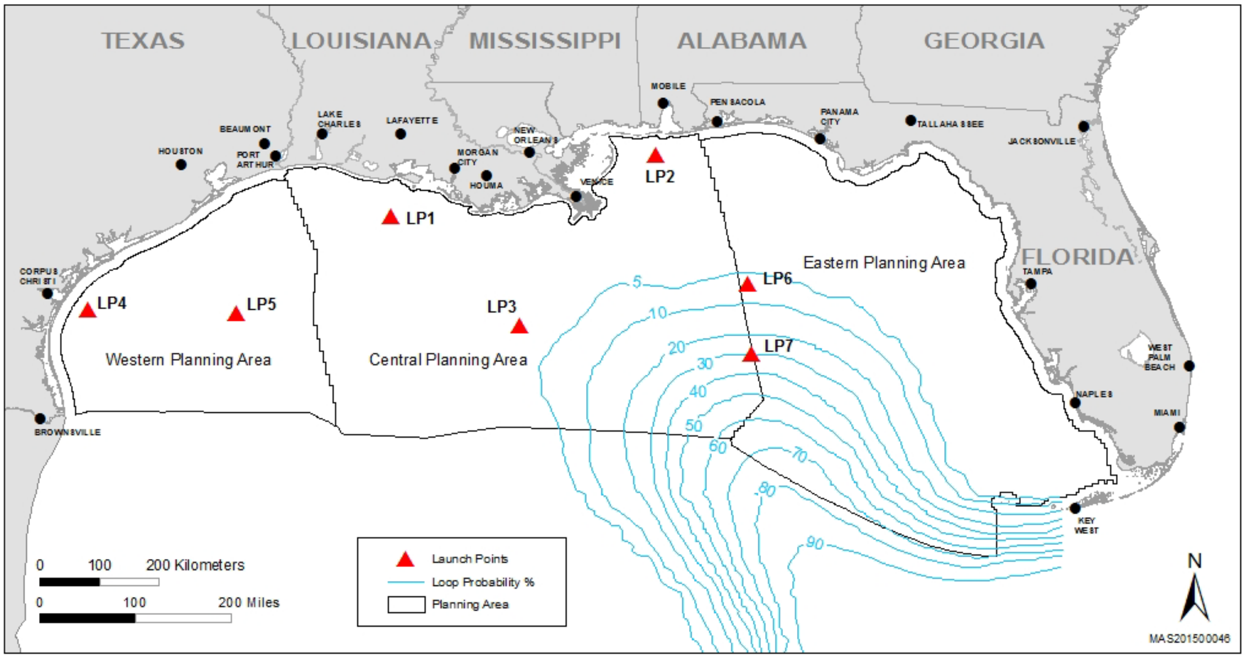

Figure 1-1. Location of Seven Hypothetical Oil-Spill Launch Points for OSRA within the Gulf of Mexico. (Spatial variability of the Loop Current is from Vukovich [2007] and is shown as percent of time that the Loop Current watermass is associated with a particular location.)

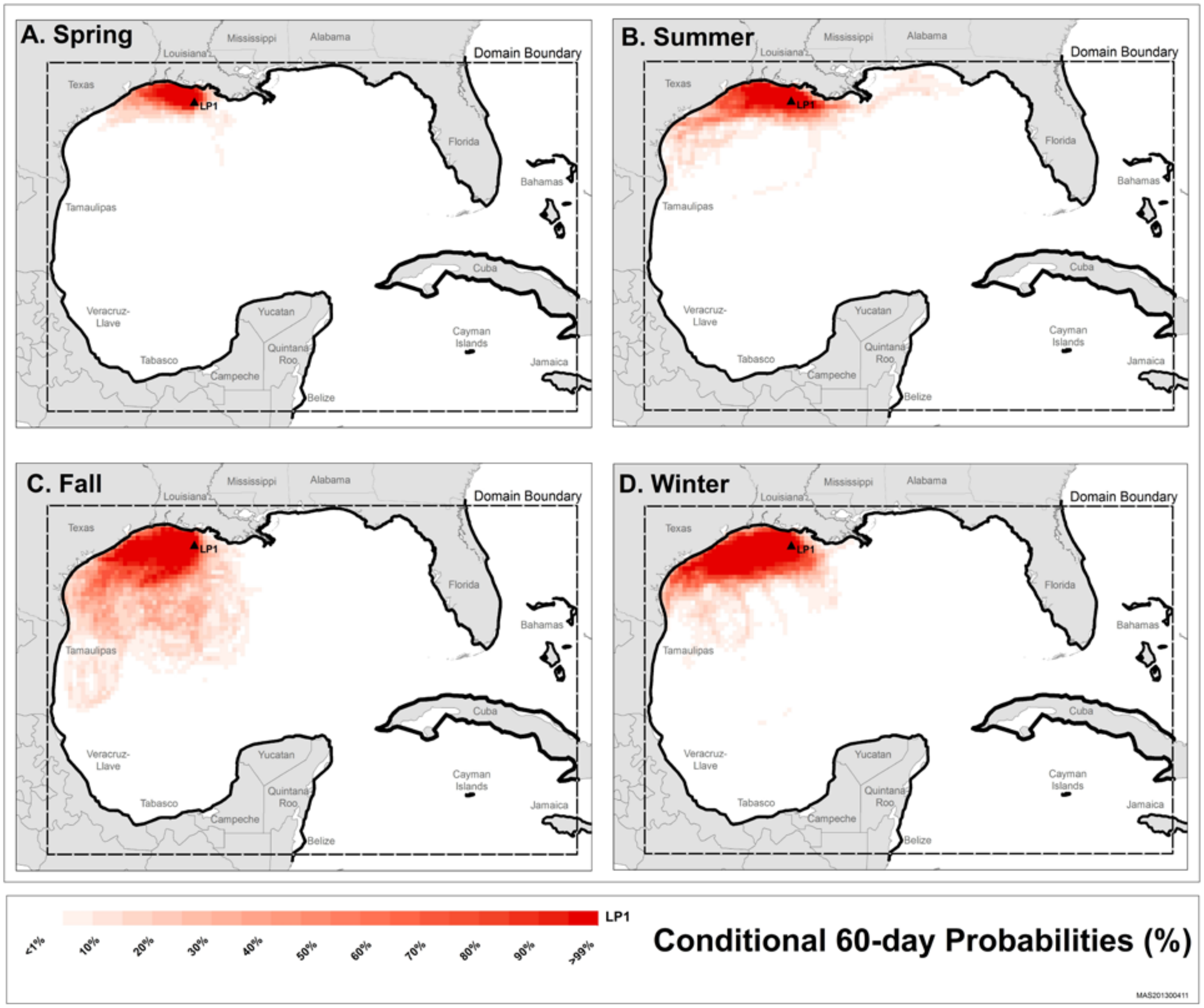

Figure 2-1. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point One with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

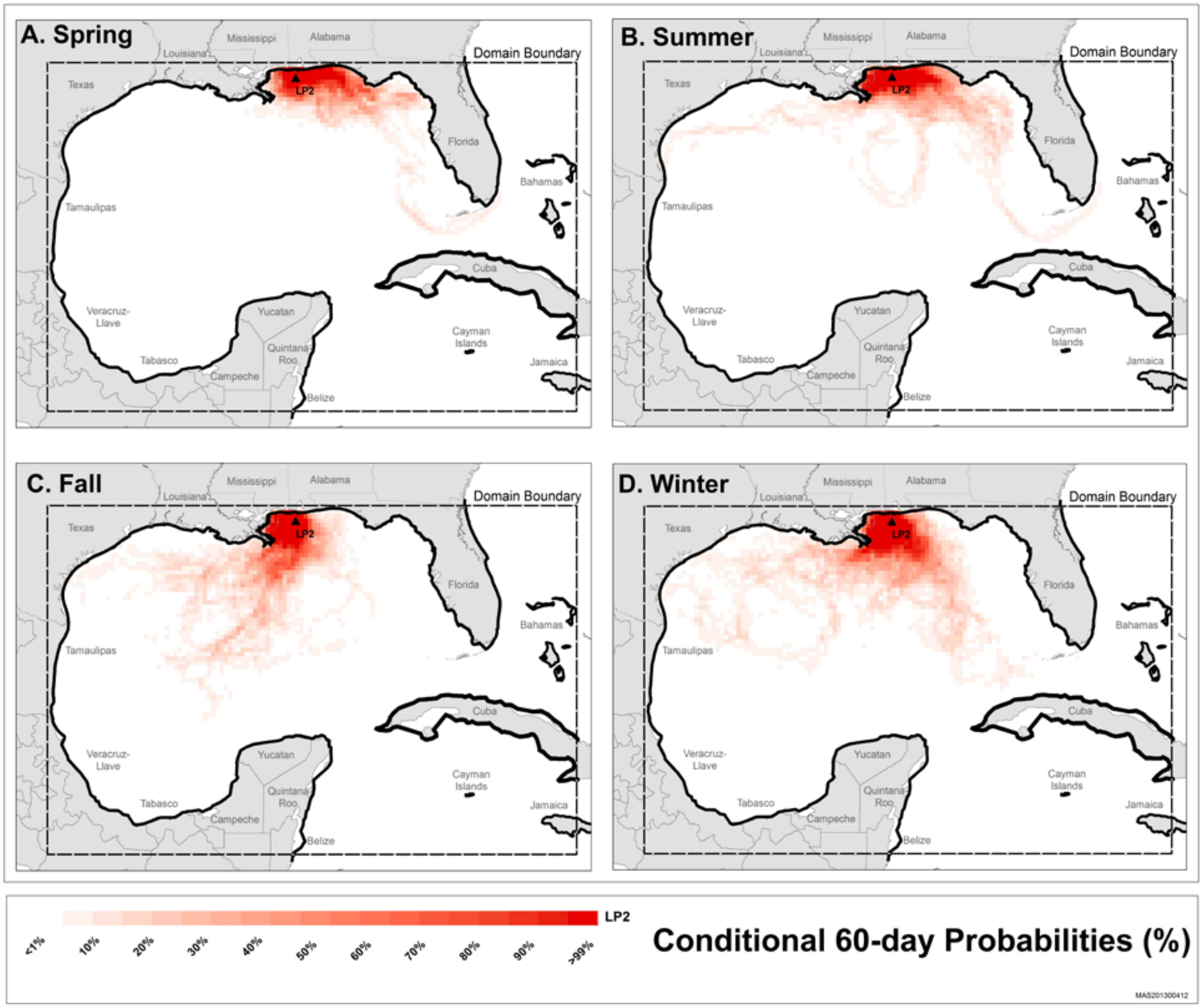

Figure 2-2. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Two with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

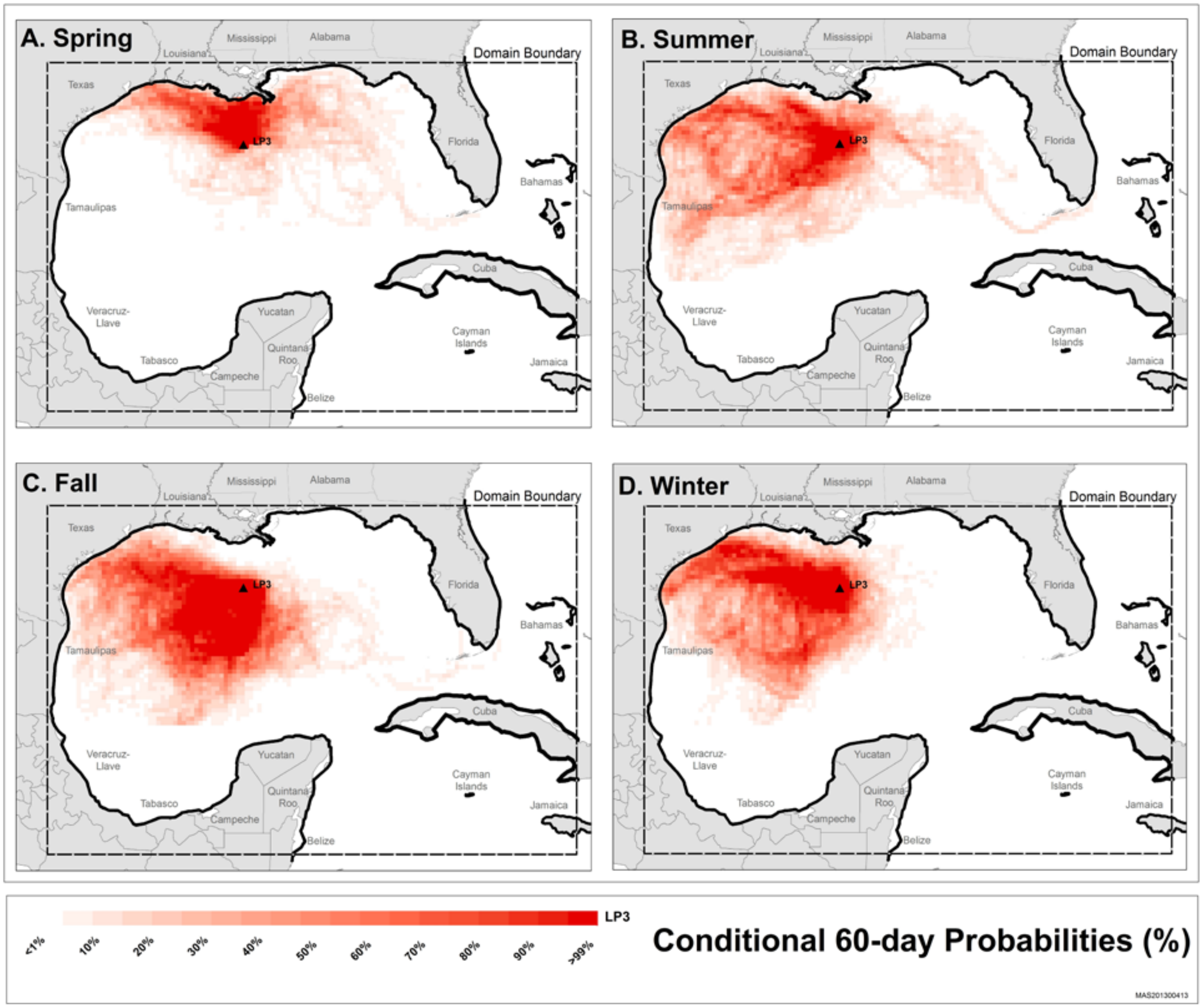

Figure 2-3. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Three with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

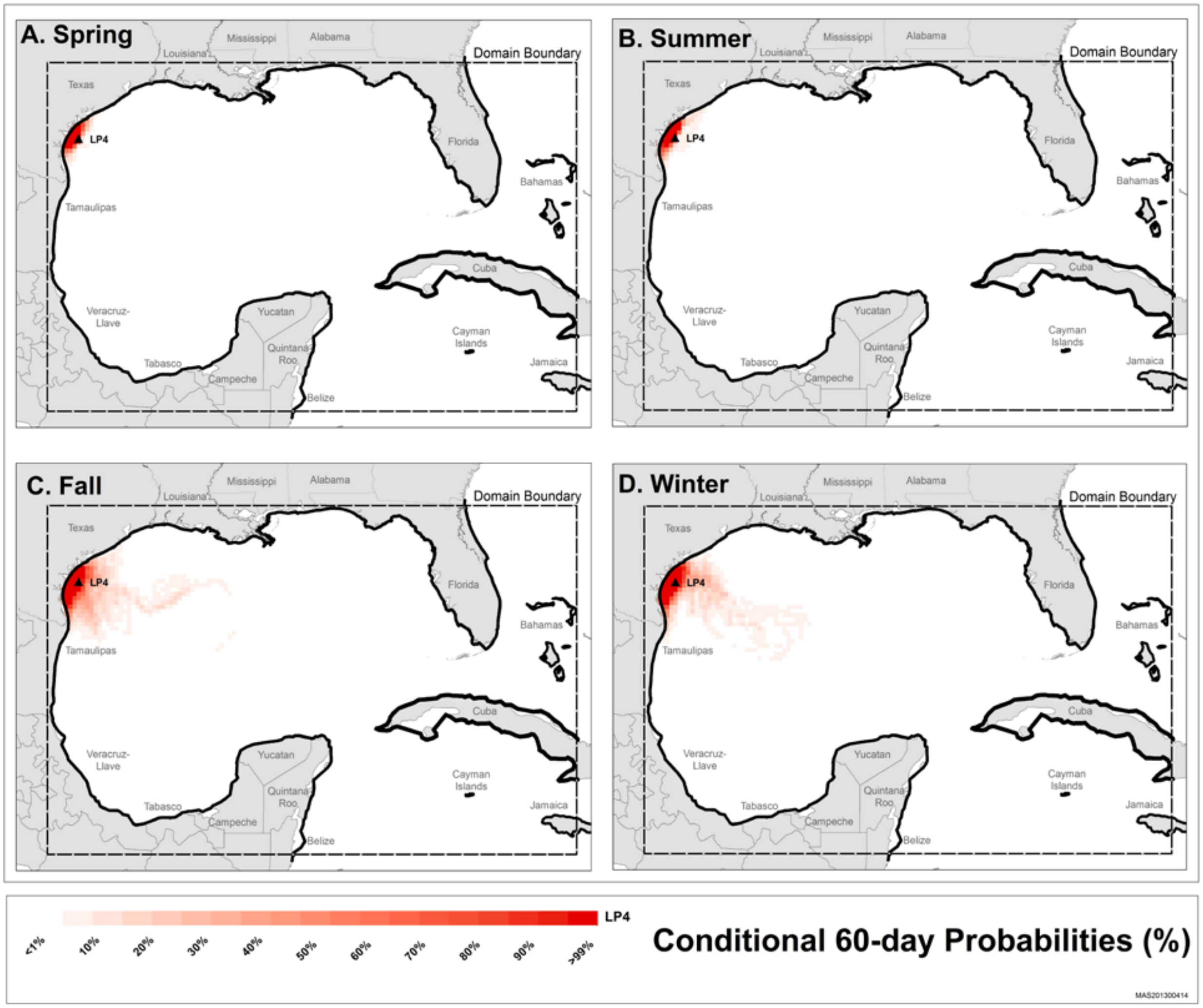

Figure 2-4. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Four with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

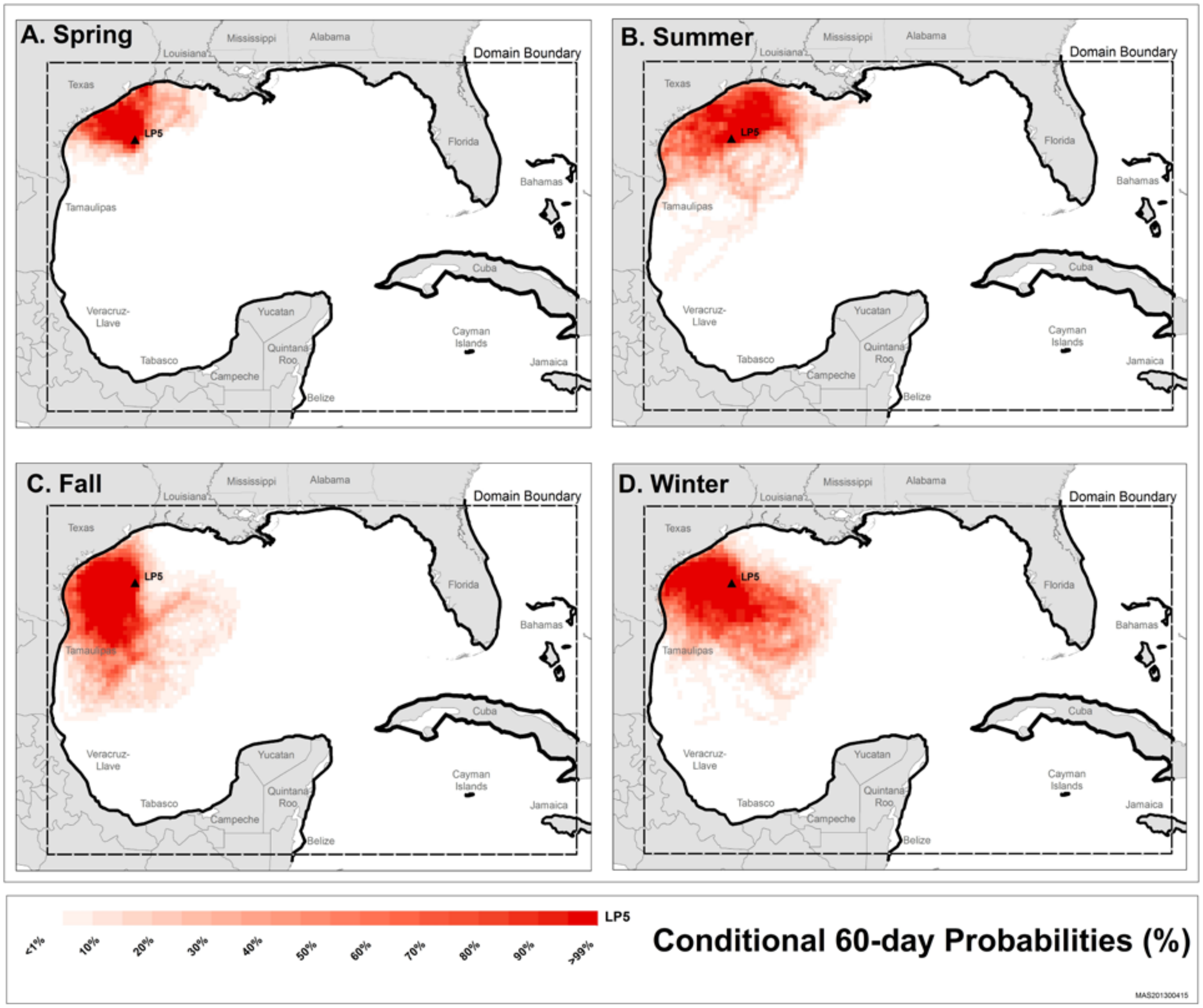

Figure 2-5. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Five with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

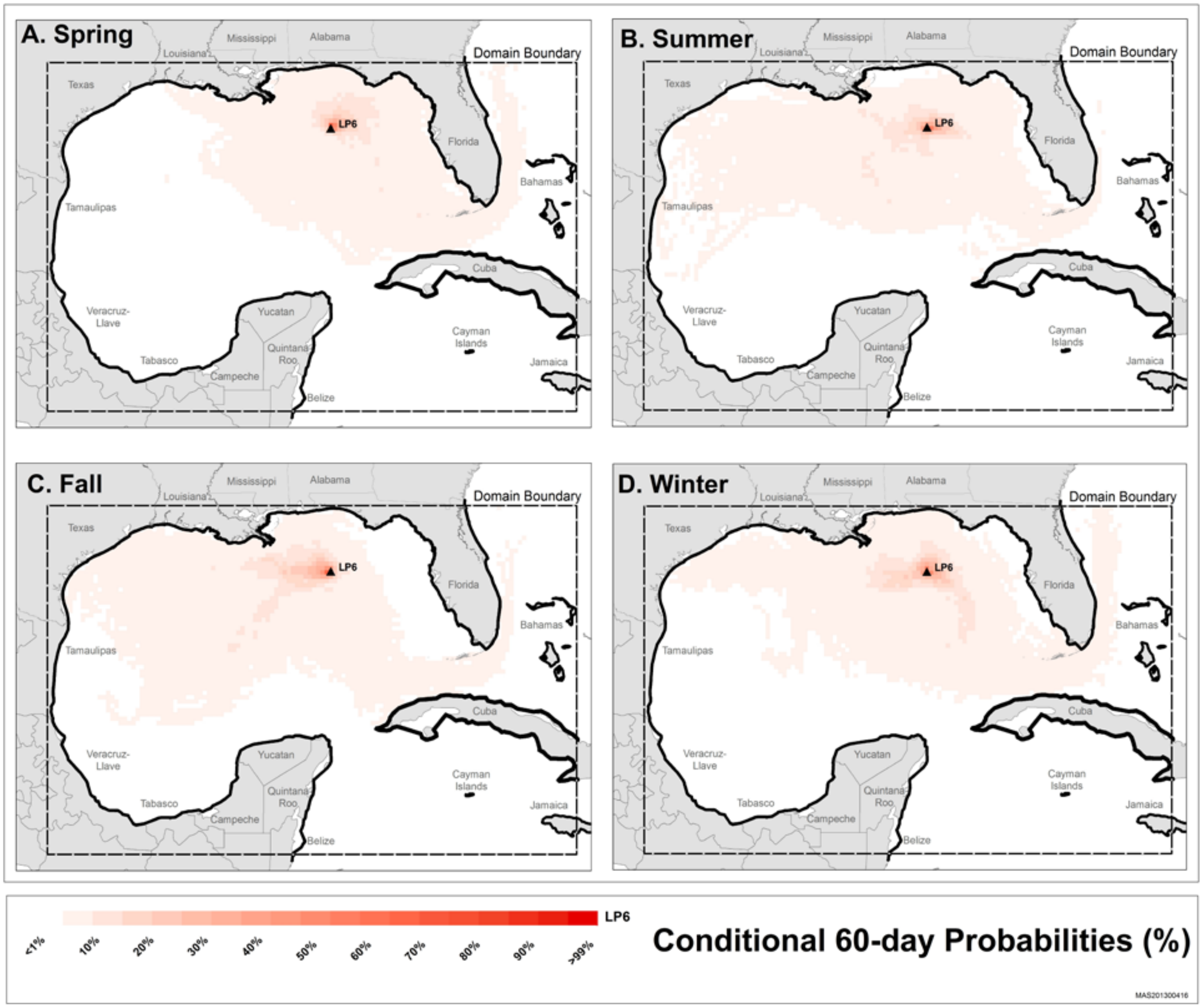

Figure 2-6. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Six with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

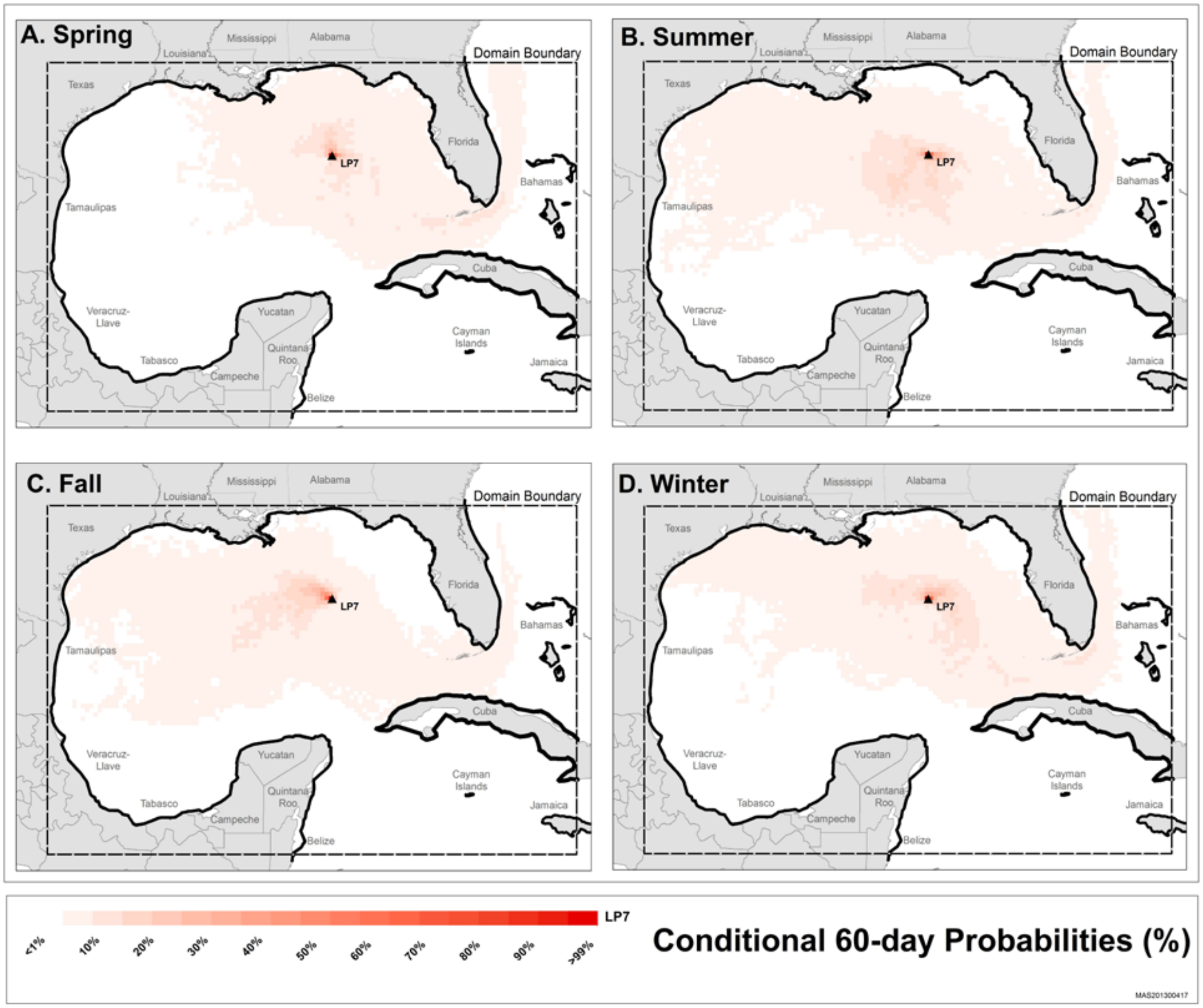

Figure 2-7. Seasonal Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Seven with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

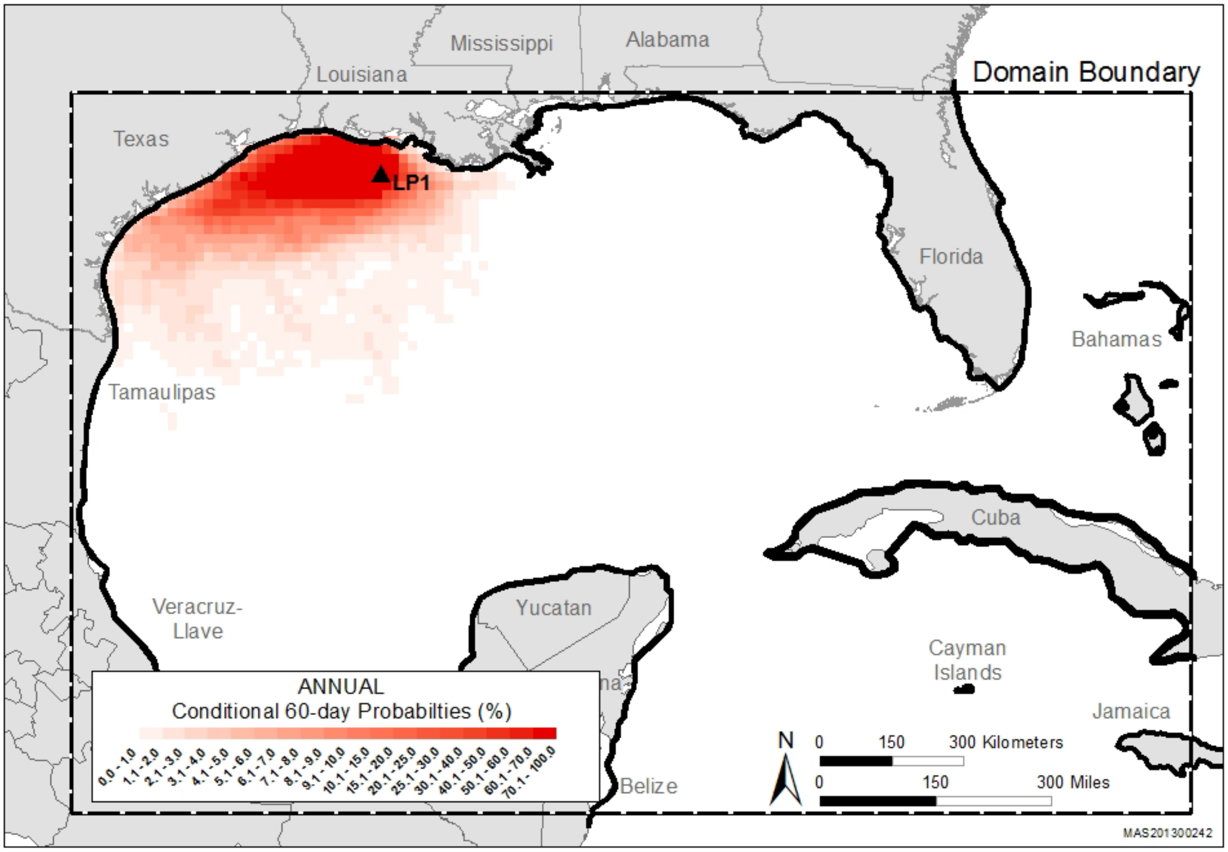

Figure 2-8. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point One with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

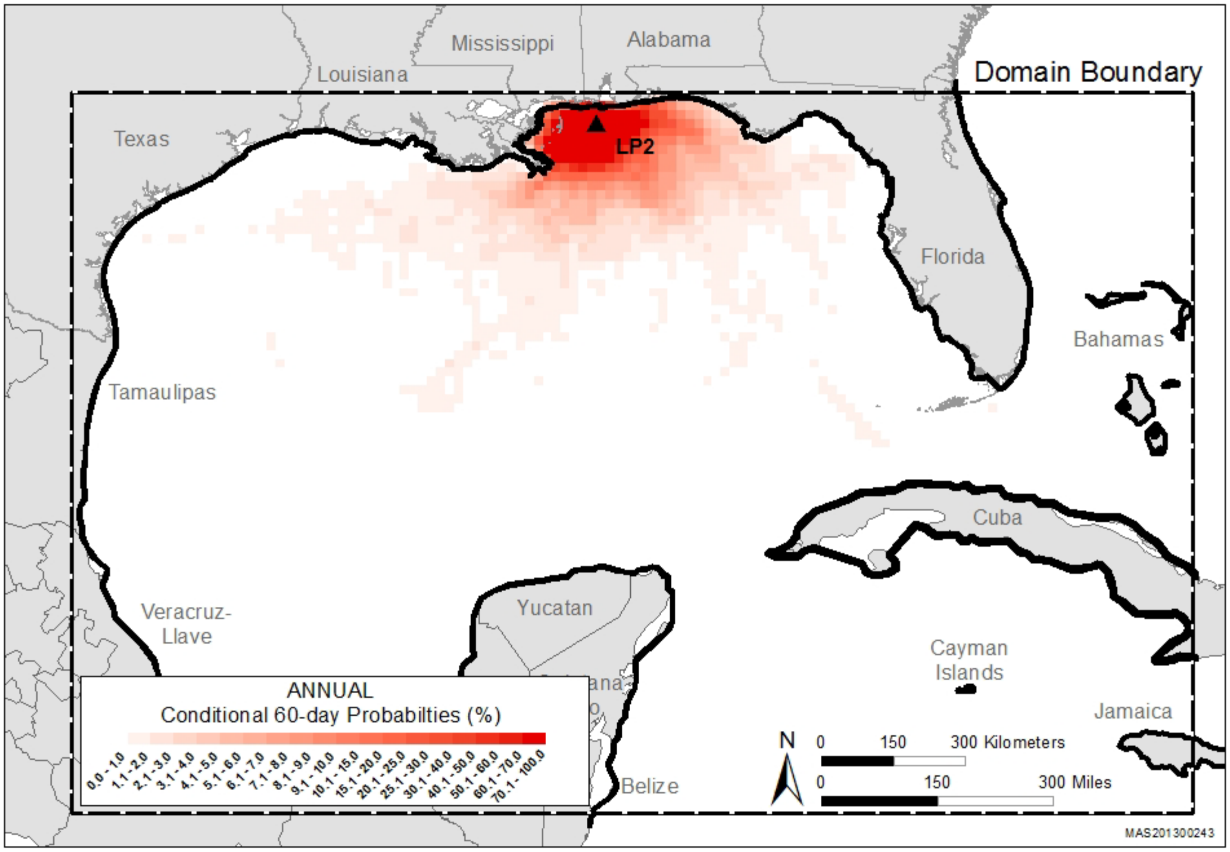

Figure 2-9. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Two with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

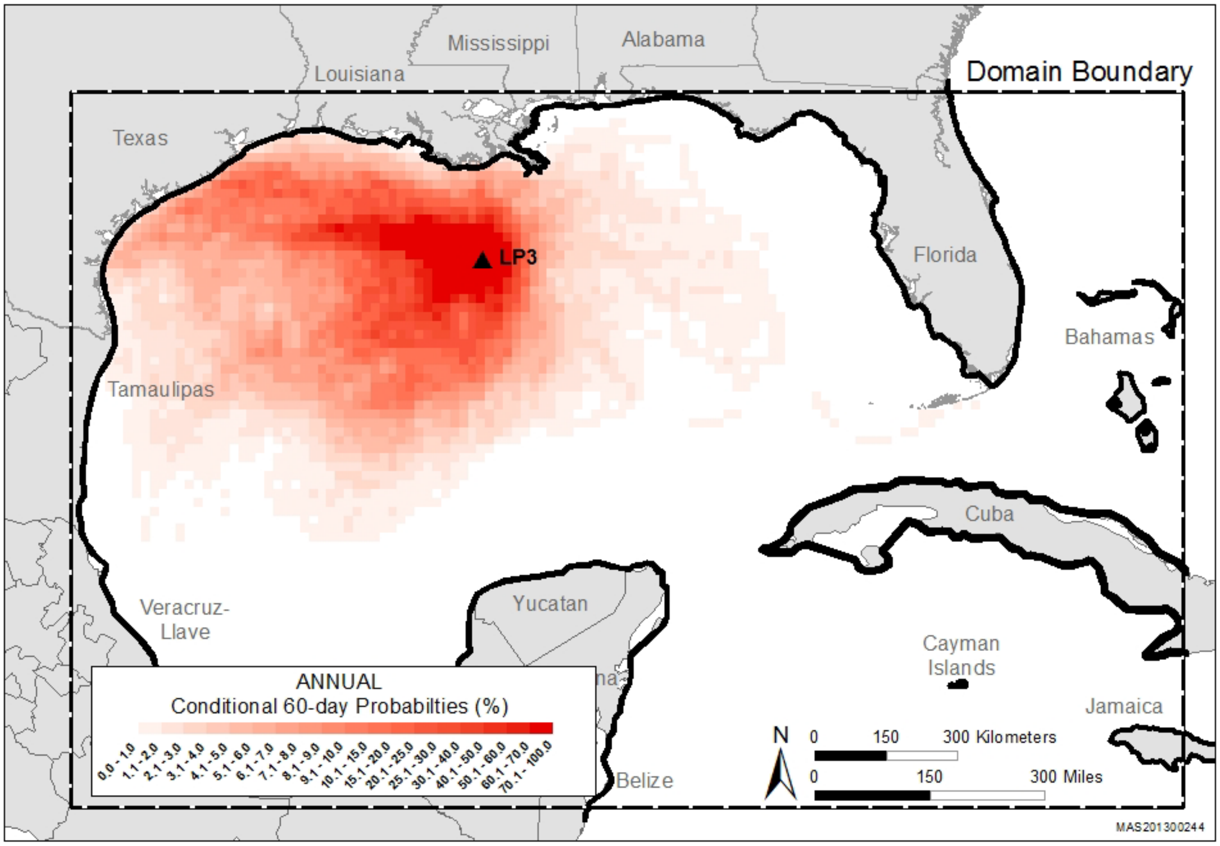

Figure 2-10. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Three with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

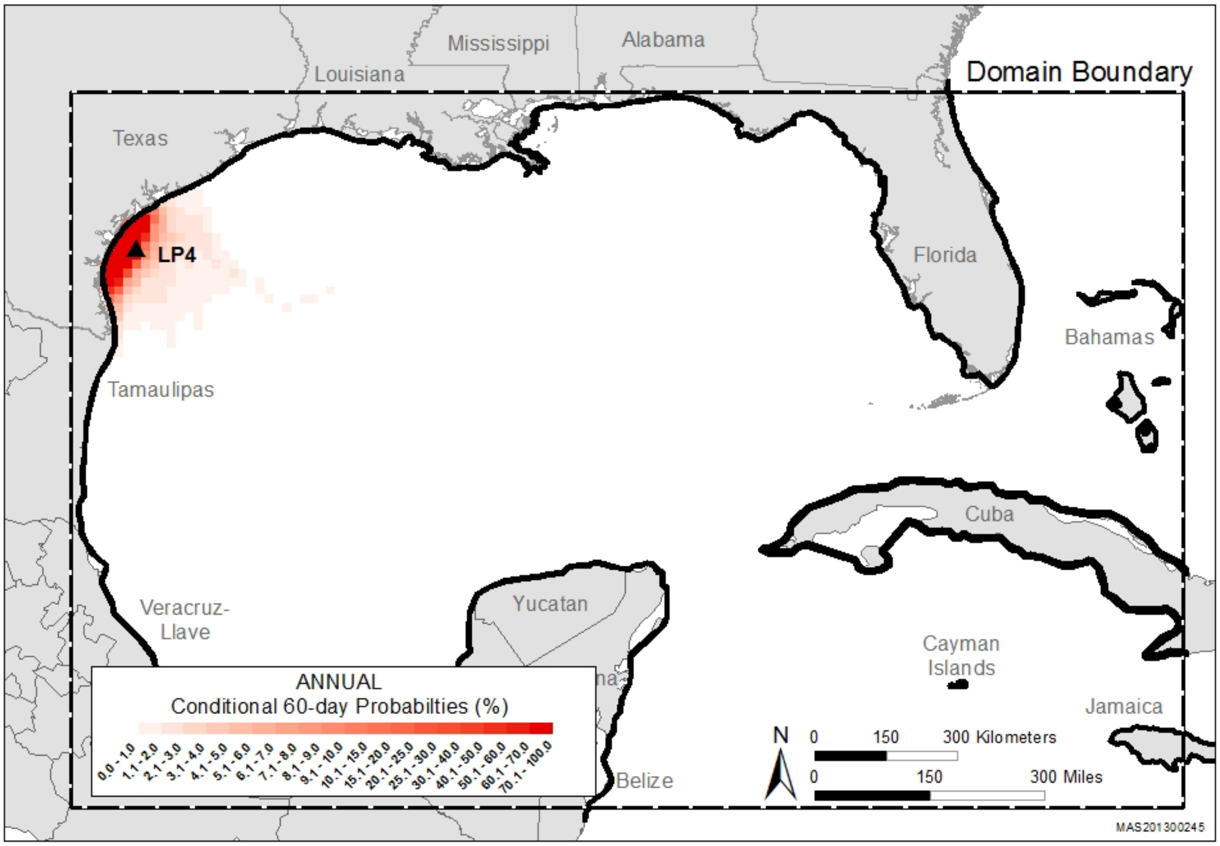

Figure 2-11. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Four with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

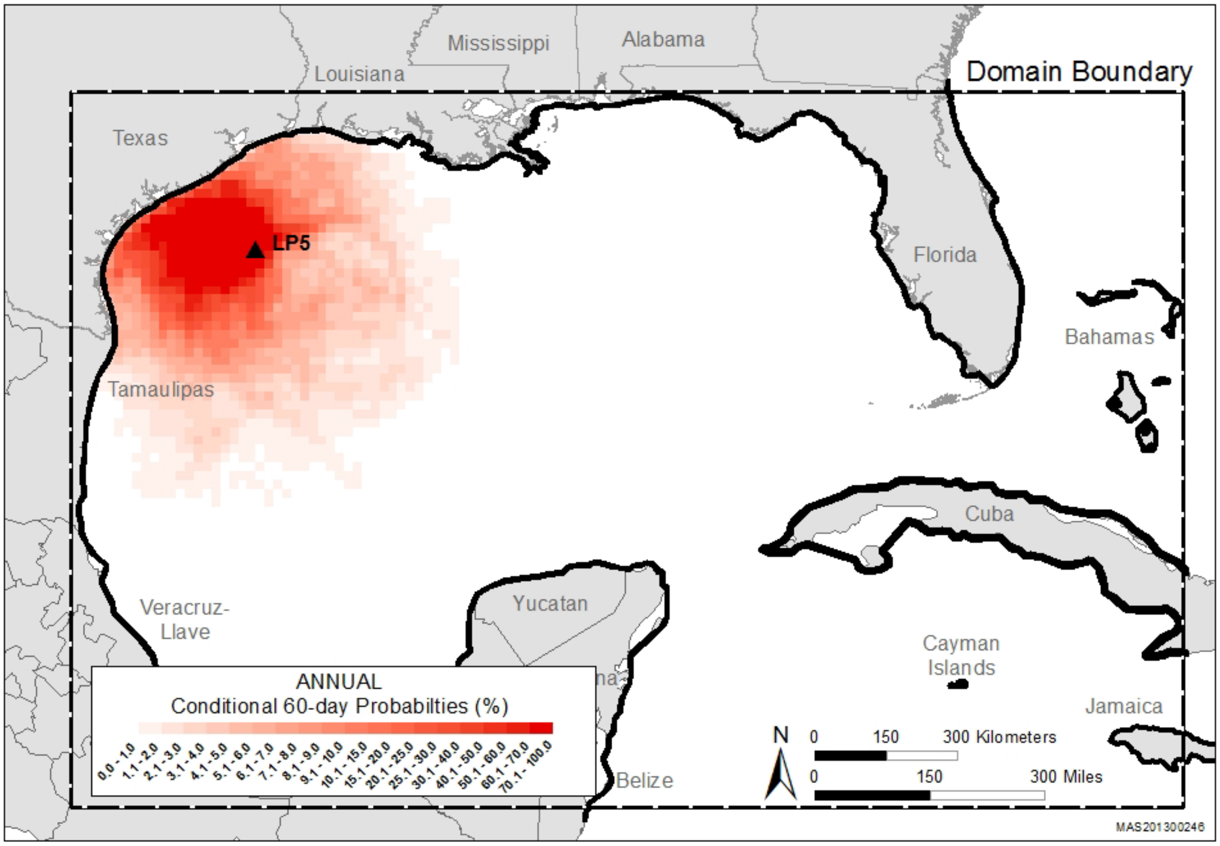

Figure 2-12. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Five with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

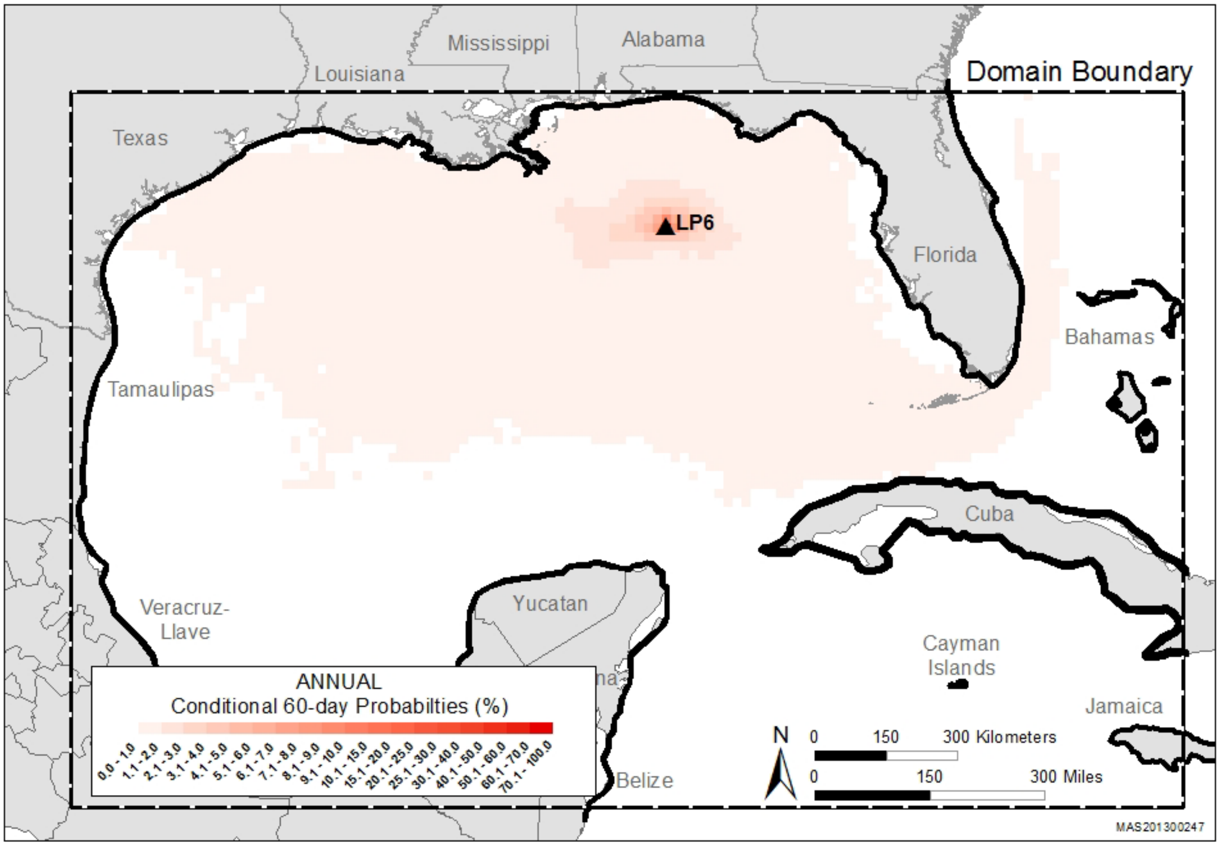

Figure 2-13. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Six with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

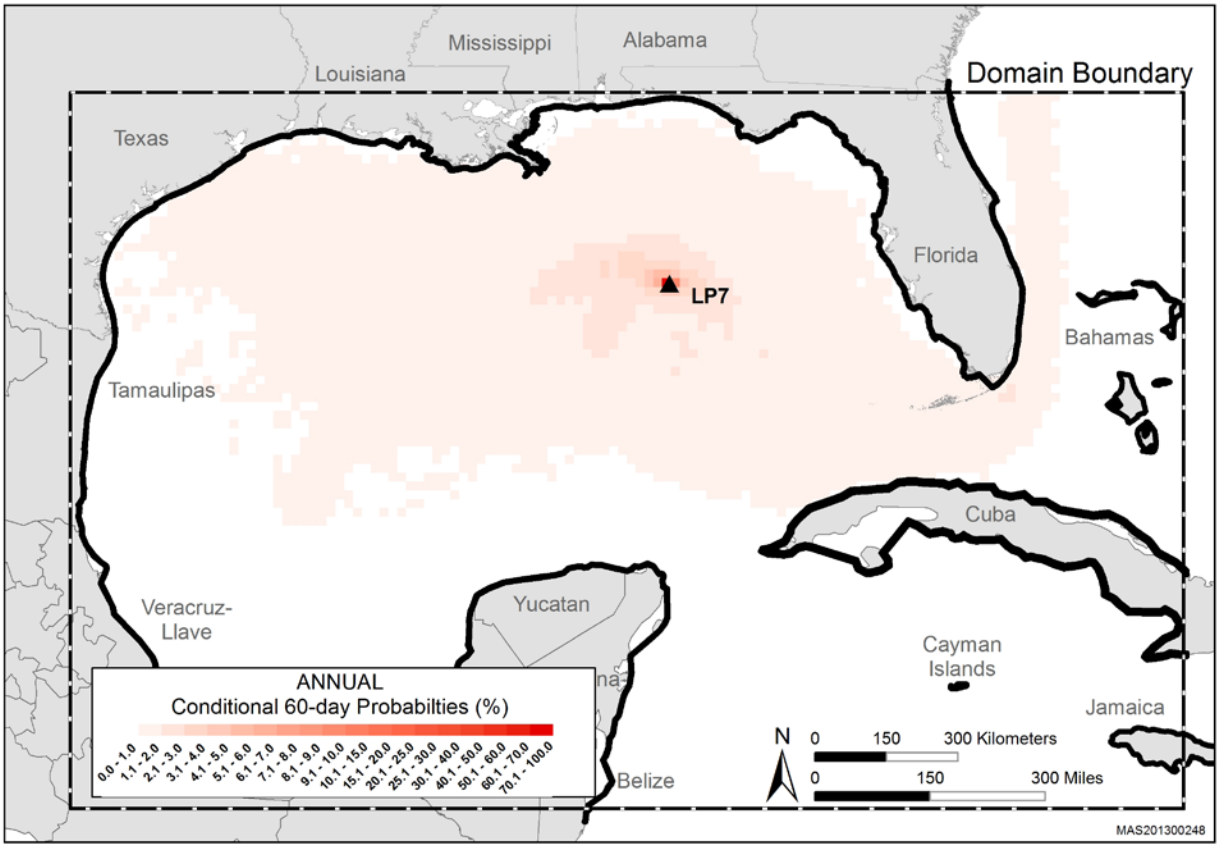

Figure 2-14. Annual Conditional Probabilities for a Hypothetical Oil Spill Initiated at Launch Point Seven with Each Simulated Trajectory Tracked for Up to 60 Days or Until Contacting Land.

6 TABLES

Table 1-1. Blowout Scenarios and Key Differences in Impacts, Response, and/or Intervention.

Location of Blowout and Leak	Key Differences in Impacts, Response, and/or Intervention
Blowout occurs at the sea surface (i.e., at the rig).	Offers the least chance for oil recovery because of the restricted access to the release point; therefore, greater impacts to coastal ecosystems. In addition to relief wells, there is the potential for other intervention measures such as capping and possible manual activation of blowout preventer (BOP) rams.
Blowout occurs along the riser anywhere from the seafloor to the sea surface. However, a severed riser would likely collapse, resulting in a leak at the seafloor.	In deep water, the use of subsea dispersants, if approved, may reduce impacts to coastal ecosystems; however, their use may increase exposure of deepwater marine resources to dispersed oil. There is a possibility for limited recovery of oil at the source. In addition to relief wells, there is the potential for other intervention measures, such as capping and possible manual activation of BOP rams.
At the seafloor, through leak paths on the BOP/wellhead	In deep water, the use of subsea dispersant, if approved, may reduce impacts to coastal ecosystems; however, their use may increase the exposure of deepwater marine resources to dispersed oil. With an intact subsea BOP, intervention may involve the use of drilling mud to kill the well. If the BOP and well stack are heavily compromised, the only intervention method may be relief wells. Greatest possibility for recovery of oil at the source, until the well is capped or killed.
Below the seafloor, outside the wellbore (i.e., broached)	Disturbance of a large amount of sediments resulting in the burial of benthic resources in the immediate vicinity of the blowout. The use of subsea dispersants would likely be more difficult (PCCI Marine and Environmental Engineering, 1999). Stopping this kind of blowout would probably involve relief wells. Any recovery of oil at the seabed would be very difficult.

Table 1-2. Properties and Persistence by Oil Component Group.

Properties and Persistence	Light Weight	Medium Weight	Heavy Weight
Hydrocarbon Compounds	Up to 10 carbon atoms	10-22 carbon atoms	>20 carbon atoms
APIº Gravity	>31.1º	31.1º-22.3º	<22.3º
Evaporation Rate	Rapid (within 1 day) and complete	Up to several days; not complete at ambient temperatures	Negligible
Solubility in Water	High	Low (at most a few milligrams/liter)	Negligible
Acute Toxicity	High because of monoaromatic hydrocarbons (BTEX)	Moderate because of diaromatic hydrocarbons (naphthalenes—2 ring PAHs)	Low except because of smothering (i.e., heavier oils may sink)
Chronic Toxicity	None, does not persist because of evaporation	PAH components (e.g., naphthalenes—2 ring PAHs)	PAH components (e.g., phenanthrene, anthracene—3 ring PAHs)
Bioaccumulation Potential	None, does not persist because of evaporation	Moderate	Low, may bioaccumulate through sediment sorption
Compositional Majority	Alkanes and cycloalkanes	Alkanes that are readily degraded	Waxes, asphaltenes, and polar compounds (not significantly bioavailable or toxic)
Persistence	Low because of evaporation	Alkanes readily degrade, but the diaromatic hydrocarbons are more persistent	High; very low degradation rates and can persist in sediments as tarballs or asphalt pavements

API = American Petroleum Institute.
BTEX = benzene, ethylbenzene, toluene, and xylene.
PAH = polycyclic aromatic hydrocarbon.

Sources: Michel, 1992; Canadian Center for Energy Information, 2010.

Table 1-3. Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water (assumptions are described in detail in the text).

Scenario	Shallow-Water Location	Deepwater Location
Phase 1. Initial Event		
Vertical Location of Blowout	4 possible locations including sea surface, along the riser, at the seafloor, and below the seafloor	4 possible locations including sea surface, along the riser, at the seafloor, and below the seafloor
Duration of Uncontrolled Fire	1-30 days	1-30 days
Phase 2. Offshore Spill		
Duration of Spill	1.5-5 months	1.5-6 months
Rate of Spill	30,000 bbl per day	30,000-60,000 bbl per day
Total Volume of Spill (1)	0.9-3.0 MMbbl crude oil	2.7-7.2 MMbbl crude oil 10,000-20,000 bbl diesel fuel
APIº Gravity	Fresh oil will float (APIº >10)	Fresh oil will float (APIº >10)
Characteristics of Oil Released	Typical South Louisiana midrange paraffinic sweet crude oil	Typical South Louisiana midrange paraffinic sweet crude oil; crude properties changed after oil traveled up the wellbore and passed through the water column, undergoing rapid depressurization and turbulence. Oil reached the surface as an emulsion stripped of many of its volatile components.
Response		
Number of Vessels	Up to 3,000	Up to 7,000
Number of Workers	Up to 25,000	Up to 50,000
Number of Aircraft/Day	55	127
Boom (million feet)	5	13.5
Dispersant Application (surface application) (2)	35,000 bbl	33,000-bbl surface application and 16,500-bbl subsea application
Number of Miles of Shoreline Requiring Some Measure of Mechanical or Manual Cleaning	778	778
In-situ Burn	Yes, will occur	Yes, will occur
Vessel Decontamination Stations	Yes	Yes
Severe Weather	The potential for severe weather is noted, which could temporarily halt containment and response efforts.	The potential for severe weather is noted, which could temporarily halt containment and response efforts.
Fisheries Closure	During the peak, anticipate an approximate maximum of 37% or 88,522 mi^2 (229,270 km^2) closed to recreational and commercial fishing.	During the peak, anticipate approximately 37% or 88,522 mi^2 (229,270 km^2) closed to recreational and commercial fishing.

Table 1-3. Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water (assumptions are described in detail in the text) (continued).

Scenario	Shallow-Water Location	Deepwater Location
Phase 3. Onshore Contact		
Shoreline Oiling Duration	1.5-5 months	1.5-6 months
Response		
Number of Staging areas	5-10	10-20
Number of Skimmers	200-300	500-600
Length of Shoreline Contacted		
	30 days[1] = 0-50 miles[2]	30 days[1] = 0-50 miles[2]
	60 days = 50-100 miles	60 days = 50-100 miles
	90 days = 100-1,102 miles	90 days = 100-1,102 miles
	120 days = >1,102 miles	120 days = >1,102 miles
	[1] Not cumulative. [2] Length was extrapolated	
Oil Characteristics and Appearance	—Essentially stable emulsions mixed with sand. —Typically initially stranded as surface layers.	—Essentially stable emulsions mixed with sand. —Typically initially stranded as surface layers.
Response Considerations for Sand Beaches	—No mechanical techniques allowed in some areas. —Much of the beach cleanup conducted at night. —Typically sand sieving, shaking, and sifting beach cleaning machines. —Repetitive tilling and mixing using agriculture plows and discs in combination with beach cleaning machines. —Sand washing treatment – sand sieve/shaker to remove debris and large oil particles and heated washing systems. —Nearshore submerged oil difficult to recover and hard to locate; vacuums and snares could be used.	—No mechanical techniques allowed in some areas. —Much of the beach cleanup conducted at night. —Typically sand sieving, shaking, and sifting beach cleaning machines. —Repetitive tilling and mixing using agriculture plows and discs in combination with beach cleaning machines. —Sand washing treatment – sand sieve/shaker to remove debris and large oil particles and heated washing systems. —Nearshore submerged oil difficult to recover and hard to locate; vacuums and snares could be used.

Table 1-3. Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water (assumptions are described in detail in the text) (continued).

Scenario	Shallow-Water Location	Deepwater Location
Response Considerations for Marshes	—Lightly oiled – allowed to recovery naturally; degrade in place or removed by tidal or wave action. —Moderately/heavily oiled – vacuumed or skimmed from boats possibly in conjunction with flushing; low-pressure flushing (with water comparable to marsh type); manual removal by hand or mechanized equipment; and vegetation cutting. —Heavily oiled areas – *in-situ* burning may be an option if water covers the sediment surface. —Bioremediation may be utilized but mostly as a secondary treatment after bulk removal.	—Lightly oiled – allowed to recovery naturally; degrade in place or removed by tidal or wave action. —Moderately or heavily oiled – vacuumed or skimmed from boats possibly in conjunction with flushing; low-pressure flushing (with water comparable to marsh type); manual removal by hand or mechanized equipment; and vegetation cutting. —Heavily oiled areas – *in-situ* burning may be an option if water covers the sediment surface. —Bioremediation may be utilized but mostly as a secondary treatment after bulk removal.
Response Considerations for Nearshore Waters	Marsh areas—skimming and vacuum (in areas too shallow to use skimmers) systems used in conjunction with flushing, and booming to temporarily contain mobile slicks.	Marsh areas—skimming and vacuum (in areas too shallow to use skimmers) systems used in conjunction with flushing, and booming to temporarily contain mobile slicks.
Phase 4. Recovery Phase		
Response		
Number of Vessels – 24-36 months post-spill/greater than 36 months	Fewer than 10/0 designated – called up only if new residual oil reported	Fewer than 10/0 designated – called up only if new residual oil reported
Number of Workers – 24-36 months post-spill/greater than 36 months	230/0 designated – called up only if new residual oil reported	230/0 designated – called up only if new residual oil reported
Miles of Shoreline Undergoing Regular Patrolling and Maintenance – 30-36 months post-spill/greater than 36 months	Fewer than 20/0	Fewer than 20/0
End Date for Dispersant Application	No dispersant usage 2 weeks after spillage ends.	No dispersant usage 2 weeks after spillage ends.
Remaining Sources of Unrecoverable Weathered Oil	Buried or in surface pockets in coastal sand, sediment, or muddy bottoms and in pockets on the seafloor.	Buried or in surface pockets in coastal sand, sediment, or muddy bottoms and in pockets on the seafloor.

Table 1-3. Description of the Scenario for a Catastrophic Spill Event Occurring in Shallow Water or Deep Water (assumptions are described in detail in the text) (continued).

Scenario	Shallow-Water Location	Deepwater Location
Oil Characteristics and Appearance	—As stranded oil weathered, some became buried through natural beach processes and appeared as surface residual balls <10 cm (4 in) or as surface residual patties 10 cm-1 m (4 in-3 ft). —Periodic re-oiling from submerged oil mats that lie in the inshore surf zone in troughs between the sand bars or from buried oil onshore that resurfaces. The three types of oil residue that were identified as challenging or potentially damaging to the environment if removed includes the following: (1) supra-tidal buried oil (buried below the 6-in [15-cm] surface cleaning depth restriction near sensitive habitats); (2) small surface residual balls, which are oil residue left behind after beaches are cleaned; and (3) surf zone submerged oil mats.	—As stranded oil weathered, some became buried through natural beach processes and appeared as surface residual balls <10 cm (4 in) or as surface residual patties 10 cm-1 m (4 in-3 ft). —Periodic re-oiling from submerged oil mats that lie in the inshore surf zone in troughs between the sand bars or from buried oil onshore that resurfaces. The three types of oil residue that were identified as challenging or potentially damaging to the environment if removed includes the following: (1) supra-tidal buried oil (buried below the 6-in [15-cm] surface cleaning depth restriction near sensitive habitats); (2) small surface residual balls, which are oil residue left behind after beaches are cleaned; and (3) surf zone submerged oil mats.
Response Considerations for Sand Beaches, Marshes, and Nearshore Waters	See Phase 3 above.	See Phase 3 above.

API = American Petroleum Institute
bbl = barrel
cm = centimeter
ft = feet
in = inch
km^2 = square kilometer
m = meter
mi^2 = square mile
MMbbl = million barrels

(1) A blowout may contain crude oil, natural gas, and condensate. Because the majority of environmental damage is due to the release of oil, this text assumes the spill to be an oil spill. However, a natural gas release would result in a less visible and less persistent adverse impact than an oil release.

(2) Subsea dispersal application must be individually approved.

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2].

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Amer. Coot	Marsh/Wading	3	2	2	2	0	0	0	1	0	1	0.67
Amer. Oystercatcher	Shorebird	13	7	3	7	3	0	3	1	3	3	0.54
Amer. Redstart	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Amer. White Pelican	Seabird	19	5	3	8	4	0	4	4	8	7	0.42
Audubon's Shearwater	Seabird	36	1	1	1	35	0	35	0	2	0	0.03
Barn Owl	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Barn Swallow	Passerine	1	1	0	1	0	0	0	0	0	0	1.00
Belted Kingfisher	Passerine	1	0	0	0	1	0	1	0	1	0	0.00
Bl.-crown. Night Heron	Marsh/Wading	18	6	3	8	7	0	7	1	4	3	0.44
Black Skimmer	**Seabird**	**253**	**51**	**16**	**55**	**153**	**0**	**153**	**40**	**14**	**45**	**0.22**
Black Tern	Seabird	9	1	0	1	7	0	7	1	3	1	0.11
Bl.-bell. Whistl. Duck	Waterfowl	2	0	0	0	0	0	0	0	2	2	0.00
Black-necked Stilt	Shorebird	3	0	0	0	3	0	3	0	0	0	0.00
Blue-winged Teal	Waterfowl	6	0	0	0	6	0	6	0	0	0	0.00
Boat-tailed Grackle	Passerine	1	0	0	0	1	0	1	0	1	0	0.00
Broad-winged Hawk	Raptor	1	0	0	0	1	0	1	0	1	0	0.00
Brown Pelican	**Seabird**	**826**	**152**	**227**	**339**	**248**	**0**	**248**	**177**	**149**	**239**	**0.41**
Brown-headed Cowbird	Passerine	1	0	0	0	0	0	0	0	1	1	0.00
Bufflehead	Waterfowl	1	0	1	1	0	0	0	0	0	0	1.00
Canada Goose	Waterfowl	4	0	1	1	1	0	1	1	2	2	0.25
Caspian Tern	Seabird	17	7	3	8	4	0	4	2	6	5	0.47
Cattle Egret	Marsh/Wading	36	4	4	7	25	0	25	3	4	4	0.19
Clapper Rail	Marsh/Wading	120	27	5	29	64	0	64	20	14	27	0.24

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Common Loon	Diving	75	33	27	39	24	0	24	4	20	12	0.52
Common Moorhen	Marsh/Wading	4	1	0	1	3	0	3	0	0	0	0.25
Common Nighthawk	Passerine	1	0	0	0	0	0	0	0	1	1	0.00
Common Tern	Seabird	25	15	12	16	9	0	9	0	0	0	0.64
Common Yellowthroat	Passerine	2	0	0	0	2	0	2	0	0	0	0.00
Cooper’s Hawk	Raptor	1	0	0	0	1	0	1	0	1	0	0.00
Cory’s Shearwater	Seabird	4	0	0	0	3	0	3	0	1	1	0.00
Dbl-crest. Cormorant	Diving	23	2	1	2	17	0	17	2	7	4	0.09
Eastern Kingbird	Passerine	2	1	0	1	1	0	1	0	0	0	0.50
Eastern Meadowlark	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Eur. Collared-dove	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Eur. Starling	Passerine	2	0	1	1	1	0	1	0	0	0	0.50
Forster’s Tern	Seabird	40	17	8	20	12	0	12	6	7	8	0.50
Fulvous Whistl. Duck	Waterfowl	1	0	0	0	0	0	0	0	1	1	0.00
Glossy Ibis	Marsh/Wading	2	1	1	1	1	0	1	0	0	0	0.50
Great Blue Heron	Marsh/Wading	42	5	3	6	26	0	26	4	16	10	0.14
Great Cormorant	Diving	1	0	0	0	1	0	1	0	0	0	0.00
Great Egret	Marsh/Wading	31	6	6	7	15	0	15	8	3	9	0.23
Great-horned Owl	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Greater Shearwater	Seabird	89	7	4	7	55	0	55	27	4	27	0.08
Green Heron	Marsh/Wading	16	2	0	2	8	0	8	1	6	6	0.13
Gull-billed Tern	Seabird	4	0	0	0	2	0	2	2	4	2	0.00
Herring Gull	Seabird	31	10	11	13	10	0	10	2	13	8	0.42
House Sparrow	Passerine	2	0	0	0	2	0	2	0	1	0	0.00
Killdeer	Shorebird	3	0	0	0	3	0	3	0	0	0	0.00
King rail	Marsh/Wading	1	0	0	0	0	0	0	0	1	1	0.00

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Laughing Gull	**Seabird**	**2,981**	**1,025**	**355**	**1,182**	**1,390**	**0**	**1,390**	**304**	**371**	**409**	**0.40**
Leach's Storm-petrel	Seabird	1	1	0	1	0	0	0	0	1	0	1.00
Least Bittern	Marsh/Wading	4	0	0	0	4	0	4	0	2	0	0.00
Least Tern	Seabird	106	46	7	49	43	0	43	12	3	14	0.46
Less. Bl.-backed Gull	Seabird	4	1	1	1	1	0	1	1	2	2	0.25
Less. Scaup	Waterfowl	1	0	0	0	0	0	0	1	0	1	0.00
Little Blue Heron	Marsh/Wading	5	0	0	0	4	0	4	1	1	1	0.00
Long-bill. Dowitcher	Shorebird	1	0	0	0	0	0	0	0	1	1	0.00
Magnif. Frigatebird	Seabird	8	3	3	4	2	0	2	1	2	2	0.50
Mallard	Waterfowl	26	5	4	6	16	0	16	0	7	4	0.23
Manx Shearwater	Seabird	6	1	0	1	5	0	5	0	0	0	0.17
Masked Booby	Seabird	9	4	3	4	1	0	1	0	4	4	0.44
Mottled Duck	Waterfowl	6	0	0	0	5	0	5	1	1	1	0.00
Mourning Dove	Passerine	15	3	1	3	8	0	8	0	6	4	0.20
Muscovy Duck	Waterfowl	1	0	0	0	1	0	1	0	1	0	0.00
Neotropic Cormorant	Diving	5	0	0	0	2	0	2	3	0	3	0.00
Northern Cardinal	Passerine	3	0	0	0	3	0	3	0	0	0	0.00
Northern Gannet	**Seabird**	**475**	**225**	**189**	**297**	**99**	**0**	**99**	**30**	**107**	**79**	**0.63**
Northern Mockingbird	Passerine	5	0	0	0	4	0	4	0	2	1	0.00
Osprey	Raptor	11	2	1	3	6	0	6	0	3	2	0.27
Pied-billed Grebe	Diving	32	18	24	24	7	0	7	1	3	1	0.75
Piping Plover	Shorebird	1	0	0	0	1	0	1	0	0	0	0.00
Purple Gallinule	Marsh/Wading	2	0	0	0	2	0	2	0	0	0	0.00
Purple Martin	Passerine	5	1	0	1	3	0	3	0	1	1	0.20
Red-breasted Merg.	Waterfowl	2	1	1	1	1	0	1	0	1	0	0.50
Reddish Egret	Marsh/Wading	2	1	1	1	1	0	1	0	1	0	0.50

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Red-shouldered Hawk	Raptor	1	0	0	0	0	0	0	0	1	1	0.00
Red-tailed Hawk	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Red-winged Blackbird	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Ring-billed Gull	Seabird	2	0	1	1	1	0	1	0	0	0	0.50
Rock Dove (pigeon)	Passerine	16	2	2	3	4	0	4	2	10	9	0.19
Roseate Spoonbill	Marsh/Wading	15	7	3	7	3	0	3	5	1	5	0.47
Royal Tern	**Seabird**	**289**	**116**	**66**	**149**	**104**	**0**	**104**	**19**	**47**	**36**	**0.52**
Ruddy Duck	Waterfowl	1	1	0	1	0	0	0	0	0	0	1.00
Ruddy Turnstone	Shorebird	13	1	3	3	8	0	8	1	5	2	0.23
Sanderling	Shorebird	26	4	2	4	20	0	20	1	6	2	0.15
Sandwich Tern	Seabird	70	28	20	34	25	0	25	8	14	11	0.49
Seaside Sparrow	Passerine	9	4	0	4	5	0	5	0	0	0	0.44
Semipalm. Sandpiper	Shorebird	3	2	1	3	0	0	0	0	0	0	1.00
Short-bill. Dowitcher	Shorebird	1	0	0	0	1	0	1	0	0	0	0.00
Snowy Egret	Marsh/Wading	22	12	9	14	6	0	6	2	3	2	0.64
Sooty Shearwater	Seabird	1	0	0	0	0	0	0	0	1	1	0.00
Sooty Tern	Seabird	3	0	1	1	2	0	2	0	1	0	0.33
Sora	Marsh/Wading	5	2	1	2	1	0	1	2	0	2	0.40
Spotted Sandpiper	Shorebird	1	0	0	0	1	0	1	0	0	0	0.00
Surf Scoter	Waterfowl	1	1	1	1	0	0	0	0	0	0	1.00
Tri-colored Heron	Marsh/Wading	31	9	5	11	7	0	7	11	2	13	0.35
Virginia Rail	Marsh/Wading	3	0	0	0	3	0	3	0	1	0	0.00
White Ibis	Marsh/Wading	7	1	1	1	4	0	4	2	3	2	0.14
White-tail. Tropicbird	Seabird	1	0	0	0	1	0	1	0	0	0	0.00
White-wing. Dove	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Willet	Shorebird	13	2	1	3	8	0	8	1	3	2	0.23

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Wilson's Plover	Shorebird	3	0	0	0	2	0	2	1	0	1	0.00
Yellow-billed Cuckoo	Passerine	2	2	0	2	0	0	0	0	0	0	1.00
Yel.-cr. Night Heron	Marsh/Wading	9	1	0	1	7	0	7	0	3	1	0.11
Unid. Blackbird	Passerine	1	0	0	0	0	0	0	0	1	1	0.00
Unid. Booby	Seabird	1	0	0	0	1	0	1	0	1	0	0.00
Unid. Cormorant	Diving	14	3	0	3	10	0	10	1	0	1	0.21
Unid. Dowitcher	Shorebird	2	1	0	1	1	0	1	0	1	0	0.50
Unid. Duck	Waterfowl	2	0	0	0	1	0	1	1	0	1	0.00
Unid. Egret	Marsh/Wading	15	2	0	2	11	0	11	2	1	2	0.13
Unid. Flycatcher	Passerine	1	1	0	1	0	0	0	0	0	0	1.00
Unid. Grebe	Diving	4	2	1	2	2	0	2	0	0	0	0.50
Unid. Gull	Seabird	248	79	1	80	134	0	134	33	4	34	0.32
Unid. Hawk	Raptor	2	0	0	0	2	0	2	0	0	0	0.00
Unid. Heron	Marsh/Wading	15	5	0	5	8	0	8	1	1	2	0.33
Unid. Loon	Diving	7	2	2	4	3	0	3	0	1	0	0.57
Unid. Mockingbird	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Owl	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Passerine	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Pelican	Seabird	25	5	1	5	15	0	15	4	1	5	0.20
Unid. Pigeon	Passerine	14	2	1	3	6	0	6	1	6	5	0.21
Unid. Rail	Marsh/Wading	4	1	0	1	3	0	3	0	0	0	0.25
Unid. Raptor	Raptor	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Sandpiper	Shorebird	2	0	0	0	2	0	2	0	2	0	0.00
Unid. Shearwater	Seabird	6	0	0	0	5	0	5	1	0	1	0.00
Unid. Shorebird	Shorebird	3	2	0	2	0	0	0	1	0	1	0.67
Unid. Skimmer	Seabird	6	0	0	0	5	0	5	1	0	1	0.00

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	
Unid. Sparrow	Passerine	3	0	0	0	1	0	1	2	0	2	0.00
Unid. Swallow	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unid. Tern	Seabird	132	38	1	39	79	0	79	13	2	14	0.30
Unid. Warbler	Passerine	1	0	0	0	1	0	1	0	0	0	0.00
Unknown spp.		593	51	2	53	451	0	451	88	1	89	0.09
Other		106	31	3	34	52	0	52	7	14	20	0.32
Column Totals		7,258	2,121		2,642	3,387		3,387	873		1,229	0.24

[1] Data obtained from the U.S. Fish and Wildlife Service (FWS) as part of the *Deepwater Horizon* post-spill monitoring and collection process are summarized for May 12, 2011 (USDOI, FWS, 2011). The data used in this table are verified as per FWS's QA/QC processes. Disclaimer: All data should be considered provisional, incomplete, and subject to change (USDOI, FWS, 2011). For more information, refer to the Weekly Bird Impact Data and Consolidated Wildlife Reports. Numbers in this table have been verified against the original data from FWS's website (USDOI, FWS, 2011).

[2] As of May 12, 2011, 104 avian species had been collected and identified through the *Deepwater Horizon* post-spill monitoring and collection process (USDOI, FWS, 2011). Note: Though the process was triggered by the *Deepwater Horizon* explosion and oil spill, not all birds recovered were oiled (36% = oiled, 47% = unoiled, 17% = unknown), suggesting that "search effort" alone accounted for a large proportion of the total (n = 7,258) birds collected (Piatt et al., 1990a, page 127). Some of the live birds collected may have been incapable of flight due to age or molt, and some of the dead birds collected may have died due to natural mortality, predation, or other anthropogenic sources of mortality. The overall oiling rate across species including "others" and "unknowns" was 0.24 versus 0.25 for individuals identified to species. The oiling rate for the **Top 5** (see bold rows in table) most-impacted avian species was 0.43 and included representatives only from the seabird group. These are listed in descending order based on the number collected: laughing gull (2,981 collected, 0.40 oiling rate); brown pelican (826 collected, 0.41 oiling rate); northern gannet (475 collected, 0.63 oiling rate); royal tern (289 collected, 0.52 oiling rate); and black skimmer (253 collected, 0.22 oiling rate). Note: There is a difference between the table structure here compared with the original table on FWS's website. Herein, columns for live birds that later died were not included. Totals associated with each larger grouping are correct and sum to those column totals for the May 12, 2011, Collection Report values. Six new species or rows were added and 3 species were removed between the December 14, 2010, Collection Report (USDOI, FWS, 2010d) and the May 12, 2011, Collection Report (USDOI, FWS, 2011). The major difference in number (-807) between the more recent and older versions was due to an ~10% overestimate in the previous report representing live birds that later died, as these individuals were counted twice in the December 14, 2010, Collection Report (USDOI, FWS, 2010d).

[3] For additional information on oiling rates by Species Group and additional statistics, refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS (USDOI, BOEM, 2012b).

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[4] Oiling Rate: For each species, an oiling rate was calculated by dividing the "total" number of oiled individuals (∑ alive + dead) /∑ of total individuals collected for a given species/row. In general, it has been well documented that the number of birds collected after a spill event represents a small fraction of the total oiled population (direct mortality) due to various factors: species-specific differences in vulnerability to spilled oil, species-specific differences in distribution, habitat use and behavior; species-specific differences in abundance; species-specific differences in carcass deposition rates, persistence rates, and detection probabilities; overall search effort and temporal and spatial variation in search effort; and carcass loss due to predation, habitat, weather, tides, and currents (Piatt et al., 1990a and 1990b; Ford et al., 1996; Piatt and Ford, 1996; Fowler and Flint, 1997; Flint and Fowler, 1998; Flint et al., 1999; Hampton and Zafonte,

Table 1-4. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Response in the Gulf of Mexico[1, 2] (continued).

Common Name	Species Group[3]	Grand Total	Visibly Oiled			Not Visibly Oiled			Unknown Oiling			Oiling Rate[4]
			Dead	Alive	Total	Dead	Alive	Total	Dead	Alive	Total	

2005; Ford, 2006; Castège et al., 2007; Ford and Zafonte, 2009; Byrd et al., 2009; Flint et al., 2010). For example, Piatt and Ford (1996, Table 1) estimated a mean carcass recovery rate of only 17% for a number of previous oil-bird impact studies. Burger (1993) and Wiese and Jones (2001) estimated recovery rates of 20% with the latter study based on a drift-block design to estimate carcass recovery rate from beached-bird surveys. Due to the fact that the coastline directly inshore of the well blowout location is primarily marsh and not sandy beaches, due to the distance from the blowout location to the coast, and due to predominant currents and wind directions during the event, the number of birds collected would likely represent a recovery estimate in the lower ranges of those provided in the literature to date (≤10%). A range of mortality estimates given the total number of dead birds collected through May 12, 2011, of 7,258 birds x recovery rates from the literature (0-59% in Piatt and Ford, 1996, Table 1) suggests a lower range of 12,302 birds* (59% recovery rate), an upper range of 725,800 birds* (0% recovery rate), and 42,694 birds based on the 17% mean recovery rate from Piatt and Ford (1996). The lower range of estimates (i.e., high carcass recovery rates) is likely biased low because it assumes no search effort after May 2011 (i.e., no more birds were collected after that date) and does not account for any of the detection probability parameters that are currently unknown. The actual avian mortality estimate would likely not be available until the NRDA process has been completed; this should include a combination of carcass drift experiments, drift-block experiments, corrections for carcass deposition and persistence rates, scavenger rates, and detection probability with additional modeling to more precisely derive an estimate. For additional information on oiling rates by Species Group and additional statistics, refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS (USDOI, BOEM, 2012b). Note: Spill volume tends to be a poor predictor of bird mortality associated with an oil spill (Burger, 1993), though it should be considered for inclusion in any models to estimate total bird mortality, preferably with some metric of species composition and abundance (preferably density) pre-spill (Wilhelm et al., 2007).

* An additional estimate for total mortality based on Piatt and Ford (1996) is also provided.

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	1
Willacy, TX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Kenedy, TX	-	-	-	-	-	-	2	2	-	-	1	2	-	-	1	4	-	-	1	2
Kleberg, TX	-	-	-	-	-	-	1	1	-	-	1	1	-	-	1	2	-	-	1	1
Nueces, TX	-	-	-	-	-	-	1	1	-	-	1	2	-	-	1	3	-	-	1	2
Aransas, TX	-	-	-	-	-	-	1	2	-	-	2	2	-	-	1	3	-	-	1	2
Calhoun, TX	-	-	-	-	-	-	5	5	-	-	2	3	-	-	3	7	-	-	2	4
Matagorda, TX	-	-	1	1	-	1	5	6	-	1	9	9	-	-	9	14	-	1	6	7
Brazoria, TX	-	1	3	3	-	1	3	4	-	1	5	5	-	1	7	9	-	1	4	5
Galveston, TX	-	3	9	9	-	3	9	11	-	2	9	9	-	3	10	13	-	3	9	10
Chambers, TX	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	5	10	10	-	3	8	8	-	3	6	6	-	2	5	6	-	3	7	7
Cameron, LA	8	36	42	42	1	12	21	23	2	11	13	15	2	9	11	12	3	17	22	23
Vermilion, LA	10	22	23	23	2	10	13	14	3	7	8	8	3	7	8	8	5	12	13	13
Iberia, LA	1	5	6	6	-	4	7	7	-	1	1	1	-	1	1	2	1	3	4	4
St. Mary, LA	-	1	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1
Terrebonne, LA	-	2	3	3	1	3	6	6	-	1	2	2	-	-	2	2	-	2	3	3
Lafourche, LA	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plaquemines, LA	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Escambia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walton, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dixie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dade, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broward, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palm Beach, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	-	11	23	23	-	7	36	41	-	7	36	41	-	6	39	64	-	8	33	43
LA	19	66	76	76	5	30	49	52	6	20	25	27	5	17	22	24	9	33	43	45
MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamaulipas, Mexico	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	1
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passerines	-	4	5	5	-	1	15	17	-	2	11	16	-	1	11	28	-	2	11	17
Raptors	-	10	18	18	-	4	27	30	-	6	23	28	-	5	23	43	-	6	23	30
Shorebirds	6	28	39	39	2	14	45	50	2	13	35	40	1	10	34	56	3	16	38	46
Wading Birds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waterfowl	19	63	75	76	5	29	62	66	6	20	39	45	5	17	38	58	9	32	53	61
Diving Birds	19	70	88	88	5	33	75	81	6	24	49	56	5	20	48	71	9	37	65	74
Gulls/Terns	19	71	90	90	5	34	77	83	6	25	53	59	5	21	51	75	9	38	68	77
Piping Plover	6	14	16	16	3	15	36	39	5	19	32	35	5	15	29	37	5	16	29	32
Sea Turtle Nesting Habitat I	-	11	23	23	-	7	24	28	-	-	-	-	-	1	9	15	-	5	14	16
Sea Turtle Nesting Habitat II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sea Turtle Sporadic Nesting Habitat I	19	66	76	76	5	30	49	51	-	-	-	-	-	1	3	4	6	24	32	33
Sea Turtle Sporadic Nesting Habitat II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Indian Manatee Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Indian Manatee Rare Habitat	19	77	99	99	5	37	85	92	2	9	17	17	-	2	12	19	6	31	53	57
Alabama Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perdido Key Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Andrews Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short Nose Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX Coastal Bend Beach Area	-	-	-	-	-	-	5	7	-	-	5	9	-	-	4	16	-	-	4	8
TX Matagorda Beach Area	-	-	1	1	-	1	9	10	-	1	11	12	-	-	12	20	-	1	9	11

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	5	12	12	-	4	13	16	-	3	14	14	-	4	17	22	-	4	14	16
TX Sea Rim State Park	-	5	10	10	-	3	8	8	-	3	6	6	-	2	5	6	-	3	7	7
LA Beach Areas	8	36	42	42	1	12	22	24	2	11	14	15	2	9	11	13	3	17	22	23
AL/MS Gulf Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf Shores	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Big Bend Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southwest Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Ten Thousand Islands Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Central East Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Northeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	-	-	-	-	-	-	5	7	-	-	5	9	-	-	4	16	-	-	4	8
Louisiana Black Bear	1	6	8	8	-	5	7	7	-	1	2	2	-	2	2	2	1	3	5	5
Northern Aplomado Falcon	-	-	-	-	-	-	-	1	-	-	1	2	-	-	1	3	-	-	-	1
Whooping Crane1	-	-	-	-	-	-	6	6	-	-	4	5	-	-	4	10	-	-	4	5
Whooping Crane2	10	22	23	23	2	10	13	14	3	7	8	8	3	7	8	8	5	12	13	13

Table 2-1. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Wood Stork	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alabama Red-bellied Turtle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gopher Tortoise and Louisiana Quillwort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern Indigo Snake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Gopher Frog	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flatwoods Salamander	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telephus Spurge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sandhill Crane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Snail Kite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape Sable Seaside Sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roseate Tern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Willacy, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kleberg, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nueces, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aransas, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calhoun, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Matagorda, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Brazoria, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galveston, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chambers, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cameron, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Iberia, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Mary, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrebonne, LA	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	2	-	-	1	1
Lafourche, LA	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-
Jefferson, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Plaquemines, LA	-	2	3	3	2	9	17	19	2	17	24	24	1	12	18	20	1	10	15	17

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	5	6	6	1	8	13	14	1	8	10	10	1	5	8	8	1	7	9	10
Hancock, MS	-	2	3	3	-	2	2	2	1	2	3	3	-	1	2	3	-	2	3	3
Harrison, MS	2	5	5	5	1	4	5	5	1	2	3	3	2	3	4	4	1	3	4	4
Jackson, MS	7	13	14	14	3	6	8	8	6	11	12	13	6	10	12	13	6	10	11	12
Mobile, AL	13	18	19	19	4	9	10	10	8	12	12	13	9	12	13	13	9	13	14	14
Baldwin, AL	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7	3	8	9	9
Escambia, FL	1	6	9	10	1	4	6	6	-	1	1	1	-	2	2	3	-	3	5	5
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	1	2	2	-	1	2	2	-	-	-	-	-	-	-	-	-	-	1	1
Walton, FL	-	-	1	1	-	1	1	1	-	-	-	1	-	-	-	-	-	-	1	1
Bay, FL	-	2	3	3	-	1	2	3	-	-	-	-	-	-	-	1	-	1	1	2
Gulf, FL	-	1	3	4	-	-	2	2	-	-	-	-	-	-	-	-	-	-	1	1
Franklin, FL	-	-	1	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dixie, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dade, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broward, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palm Beach, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	2	-	-	-	1
LA	-	6	8	9	3	17	30	35	3	25	36	36	2	18	29	33	2	17	26	28
MS	9	20	22	22	5	12	15	15	8	15	18	19	8	15	18	20	7	15	18	19
AL	21	33	37	37	6	17	20	20	9	14	15	15	12	18	20	20	12	20	23	23
FL	1	11	19	26	1	7	14	16	-	1	3	3	-	2	4	5	1	5	10	13
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passerines	28	53	61	62	12	33	42	45	17	31	37	39	19	33	39	44	19	38	45	48
Raptors	22	37	42	46	7	17	24	26	13	19	22	23	15	22	24	27	14	24	28	31
Shorebirds	23	44	53	58	8	24	34	38	13	23	28	30	15	26	33	39	15	29	37	41
Wading Birds	27	48	54	55	11	28	36	37	17	30	34	36	19	31	36	40	18	34	40	42
Waterfowl	19	37	43	45	9	33	50	56	13	41	54	56	13	35	48	56	14	36	49	53
Diving Birds	31	60	67	68	14	46	65	72	20	54	69	72	22	50	66	75	22	52	67	72
Gulls/Terns	31	61	72	76	13	36	52	58	19	42	55	58	22	43	57	67	21	46	59	65
Piping Plover	11	18	20	20	7	23	32	35	17	31	39	42	19	32	41	46	14	26	33	36
Sea Turtle Nesting Habitat I	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Sea Turtle Nesting Habitat II	32	64	77	83	12	35	48	51	11	19	20	21	1	3	4	8	14	30	37	41
Sea Turtle Sporadic Nesting Habitat I	-	-	1	1	-	-	-	1	-	-	-	-	-	-	1	2	-	-	1	1
Sea Turtle Sporadic Nesting Habitat II	-	6	9	10	3	17	29	33	2	18	24	24	-	1	4	4	2	11	17	18
West Indian Manatee Habitat	1	11	19	26	1	7	14	16	-	1	3	3	-	2	4	5	1	5	10	13

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	31	58	65	66	13	38	50	52	5	13	14	14	1	3	5	8	12	28	34	35
West Indian Manatee Rare Habitat	-	2	2	3	2	8	15	19	1	6	6	6	-	1	3	5	1	4	7	8
Alabama Beach Mouse	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7	3	8	9	9
Perdido Key Beach Mouse	9	21	27	28	3	12	15	16	1	3	4	4	3	7	9	10	4	11	14	15
Santa Rosa Beach Mouse	-	3	5	6	-	3	4	5	-	1	1	1	-	1	2	2	-	2	3	3
Choctawhatchee Beach Mouse	-	3	6	7	-	2	5	6	-	-	1	1	-	1	1	1	-	2	3	4
St. Andrews Beach Mouse	-	3	5	7	-	1	4	5	-	-	-	-	-	-	-	1	-	1	2	3
Southeastern Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short Nose Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon Critical Habitat	32	69	83	89	13	44	62	65	18	40	47	48	21	40	49	54	21	48	60	64
Gulf Sturgeon	32	70	86	92	15	52	78	83	20	55	68	70	22	51	65	71	22	57	74	79
TX Coastal Bend Beach Area	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
TX Matagorda Beach Area	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
TX Sea Rim State Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Beach Areas	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	2	-	-	1	1
AL/MS Gulf Islands	23	38	41	41	9	21	25	26	16	27	30	32	17	27	30	33	16	28	32	33
AL Gulf Shores	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7	3	8	9	9
FL Panhandle Beach Area	1	11	18	23	1	7	14	15	-	1	3	3	-	2	4	5	1	5	10	11
FL Big Bend Beach Area	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
FL Southwest Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Ten Thousand Islands Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southeast Beach Area	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
FL Central East Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Northeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Louisiana Black Bear	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Aplomado Falcon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Whooping Crane1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-2. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Wood Stork	22	44	56	63	7	24	34	36	9	15	18	18	12	20	23	25	13	26	33	36
Alabama Red-bellied Turtle	30	51	56	57	11	27	32	33	16	27	30	31	20	31	35	37	19	34	38	39
Gopher Tortoise and Louisiana Quillwort	9	20	22	22	5	12	15	15	8	15	18	19	8	15	18	20	7	15	18	19
Eastern Indigo Snake	1	11	19	26	1	7	14	16	-	1	3	3	-	2	4	5	1	5	10	13
Mississippi Gopher Frog	9	18	19	19	4	10	13	13	7	13	15	16	8	13	16	17	7	14	16	16
Flatwoods Salamander	-	-	1	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
Telephus Spurge	-	3	6	9	-	1	5	5	-	-	-	-	-	-	-	1	-	1	3	4
Mississippi Sandhill Crane	9	18	19	19	4	10	13	13	7	13	15	16	8	13	16	17	7	14	16	16
Everglades Snail Kite	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Cape Sable Seaside Sparrow	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roseate Tern	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	1	-	-	-	1
Willacy, TX	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-	-	1
Kenedy, TX	-	-	-	-	-	-	1	5	-	-	-	2	-	-	-	3	-	-	-	3
Kleberg, TX	-	-	-	-	-	-	1	3	-	-	1	2	-	-	-	2	-	-	-	2
Nueces, TX	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	3	-	-	-	1
Aransas, TX	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	3	-	-	-	2
Calhoun, TX	-	-	-	-	-	-	-	3	-	-	1	2	-	-	1	4	-	-	1	2
Matagorda, TX	-	-	3	5	-	-	1	4	-	-	2	5	-	-	3	10	-	-	2	6
Brazoria, TX	-	-	3	3	-	-	2	5	-	-	1	2	-	-	3	8	-	-	2	5
Galveston, TX	-	-	3	5	-	-	2	3	-	-	1	2	-	-	2	5	-	-	2	4
Chambers, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	-	4	5	-	-	1	1	-	-	-	-	-	-	1	2	-	-	1	2
Cameron, LA	-	-	9	11	-	-	1	3	-	-	-	2	-	-	1	3	-	-	3	5
Vermilion, LA	-	1	5	6	-	-	1	1	-	-	-	-	-	-	1	2	-	-	2	2
Iberia, LA	-	1	3	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1
St. Mary, LA	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrebonne, LA	-	5	12	13	-	-	1	2	-	-	1	1	-	1	2	2	-	2	4	5
Lafourche, LA	-	2	5	6	-	-	1	2	-	-	-	-	-	-	1	2	-	1	2	2
Jefferson, LA	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1
Plaquemines, LA	-	3	10	10	-	-	2	3	-	-	-	-	-	-	2	2	-	1	3	4

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin, AL	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Escambia, FL	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walton, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dixie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dade, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Broward, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palm Beach, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	-	-	13	19	-	-	7	30	-	-	7	21	-	-	11	44	-	-	10	28
LA	-	12	46	52	-	2	6	12	-	1	2	4	-	2	8	12	-	4	16	20
MS	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
AL	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL	-	-	2	5	-	-	-	2	-	-	-	-	-	-	-	1	-	-	1	2
Tamaulipas, Mexico	-	-	-	-	-	-	-	4	-	-	-	3	-	-	-	1	-	-	-	2
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	1
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passerines	-	-	5	7	-	-	3	21	-	-	5	14	-	-	3	23	-	-	4	16
Raptors	-	-	10	15	-	-	6	25	-	-	6	16	-	-	5	29	-	-	7	21
Shorebirds	-	8	36	44	-	1	10	34	-	1	8	19	-	1	11	40	-	3	16	35
Wading Birds	-	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Waterfowl	-	12	49	57	-	2	11	35	-	1	8	20	-	2	12	38	-	4	20	38
Diving Birds	-	12	56	66	-	2	12	39	-	1	8	21	-	2	15	47	-	4	23	43
Gulls/Terns	-	13	58	69	-	2	13	41	-	1	8	22	-	2	16	50	-	4	24	46
Piping Plover	-	2	4	6	-	1	6	16	-	1	5	10	-	1	8	18	-	1	6	12
Sea Turtle Nesting Habitat I	-	-	13	19	-	-	3	11	-	-	-	-	-	-	7	24	-	-	6	13
Sea Turtle Nesting Habitat II	-	-	3	7	-	-	1	3	-	-	-	-	-	-	-	1	-	-	1	3
Sea Turtle Sporadic Nesting Habitat I	-	11	43	48	-	1	6	10	-	-	-	-	-	-	3	7	-	3	13	16
Sea Turtle Sporadic Nesting Habitat II	-	1	3	4	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	2
West Indian Manatee Habitat	-	-	2	5	-	-	-	2	-	-	-	-	-	-	-	1	-	-	1	2

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	-	-	2	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1
West Indian Manatee Rare Habitat	-	12	59	70	-	2	13	36	-	-	2	2	-	-	11	30	-	4	21	34
Alabama Beach Mouse	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perdido Key Beach Mouse	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Santa Rosa Beach Mouse	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Beach Mouse	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
St. Andrews Beach Mouse	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern Beach Mouse	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short Nose Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon Critical Habitat	-	-	4	7	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	2
Gulf Sturgeon	-	1	6	10	-	-	1	3	-	-	-	-	-	-	1	1	-	-	2	3
TX Coastal Bend Beach Area	-	-	-	-	-	-	2	14	-	-	3	10	-	-	1	14	-	-	2	10
TX Matagorda Beach Area	-	-	3	5	-	-	1	7	-	-	3	7	-	-	3	15	-	-	3	8

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	-	6	9	-	-	3	8	-	-	1	5	-	-	5	13	-	-	4	8
TX Sea Rim State Park	-	-	4	5	-	-	1	1	-	-	-	-	-	-	1	2	-	-	1	2
LA Beach Areas	-	3	15	18	-	1	3	5	-	-	1	3	-	-	2	5	-	1	5	8
AL/MS Gulf Islands	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf Shores	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle Beach Area	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
FL Big Bend Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southwest Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Ten Thousand Islands Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southeast Beach Area	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
FL Central East Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Northeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	-	-	-	-	-	-	2	14	-	-	3	10	-	-	1	14	-	-	2	10
Louisiana Black Bear	-	1	4	4	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1
Northern Aplomado Falcon	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	3	-	-	-	2
Whooping Crane1	-	-	-	-	-	-	1	5	-	-	2	4	-	-	1	7	-	-	1	4

Table 2-3. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane2	-	1	5	6	-	-	1	1	-	-	-	-	-	-	1	2	-	-	2	2
Wood Stork	-	-	3	7	-	-	1	2	-	-	-	-	-	-	-	1	-	-	1	3
Alabama Red-bellied Turtle	-	-	1	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Gopher Tortoise and Louisiana Quillwort	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Eastern Indigo Snake	-	-	2	5	-	-	-	2	-	-	-	-	-	-	-	1	-	-	1	2
Mississippi Gopher Frog	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flatwoods Salamander	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telephus Spurge	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sandhill Crane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Snail Kite	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Cape Sable Seaside Sparrow	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Roseate Tern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by "-"

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	-	-	-	2	2	2	1	2	2	2	-	1	1	1
Willacy, TX	1	1	1	1	-	1	1	1	2	5	6	6	2	3	3	3	1	2	3	3
Kenedy, TX	5	7	7	7	5	9	9	9	10	22	23	24	10	22	23	23	8	15	16	16
Kleberg, TX	8	11	11	11	8	13	13	13	7	12	12	12	9	14	14	14	8	12	13	13
Nueces, TX	23	27	27	27	12	19	19	19	13	18	19	19	12	19	20	20	15	21	21	21
Aransas, TX	33	36	36	36	18	26	26	26	10	13	14	14	10	16	17	17	18	23	23	23
Calhoun, TX	11	14	14	14	15	22	23	23	7	11	12	13	5	10	11	11	10	14	15	15
Matagorda, TX	1	2	2	2	1	4	5	5	-	1	2	2	-	2	2	2	1	2	3	3
Brazoria, TX	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	-
Galveston, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chambers, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cameron, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iberia, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Mary, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrebonne, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lafourche, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plaquemines, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Escambia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walton, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dixie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dade, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broward, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palm Beach, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	82	97	97	98	58	94	96	96	49	84	92	93	48	87	93	93	60	91	95	95
LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	-
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passerines	82	96	97	97	58	91	93	93	49	83	90	91	48	87	91	92	59	89	93	93
Raptors	82	96	97	97	58	92	93	93	49	84	91	91	48	87	92	92	59	90	93	94
Shorebirds	82	96	97	97	58	92	94	94	49	84	91	92	48	87	92	93	59	90	93	94
Wading Birds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waterfowl	82	96	97	97	58	92	93	93	49	84	91	91	48	87	92	92	59	90	93	94
Diving Birds	82	96	97	97	58	92	94	94	49	84	91	92	48	87	92	93	59	90	93	94
Gulls/Terns	82	96	97	97	58	92	94	94	49	84	92	92	48	87	92	93	59	90	94	94
Piping Plover	9	11	11	11	12	22	23	23	14	23	26	26	14	24	25	25	12	20	21	21
Sea Turtle Nesting Habitat I	82	97	97	98	56	89	90	90	-	-	-	-	2	3	3	3	35	47	48	48
Sea Turtle Nesting Habitat II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sea Turtle Sporadic Nesting Habitat I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sea Turtle Sporadic Nesting Habitat II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Indian Manatee Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Indian Manatee Rare Habitat	82	97	97	98	58	94	96	96	21	28	28	28	2	3	3	3	41	56	56	56
Alabama Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perdido Key Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Andrews Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short Nose Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX Coastal Bend Beach Area	71	81	81	82	43	67	68	68	42	72	77	77	42	75	79	79	49	74	76	76
TX Matagorda Beach Area	12	16	16	16	16	27	28	28	7	12	14	15	6	12	13	13	10	17	18	18

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	-	-	-	-	1	1	1	-	-	1	1	-	-	1	1	-	-	1	1
TX Sea Rim State Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Beach Areas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL/MS Gulf Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf Shores	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Big Bend Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southwest Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Ten Thousand Islands Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Central East Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Northeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	71	81	81	82	43	67	68	68	42	72	77	77	42	75	79	79	49	74	76	76
Louisiana Black Bear	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Aplomado Falcon	1	1	1	1	-	1	1	1	3	7	8	8	2	5	5	5	1	3	4	4
Whooping Crane1	10	12	12	12	5	8	9	9	17	24	27	27	15	26	28	28	12	18	19	19

Table 2-4. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood Stork	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alabama Red-bellied Turtle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gopher Tortoise and Louisiana Quillwort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern Indigo Snake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Gopher Frog	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flatwoods Salamander	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telephus Spurge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sandhill Crane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Snail Kite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape Sable Seaside Sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roseate Tern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	2	3	-	1	5	6	-	-	3	4	-	-	2	3
Willacy, TX	-	-	-	-	-	-	2	3	-	-	3	3	-	-	2	3	-	-	2	2
Kenedy, TX	-	-	-	-	-	-	3	8	-	1	7	9	-	1	9	12	-	1	5	7
Kleberg, TX	-	1	1	1	-	-	2	3	-	1	4	4	-	-	5	6	-	-	3	3
Nueces, TX	-	1	2	2	-	-	1	2	-	1	4	4	-	1	5	6	-	1	3	4
Aransas, TX	-	1	3	3	-	-	2	3	-	1	4	5	-	1	7	8	-	1	4	5
Calhoun, TX	-	5	10	10	-	-	5	7	-	2	6	7	-	2	10	13	-	2	8	9
Matagorda, TX	-	17	28	28	-	1	9	13	-	3	9	11	-	3	12	15	-	6	14	17
Brazoria, TX	-	8	13	13	-	1	6	9	-	1	3	4	-	1	3	5	-	3	6	8
Galveston, TX	-	5	16	17	-	1	7	11	-	1	2	2	-	1	2	3	-	2	7	8
Chambers, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	-	10	11	-	-	2	4	-	-	-	1	-	-	-	1	-	-	3	4
Cameron, LA	-	1	5	5	-	-	4	6	-	-	-	-	-	-	-	-	-	-	2	3
Vermilion, LA	-	-	1	2	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	1
Iberia, LA	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
St. Mary, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrebonne, LA	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Lafourche, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plaquemines, LA	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin, AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Escambia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walton, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dixie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dade, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Broward, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Palm Beach, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	-	39	84	88	-	5	40	66	-	12	47	55	-	9	58	76	-	16	57	71
LA	-	1	7	8	-	-	7	11	-	-	-	-	-	-	-	-	-	-	3	5
MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tamaulipas, Mexico	-	-	-	-	-	-	2	5	-	-	2	5	-	-	2	4	-	-	2	4
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passerines	-	12	23	24	-	2	20	33	-	8	36	41	-	6	45	58	-	7	31	39
Raptors	-	18	46	49	-	3	28	46	-	9	39	45	-	6	48	62	-	9	40	50
Shorebirds	-	25	58	61	-	4	33	54	-	9	41	48	-	8	51	66	-	11	46	57
Wading Birds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waterfowl	-	19	44	46	-	3	33	51	-	9	39	45	-	6	48	62	-	9	41	51
Diving Birds	-	27	64	67	-	4	39	63	-	10	42	49	-	8	52	67	-	12	49	62
Gulls/Terns	-	31	73	77	-	4	41	68	-	10	43	51	-	9	54	71	-	14	53	66
Piping Plover	-	4	7	7	-	2	15	24	-	3	14	16	-	4	19	24	-	3	14	18
Sea Turtle Nesting Habitat I	-	39	84	88	-	4	30	45	-	-	-	-	-	3	15	23	-	12	32	39
Sea Turtle Nesting Habitat II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sea Turtle Sporadic Nesting Habitat I	-	1	7	8	-	-	7	10	-	-	-	-	-	-	-	-	-	-	3	4
Sea Turtle Sporadic Nesting Habitat II	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Indian Manatee Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Indian Manatee Rare Habitat	-	40	90	95	-	5	47	74	-	5	13	13	-	3	15	23	-	13	41	51
Alabama Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perdido Key Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Andrews Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short Nose Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon Critical Habitat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
TX Coastal Bend Beach Area	-	4	7	7	-	1	12	22	-	4	27	31	-	3	31	40	-	3	19	25
TX Matagorda Beach Area	-	22	38	38	-	1	14	20	-	5	15	17	-	5	22	28	-	8	22	26

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	13	30	31	-	2	13	20	-	2	6	6	-	2	5	8	-	5	13	16
TX Sea Rim State Park	-	-	10	11	-	-	2	4	-	-	-	1	-	-	-	1	-	-	3	4
LA Beach Areas	-	1	5	6	-	-	4	6	-	-	-	-	-	-	-	-	-	-	2	3
AL/MS Gulf Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf Shores	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Big Bend Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southwest Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Ten Thousand Islands Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Southeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Central East Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Northeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	-	4	7	7	-	1	12	22	-	4	27	31	-	3	31	40	-	3	19	25
Louisiana Black Bear	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Northern Aplomado Falcon	-	-	-	-	-	-	3	5	-	1	7	9	-	-	5	8	-	-	4	6
Whooping Crane1	-	3	4	4	-	1	7	10	-	3	10	11	-	3	16	20	-	2	9	11

Table 2-5. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane2	-	-	1	2	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	1
Wood Stork	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alabama Red-bellied Turtle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gopher Tortoise and Louisiana Quillwort	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern Indigo Snake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Gopher Frog	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flatwoods Salamander	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telephus Spurge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sandhill Crane	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Snail Kite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cape Sable Seaside Sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Roseate Tern	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by "-"

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Willacy, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy, TX	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	1
Kleberg, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nueces, TX	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Aransas, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calhoun, TX	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Matagorda, TX	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	3	-	-	-	2
Brazoria, TX	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Galveston, TX	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	2	-	-	-	1
Chambers, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Cameron, LA	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Vermilion, LA	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Iberia, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
St. Mary, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrebonne, LA	-	-	1	2	-	-	2	3	-	-	1	2	-	-	1	3	-	-	1	3
Lafourche, LA	-	-	1	1	-	-	1	2	-	-	1	2	-	-	1	2	-	-	1	2
Jefferson, LA	-	-	1	1	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1
Plaquemines, LA	-	-	2	4	-	1	8	11	-	1	4	6	-	-	3	5	-	1	4	7

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	-	1	1	-	-	2	3	-	-	-	-	-	-	-	1	-	-	1	1
Hancock, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison, MS	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson, MS	-	-	1	1	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Mobile, AL	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Baldwin, AL	-	-	2	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	1
Escambia, FL	-	-	2	3	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	1
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Walton, FL	-	-	2	3	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1
Bay, FL	-	-	3	5	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1
Gulf, FL	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Franklin, FL	-	-	2	4	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	1
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Dixie, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	-	1	-	-	-	1	-	-	-	1	-	-	1	3	-	-	-	1
Dade, FL	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	1
Broward, FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Palm Beach, FL	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	-	-	-	-	-	-	-	10	-	-	1	10	-	-	-	9	-	-	-	7
LA	-	-	5	11	-	2	14	22	-	1	7	13	-	-	6	16	-	1	8	16
MS	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
AL	-	-	3	4	-	-	-	1	-	-	1	1	-	-	-	2	-	-	1	2
FL	-	-	15	34	-	-	2	7	-	-	1	2	-	-	4	13	-	-	5	14
Tamaulipas, Mexico	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	1	-	-	1	4	-	-	1	3	-	-	1	2
Passerines	-	-	5	9	-	-	1	8	-	-	1	7	-	-	2	9	-	-	2	8
Raptors	-	-	11	22	-	-	1	10	-	-	1	8	-	-	1	9	-	-	4	12
Shorebirds	-	-	15	27	-	-	7	20	-	-	5	16	-	-	6	22	-	-	8	21
Wading Birds	-	-	5	8	-	-	1	2	-	-	1	2	-	-	1	3	-	-	2	4
Waterfowl	-	-	10	25	-	2	15	30	-	1	8	20	-	-	7	23	-	1	10	24
Diving Birds	-	-	10	20	-	2	15	31	-	1	8	23	-	-	7	26	-	1	10	25
Gulls/Terns	-	-	17	34	-	2	12	31	-	1	9	25	-	-	9	32	-	1	12	31
Piping Plover	-	-	2	3	-	1	6	15	-	-	5	13	-	-	4	13	-	-	4	11
Sea Turtle Nesting Habitat I	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	5	-	-	-	2
Sea Turtle Nesting Habitat II	-	-	17	32	-	-	2	7	-	-	1	1	-	-	3	11	-	-	6	13
Sea Turtle Sporadic Nesting Habitat I	-	-	4	8	-	-	5	8	-	-	-	-	-	-	1	5	-	-	2	5
Sea Turtle Sporadic Nesting Habitat II	-	-	4	12	-	1	9	13	-	1	2	2	-	-	1	3	-	-	4	7
West Indian Manatee Habitat	-	-	15	34	-	-	2	7	-	-	1	2	-	-	4	13	-	-	5	14

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	-	-	5	8	-	-	3	4	-	-	-	-	-	-	1	3	-	-	2	4
West Indian Manatee Rare Habitat	-	-	5	11	-	2	12	24	-	1	2	2	-	-	2	12	-	1	5	12
Alabama Beach Mouse	-	-	2	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	1
Perdido Key Beach Mouse	-	-	3	5	-	-	-	1	-	-	-	1	-	-	1	4	-	-	1	3
Santa Rosa Beach Mouse	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	1
Choctawhatchee Beach Mouse	-	-	6	10	-	-	-	1	-	-	-	-	-	-	2	2	-	-	2	3
St. Andrews Beach Mouse	-	-	5	8	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	2
Southeastern Beach Mouse	-	-	-	1	-	-	-	2	-	-	-	1	-	-	1	3	-	-	-	2
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	-	2	-	-	-	1	-	-	-	1	-	-	1	4	-	-	1	2
Short Nose Sturgeon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Sturgeon Critical Habitat	-	-	17	28	-	-	3	6	-	-	1	3	-	-	4	9	-	-	6	12
Gulf Sturgeon	-	-	20	39	-	1	9	15	-	1	3	6	-	-	5	13	-	-	9	18
TX Coastal Bend Beach Area	-	-	-	-	-	-	-	4	-	-	-	3	-	-	-	1	-	-	-	2
TX Matagorda Beach Area	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	4	-	-	-	3

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	-	-	-	-	-	-	2	-	-	-	3	-	-	-	3	-	-	-	2
TX Sea Rim State Park	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
LA Beach Areas	-	-	2	4	-	-	1	4	-	-	2	3	-	-	1	4	-	-	2	4
AL/MS Gulf Islands	-	-	2	4	-	-	-	1	-	-	1	1	-	-	-	2	-	-	1	2
AL Gulf Shores	-	-	2	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	1
FL Panhandle Beach Area	-	-	12	20	-	-	-	2	-	-	-	-	-	-	3	5	-	-	4	7
FL Big Bend Beach Area	-	-	2	9	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2
FL Southwest Beach Area	-	-	-	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
FL Ten Thousand Islands Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
FL Southeast Beach Area	-	-	-	3	-	-	-	3	-	-	1	2	-	-	1	6	-	-	1	3
FL Central East Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Northeast Beach Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	-	-	-	-	-	-	-	4	-	-	-	3	-	-	-	1	-	-	-	2
Louisiana Black Bear	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Northern Aplomado Falcon	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Whooping Crane1	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-	-	1

Table 2-6. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Wood Stork	-	-	18	39	-	-	2	8	-	-	1	4	-	-	5	15	-	-	7	16
Alabama Red-bellied Turtle	-	-	4	6	-	-	-	1	-	-	1	2	-	-	1	3	-	-	1	3
Gopher Tortoise and Louisiana Quillwort	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Eastern Indigo Snake	-	-	15	34	-	-	2	7	-	-	1	2	-	-	4	13	-	-	5	14
Mississippi Gopher Frog	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Flatwoods Salamander	-	-	3	5	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	2
Telephus Spurge	-	-	8	12	-	-	-	1	-	-	-	-	-	-	-	2	-	-	2	4
Mississippi Sandhill Crane	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Everglades Snail Kite	-	-	-	3	-	-	-	3	-	-	1	2	-	-	1	6	-	-	1	3
Cape Sable Seaside Sparrow	-	-	-	3	-	-	-	2	-	-	1	1	-	-	1	5	-	-	1	3
Roseate Tern	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	2	-	-	-	1

Note: Values of <0.5% are indicated by "-"

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cameron, TX	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Willacy, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy, TX	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Kleberg, TX	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Nueces, TX	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
Aransas, TX	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
Calhoun, TX	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	1
Matagorda, TX	-	-	-	1	-	-	-	3	-	-	-	2	-	-	-	2	-	-	-	2
Brazoria, TX	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	1	-	-	-	1
Galveston, TX	-	-	-	-	-	-	1	2	-	-	-	1	-	-	-	3	-	-	-	2
Chambers, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, TX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Cameron, LA	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	1
Vermilion, LA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iberia, LA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
St. Mary, LA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terrebonne, LA	-	-	1	2	-	-	1	2	-	-	1	1	-	-	1	2	-	-	1	2
Lafourche, LA	-	-	1	2	-	-	1	3	-	-	-	-	-	-	-	1	-	-	1	1
Jefferson, LA	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Plaquemines, LA	-	-	2	3	-	-	2	3	-	-	2	2	-	-	1	3	-	-	2	3

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
St. Bernard, LA	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson, MS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile, AL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Baldwin, AL	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Escambia, FL	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Santa Rosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Okaloosa, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walton, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay, FL	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Gulf, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wakulla, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Taylor, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dixie, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Levy, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citrus, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hernando, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pasco, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinellas, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hillsborough, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatee, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sarasota, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Charlotte, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lee, FL	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collier, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monroe, FL	-	-	1	3	-	-	1	2	-	-	1	1	-	-	2	4	-	-	1	3
Dade, FL	-	-	1	2	-	-	1	3	-	-	1	2	-	-	2	4	-	-	1	3
Broward, FL	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	2	-	-	-	1
Palm Beach, FL	-	-	-	1	-	-	-	1	-	-	-	1	-	-	1	2	-	-	1	1
Martin, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Lucie, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indian River, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brevard, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volusia, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flagler, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
St. Johns, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duval, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassau, FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX	-	-	1	2	-	-	2	12	-	-	1	7	-	-	-	11	-	-	1	8
LA	-	-	6	12	-	-	5	11	-	-	3	4	-	-	3	9	-	-	4	9
MS	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
FL	-	-	6	21	-	-	3	9	-	-	2	5	-	-	7	15	-	-	4	13
Tamaulipas, Mexico	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Veracruz-Llave, Mexico	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Tabasco, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Campeche, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yucatan, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quintana Roo, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belize (country)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	1	-	-	-	1	-	-	2	5	-	-	2	4	-	-	1	3
Passerines	-	-	1	4	-	-	1	7	-	-	1	4	-	-	-	5	-	-	1	5
Raptors	-	-	2	10	-	-	1	9	-	-	1	5	-	-	2	11	-	-	1	9
Shorebirds	-	-	8	20	-	-	6	19	-	-	4	10	-	-	4	18	-	-	5	17
Wading Birds	-	-	1	5	-	-	-	2	-	-	-	1	-	-	1	2	-	-	1	3
Waterfowl	-	-	8	19	-	-	6	19	-	-	4	8	-	-	3	15	-	-	5	15
Diving Birds	-	-	9	18	-	-	7	22	-	-	4	10	-	-	3	18	-	-	6	17
Gulls/Terns	-	-	11	27	-	-	9	27	-	-	5	14	-	-	7	27	-	-	8	24
Piping Plover	-	-	-	1	-	-	4	12	-	-	2	5	-	-	3	9	-	-	2	7
Sea Turtle Nesting Habitat I	-	-	1	4	-	-	2	6	-	-	-	-	-	-	1	9	-	-	1	5
Sea Turtle Nesting Habitat II	-	-	7	21	-	-	4	9	-	-	-	1	-	-	2	8	-	-	3	10
Sea Turtle Sporadic Nesting Habitat I	-	-	5	10	-	-	4	7	-	-	-	-	-	-	1	4	-	-	2	6
Sea Turtle Sporadic Nesting Habitat II	-	-	1	6	-	-	1	2	-	-	-	-	-	-	-	1	-	-	1	2
West Indian Manatee Habitat	-	-	6	21	-	-	3	9	-	-	2	5	-	-	7	15	-	-	4	13

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
West Indian Manatee Sporadic Habitat	-	-	2	4	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	2
West Indian Manatee Rare Habitat	-	-	7	13	-	-	7	19	-	-	-	-	-	-	1	12	-	-	4	11
Alabama Beach Mouse	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Perdido Key Beach Mouse	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Santa Rosa Beach Mouse	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Beach Mouse	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
St. Andrews Beach Mouse	-	-	1	3	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1
Southeastern Beach Mouse	-	-	1	3	-	-	1	2	-	-	1	2	-	-	2	4	-	-	1	3
Anastasia Island Beach Mouse	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Smalltooth Sawfish Critical Habitat	-	-	2	5	-	-	2	4	-	-	1	1	-	-	3	6	-	-	2	4
Short Nose Sturgeon	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	1
Gulf Sturgeon Critical Habitat	-	-	5	11	-	-	-	1	-	-	-	1	-	-	1	3	-	-	2	4
Gulf Sturgeon	-	-	5	16	-	-	1	2	-	-	1	1	-	-	2	5	-	-	2	6
TX Coastal Bend Beach Area	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	2	-	-	-	2
TX Matagorda Beach Area	-	-	-	1	-	-	-	5	-	-	-	2	-	-	-	3	-	-	-	3

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
TX Galveston Beach Area	-	-	-	1	-	-	1	3	-	-	-	2	-	-	-	5	-	-	-	3
TX Sea Rim State Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
LA Beach Areas	-	-	2	4	-	-	2	5	-	-	-	-	-	-	1	2	-	-	1	3
AL/MS Gulf Islands	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
AL Gulf Shores	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle Beach Area	-	-	3	6	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	2
FL Big Bend Beach Area	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
FL Southwest Beach Area	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
FL Ten Thousand Islands Area	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
FL Southeast Beach Area	-	-	2	7	-	-	3	6	-	-	2	4	-	-	5	10	-	-	3	7
FL Central East Beach Area	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
FL Northeast Beach Area	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
FL Gulf Coast Jaguarondi and Ocelot	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	2	-	-	-	2
Louisiana Black Bear	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Northern Aplomado Falcon	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Whooping Crane1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	1	-	-	-	1

Table 2-7. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Whooping Crane2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wood Stork	-	-	7	24	-	-	3	9	-	-	2	6	-	-	7	15	-	-	5	14
Alabama Red-bellied Turtle	-	-	2	3	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	1
Gopher Tortoise and Louisiana Quillwort	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eastern Indigo Snake	-	-	6	21	-	-	3	9	-	-	2	5	-	-	7	15	-	-	4	13
Mississippi Gopher Frog	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flatwoods Salamander	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telephus Spurge	-	-	1	3	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1
Mississippi Sandhill Crane	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Snail Kite	-	-	2	7	-	-	3	6	-	-	2	5	-	-	5	11	-	-	3	7
Cape Sable Seaside Sparrow	-	-	2	6	-	-	2	5	-	-	1	3	-	-	4	8	-	-	2	6
Roseate Tern	-	-	2	6	-	-	2	4	-	-	-	-	-	-	1	3	-	-	1	3

Note: Values of <0.5% are indicated by "-"

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	-	13	24	24	-	10	38	43	-	10	39	43	-	10	44	67	-	11	36	44
West LA State Waters	26	72	80	80	7	35	55	57	8	25	30	33	9	22	27	29	13	38	48	50
East LA State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MS State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle State Waters	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
West FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexican Waters	-	-	-	-	-	-	1	1	-	-	-	3	-	-	-	1	-	-	-	1

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	-	-	-	-	-	1	13	14	-	-	14	20	-	-	15	28	-	1	11	16
Texas East Waters (0-200 m) for EFH	1	20	24	24	4	29	44	46	4	47	60	62	2	47	69	74	3	36	49	52
Louisiana Waters West of Mississippi River (0-200 m)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
Louisiana Waters East of Mississippi River (0-200 m)	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Waters (0-200 m)	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1
Alabama Waters (0-200 m)	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1
Florida Panhandle Waters (0-200 m)	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1
Florida Bend Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Southwest Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Southeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Northeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (1)	-	-	-	-	-	-	1	1	-	-	-	2	-	-	-	1	-	-	-	1
Shoreline - 20 m (2)	-	-	-	-	-	-	12	13	-	-	9	14	-	-	9	25	-	-	8	13
Shoreline - 20 m (3)	1	19	24	24	2	18	34	37	1	26	43	45	1	27	51	55	1	22	38	40
Shoreline - 20 m (4)	84	95	96	96	68	82	85	86	55	68	70	71	63	76	78	78	68	80	82	83

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (5)	1	3	4	4	4	11	15	16	-	3	5	6	1	5	7	8	2	6	8	8
Shoreline - 20 m (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (8)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (9)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (1)	-	-	-	-	-	1	12	12	-	-	14	20	-	-	15	27	-	1	10	15
20 m - 300 m (2)	-	8	10	10	3	20	30	32	3	40	55	57	2	39	62	67	2	27	39	41
20 m - 300 m (3)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
20 m - 300 m (4)	-	1	1	2	1	8	11	12	1	4	9	10	2	7	9	10	1	5	8	8
20 m - 300 m (5)	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (6)	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1
20 m - 300 m (7)	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1
20 m - 300 m (8)	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1
20 m - 300 m (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	-	-	-	-	-	1	5	5	-	2	13	19	-	-	15	23	-	1	8	12
300 m - outer jurisdiction (2)	-	-	-	-	-	1	4	4	-	1	11	19	-	-	8	12	-	-	6	9
300 m - outer jurisdiction (3)	-	-	-	-	-	2	5	6	-	8	21	25	-	6	22	27	-	4	12	15
300 m - outer jurisdiction (4)	-	-	-	-	-	1	4	4	-	3	16	24	-	2	11	15	-	2	8	11
300 m - outer jurisdiction (5)	-	-	-	-	-	-	1	2	-	-	7	17	-	-	5	7	-	-	3	6
300 m - outer jurisdiction (6)	-	-	-	-	-	2	3	3	1	12	25	27	-	6	14	17	-	5	11	12
300 m - outer jurisdiction (7)	-	-	-	-	-	-	1	2	-	3	16	20	-	2	8	11	-	1	6	8
300 m - outer jurisdiction (8)	-	-	-	-	-	-	-	1	-	1	9	13	-	-	5	7	-	-	3	5
300 m - outer jurisdiction (9)	-	-	-	1	-	-	1	2	-	6	15	17	-	5	9	11	-	3	6	8
300 m - outer jurisdiction (10)	-	-	-	-	-	-	1	2	-	4	14	17	-	3	8	9	-	2	6	7
300 m - outer jurisdiction (11)	-	-	-	-	-	-	1	1	-	1	10	12	-	-	3	5	-	-	3	5
300 m - outer jurisdiction (12)	-	-	-	-	-	2	4	4	-	-	3	5	-	1	3	3	-	1	2	3
300 m - outer jurisdiction (13)	-	-	-	-	-	1	2	2	-	1	4	6	-	2	3	4	-	1	2	3
300 m - outer jurisdiction (14)	-	-	-	-	-	-	1	1	-	-	3	5	-	-	2	3	-	-	1	2
300 m - outer jurisdiction (15)	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1
300 m - outer jurisdiction (16)	-	-	-	-	-	-	2	2	-	-	-	2	-	-	1	2	-	-	1	2

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	-	-	-	-	-	-	1	2	-	-	1	2	-	-	2	3	-	-	1	2
300 m - outer jurisdiction (18)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (20)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	1
300 m - outer jurisdiction (21)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (22)	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1
300 m - outer jurisdiction (23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (24)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	1
300 m - outer jurisdiction (25)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
300 m - outer jurisdiction (26)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
300 m - outer jurisdiction (27)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Atlantic Right Whale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Sargassum (May/June)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum (July/August)	-	-	-	1	1	6	10	10	-	-	-	-	-	-	-	-	-	2	2	3
Seagrass-Wakulla County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Dixie County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Levy County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (3)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Topographic Features (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (12)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2	2	-	-	1	1
Stetson Bank	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	1
Topographic Features (13)	-	-	-	-	-	-	1	1	-	-	2	2	-	-	3	4	-	-	2	2
Topographic Features (14)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1
Topographic Features (15)	-	-	-	-	-	-	1	1	-	1	2	3	-	1	4	4	-	1	2	2
East Flower Garden Bank	-	-	-	-	-	-	1	1	-	2	4	5	-	2	5	6	-	1	3	3
West Flower Garden Bank	-	-	-	-	-	1	1	1	-	2	5	6	-	1	3	4	-	1	2	3
Topographic Features (16)	-	-	-	-	-	-	-	-	-	1	3	3	-	1	2	3	-	1	1	2
Topographic Features (17)	-	-	-	-	-	-	1	1	-	1	2	3	-	1	2	2	-	1	1	1
Topographic Features (18)	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	-	-	1	1
Topographic Features (19)	-	-	-	-	-	-	-	-	-	1	2	2	-	1	1	1	-	1	1	1
Topographic Features (20)	-	-	-	-	-	1	1	1	-	1	3	3	-	1	2	2	-	1	1	2
Topographic Features (21)	-	-	-	-	-	-	1	1	-	2	4	5	-	1	2	3	-	1	2	2

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1
Topographic Features (23)	-	-	-	-	-	-	-	-	-	1	3	3	-	1	2	2	-	-	1	1
Sonnier Bank	-	-	-	-	-	-	1	1	1	3	3	3	1	2	3	3	1	1	2	2
Topographic Features (24)	-	-	-	-	-	-	1	1	1	2	3	3	-	2	2	3	-	1	2	2
Topographic Features (25)	-	-	-	-	-	-	-	-	-	1	2	3	-	1	2	2	-	1	1	1
Topographic Features (26)	-	-	-	-	-	-	-	-	-	1	2	2	-	-	1	1	-	-	1	1
Topographic Features (27)	-	-	-	-	-	-	-	1	-	1	2	2	-	1	2	3	-	1	1	1
Topographic Features (28)	-	-	-	-	-	-	-	-	-	1	2	2	-	1	2	2	-	1	1	1
Topographic Features (29)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	-
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (31)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
Topographic Features (32)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	1	-	-	1	1
Topographic Features (33)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (34)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Topographic Features (35)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinnacle Trend	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulley Ridge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madison Swanson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steamboat Lumps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dry Tortugas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (Year Round)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Key Biscayne National Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas Clipper and South Texas Platform	-	-	-	-	-	-	1	2	-	-	1	1	-	-	-	-	-	-	-	1
Port Lavaca/Liberty Ship Reef	-	3	4	4	-	7	16	17	-	7	17	17	-	1	4	4	-	4	10	11
High Island	-	8	13	13	1	6	13	14	-	10	15	15	-	1	4	4	-	6	11	11
West Cameron	12	27	30	30	11	31	38	40	12	32	33	33	-	3	4	4	9	23	26	27
Galveston Area (GA 393)	-	-	-	-	-	1	2	2	-	-	2	2	-	-	1	1	-	-	1	1
Cognac Platform (MC 194)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horseshoe Rigs (MP 306)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion Area	>99	>99	>99	>99	>99	>99	>99	>99	66	66	66	66	1	1	1	1	67	67	67	67
Vermilion Area, South Addition	3	6	6	6	3	8	9	10	7	11	13	13	-	-	-	-	3	6	7	7

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
South Timbalier	-	1	1	1	-	6	8	8	-	-	-	-	-	-	-	1	-	2	2	3
South Timbalier Area, South Addition	-	-	-	-	-	2	3	3	-	-	-	-	-	-	-	-	-	1	1	1
Panhandle FL	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Tampa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daytona Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank (April-Nov)	-	-	-	-	-	-	1	1	-	1	2	2	-	-	-	-	-	-	1	1
West Flower Garden Bank (April-Nov)	-	-	-	-	-	1	1	1	-	1	2	2	-	-	-	-	-	1	1	1
Chandeleur Islands (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve1 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve2 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX Gulf_State WatersState Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State WatersState Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-8. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point One Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
LA Gulf_State WatersState Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MS Gulf_State WatersState Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State WatersState Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	2	-	-	-	2
West LA State Waters	-	-	1	1	-	1	3	5	-	4	8	8	-	3	9	12	-	2	5	6
East LA State Waters	6	15	17	17	13	29	38	41	14	37	42	43	12	30	38	40	11	28	34	35
MS State Waters	12	22	23	23	7	15	18	19	10	18	21	21	11	19	22	24	10	18	21	22
AL State Waters	29	43	46	47	11	22	26	26	13	18	19	20	17	25	27	28	17	27	30	30
FL Panhandle State Waters	5	17	23	27	3	13	21	22	1	3	5	5	1	4	6	7	3	9	14	15
West FL State Waters	-	-	2	4	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	2
Tortugas State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeast FL State Waters	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Northeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexican Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	1	-	-	-	1
Texas East Waters (0-200 m) for EFH	-	-	-	-	-	-	1	2	-	-	2	3	-	-	1	3	-	-	1	2
Louisiana Waters West of Mississippi River (0-200 m)	-	-	1	1	-	2	4	7	1	7	13	16	-	5	13	17	-	4	8	10
Louisiana Waters East of Mississippi River (0-200 m)	7	16	18	18	15	30	40	43	19	43	49	50	16	35	44	46	14	31	38	39
Mississippi Waters (0-200 m)	30	39	40	41	36	50	57	60	52	67	71	71	46	60	65	66	41	54	58	60
Alabama Waters (0-200 m)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
Florida Panhandle Waters (0-200 m)	17	30	34	35	15	36	40	40	6	12	15	15	9	19	22	23	12	24	28	28
Florida Bend Waters (0-200 m)	-	1	7	9	-	2	6	7	-	-	2	2	-	1	2	3	-	1	4	5
Florida Southwest Waters (0-200 m)	-	-	2	2	-	-	1	1	-	-	1	1	-	-	-	2	-	-	1	2
Florida Keys Waters (0-200m)	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Florida Southeast Waters (0-200 m)	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Florida Northeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (2)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Shoreline - 20 m (3)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
Shoreline - 20 m (4)	-	-	-	-	-	-	1	2	-	-	1	2	-	-	1	2	-	-	1	1
Shoreline - 20 m (5)	-	-	1	1	-	1	3	5	-	3	8	9	-	2	9	11	-	2	5	7

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	7	16	17	18	14	29	38	40	17	39	43	44	15	31	39	41	13	29	34	36
Shoreline - 20 m (7)	22	33	34	35	27	42	49	51	33	49	52	53	30	43	48	50	28	42	46	47
Shoreline - 20 m (8)	52	63	66	67	30	43	47	47	26	33	34	35	35	44	46	47	35	46	48	49
Shoreline - 20 m (9)	3	13	21	26	2	10	18	19	-	2	4	4	1	3	5	6	1	7	12	14
Shoreline - 20 m (10)	-	-	2	5	-	-	1	2	-	-	-	-	-	-	-	-	-	-	1	2
Shoreline - 20 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (12)	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Shoreline - 20 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (1)	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	2	-	-	-	1
20 m - 300 m (2)	-	-	-	-	-	-	1	2	-	-	2	3	-	-	1	3	-	-	1	2
20 m - 300 m (3)	-	-	-	-	-	-	2	3	-	1	3	5	-	-	2	4	-	-	2	3
20 m - 300 m (4)	-	-	1	1	-	2	5	7	1	8	13	16	-	5	14	17	-	4	8	10
20 m - 300 m (5)	1	3	5	5	2	5	10	13	3	20	26	28	4	17	24	26	2	11	16	18
20 m - 300 m (6)	21	28	30	30	31	42	49	52	47	62	65	66	40	52	58	60	35	46	51	52
20 m - 300 m (7)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
20 m - 300 m (8)	16	28	32	32	15	36	39	39	6	12	15	15	9	19	22	23	11	24	27	28
20 m - 300 m (9)	-	1	7	9	-	3	7	7	-	1	3	3	-	1	3	5	-	1	5	6
20 m - 300 m (10)	-	-	2	2	-	-	1	1	-	-	1	1	-	-	-	2	-	-	1	2
20 m - 300 m (11)	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
20 m - 300 m (12)	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
20 m - 300 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	2	-	-	-	1
300 m - outer jurisdiction (2)	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	2	-	-	-	1
300 m - outer jurisdiction (3)	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	2	-	-	-	1
300 m - outer jurisdiction (4)	-	-	-	-	-	-	-	1	-	-	1	4	-	-	-	3	-	-	-	2
300 m - outer jurisdiction (5)	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	3	-	-	-	2
300 m - outer jurisdiction (6)	-	-	-	-	-	-	-	1	-	-	2	5	-	-	1	2	-	-	1	2
300 m - outer jurisdiction (7)	-	-	-	-	-	-	-	1	-	-	1	5	-	-	1	4	-	-	1	2
300 m - outer jurisdiction (8)	-	-	-	-	-	-	-	1	-	-	1	5	-	-	-	3	-	-	-	2
300 m - outer jurisdiction (9)	-	-	-	-	-	-	1	1	-	-	3	6	-	-	3	5	-	-	1	3
300 m - outer jurisdiction (10)	-	-	-	-	-	-	1	1	-	-	4	8	-	-	3	6	-	-	2	4
300 m - outer jurisdiction (11)	-	-	-	-	-	-	1	1	-	-	3	9	-	-	2	5	-	-	1	4
300 m - outer jurisdiction (12)	-	-	1	1	-	1	2	5	-	6	14	18	-	4	12	15	-	3	7	10
300 m - outer jurisdiction (13)	-	-	-	-	-	-	1	3	-	3	14	17	-	1	6	10	-	1	5	7
300 m - outer jurisdiction (14)	-	-	-	-	-	-	1	3	-	-	7	12	-	-	4	7	-	-	3	6
300 m - outer jurisdiction (15)	1	5	7	7	-	3	7	9	7	23	27	28	7	20	28	30	4	13	17	18
300 m - outer jurisdiction (16)	-	2	4	4	-	1	5	8	2	16	25	26	3	15	24	26	1	9	14	16

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	-	1	1	1	-	-	1	5	-	4	16	17	-	4	15	19	-	2	8	11
300 m - outer jurisdiction (18)	-	1	2	2	-	1	3	6	-	6	16	17	1	8	17	20	-	4	10	11
300 m - outer jurisdiction (19)	-	-	2	2	-	-	3	6	-	3	12	12	-	4	15	16	-	2	8	9
300 m - outer jurisdiction (20)	-	-	-	-	-	-	-	2	-	-	3	6	-	-	2	5	-	-	1	3
300 m - outer jurisdiction (21)	-	-	1	1	-	-	2	4	-	1	6	8	-	2	9	10	-	1	5	6
300 m - outer jurisdiction (22)	1	8	12	12	1	9	15	17	4	14	18	18	5	18	24	24	3	12	17	18
300 m - outer jurisdiction (23)	-	-	1	2	-	-	2	3	-	-	2	4	-	1	5	6	-	-	2	4
300 m - outer jurisdiction (24)	-	-	-	1	-	-	1	3	-	-	3	7	-	-	7	8	-	-	3	5
300 m - outer jurisdiction (25)	-	-	-	1	-	-	-	1	-	-	1	2	-	-	1	3	-	-	1	2
300 m - outer jurisdiction (26)	-	-	-	-	-	-	-	1	-	-	1	3	-	-	1	4	-	-	1	2
300 m - outer jurisdiction (27)	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Atlantic Right Whale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Sargassum (May/June)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum (July/August)	-	-	1	1	-	-	3	4	-	-	-	-	-	-	-	-	-	-	1	1
Seagrass-Wakulla County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Dixie County	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Levy County	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
West Flower Garden Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (16)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (17)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (18)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (20)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (21)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sonnier Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (25)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (26)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (27)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (29)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (31)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (32)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (33)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (34)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (35)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Pinnacle Trend	7	13	15	15	5	13	19	20	24	36	38	38	25	38	42	42	15	25	28	29
Chandeleur Islands	6	14	15	15	12	25	31	33	13	28	30	31	11	24	30	31	11	23	27	28

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Pulley Ridge	-	-	1	2	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Madison Swanson	-	1	3	4	-	1	2	3	-	1	2	2	-	1	2	2	-	1	2	3
Steamboat Lumps	-	-	1	1	-	-	-	1	-	-	-	1	-	-	1	1	-	-	-	1
Dry Tortugas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve South	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Florida Keys National Marine Sanctuary (Year Round)	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Key Biscayne National Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas Clipper and South Texas Platform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Port Lavaca/Liberty Ship Reef	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
High Island	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
West Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galveston Area (GA 393)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cognac Platform (MC 194)	-	-	-	-	-	-	-	1	-	1	1	1	-	-	-	-	-	-	1	1
Horseshoe Rigs (MP 306)	-	-	1	1	-	-	1	2	1	2	2	2	-	1	1	1	-	1	1	1
Vermilion Area	-	-	-	-	-	-	1	2	-	-	1	1	-	-	-	-	-	-	-	1
Vermilion Area, South Addition	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-	-	-	-	1

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Timbalier	-	-	-	-	-	-	2	3	-	1	2	2	-	-	-	1	-	-	1	2
South Timbalier Area, South Addition	-	-	-	-	-	-	1	2	-	-	2	2	-	-	-	-	-	-	1	1
Panhandle FL	6	17	23	24	5	20	24	25	1	3	4	4	-	-	1	1	3	10	13	14
Tampa	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Daytona Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur Islands (April-Nov)	6	14	15	15	12	25	31	33	10	20	21	21	-	1	3	4	7	15	18	18
Tortugas Ecological Reserve1 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve2 (April-Nov)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (April-Nov)	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
TX Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-9. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Two Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
MS Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	-	-	15	19	-	-	8	32	-	-	10	22	-	-	13	45	-	-	11	30
West LA State Waters	-	15	50	54	-	2	7	12	-	1	3	6	-	2	9	13	-	5	17	21
East LA State Waters	-	1	3	3	-	-	1	2	-	-	-	1	-	-	1	1	-	-	1	2
MS State Waters	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL State Waters	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
FL Panhandle State Waters	-	-	3	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2
West FL State Waters	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	1
Tortugas State Waters	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Southeast FL State Waters	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	1
Northeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexican Waters	-	-	-	-	-	-	1	5	-	-	-	5	-	-	-	2	-	-	-	3

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	-	-	1	1	-	-	7	23	-	-	10	22	-	-	4	24	-	-	6	18
Texas East Waters (0-200 m) for EFH	-	1	18	21	-	2	18	33	-	1	20	33	-	-	27	47	-	1	21	33
Louisiana Waters West of Mississippi River (0-200 m)	14	57	75	79	3	18	38	47	2	13	25	33	4	25	47	55	6	28	46	53
Louisiana Waters East of Mississippi River (0-200 m)	-	2	7	8	-	-	2	3	-	-	-	-	-	-	2	2	-	1	3	3
Mississippi Waters (0-200 m)	-	2	8	9	-	-	2	3	-	-	-	-	-	-	1	1	-	-	3	3
Alabama Waters (0-200 m)	-	2	8	10	-	-	2	3	-	-	-	-	-	-	1	1	-	-	3	4
Florida Panhandle Waters (0-200 m)	-	1	7	9	-	-	1	2	-	-	-	-	-	-	1	1	-	-	2	3
Florida Bend Waters (0-200 m)	-	-	1	5	-	-	1	3	-	-	-	-	-	-	1	1	-	-	1	2
Florida Southwest Waters (0-200 m)	-	-	-	3	-	-	2	4	-	-	-	1	-	-	1	3	-	-	1	2
Florida Keys Waters (0-200 m)	-	-	-	1	-	-	1	2	-	-	-	1	-	-	-	2	-	-	-	2
Florida Southeast Waters (0-200 m)	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1
Florida Northeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (1)	-	-	-	-	-	-	1	4	-	-	-	3	-	-	-	1	-	-	-	2
Shoreline - 20 m (2)	-	-	1	1	-	-	3	19	-	-	5	12	-	-	3	21	-	-	3	13
Shoreline - 20 m (3)	-	-	16	20	-	1	8	18	-	-	7	16	-	-	13	30	-	-	11	21
Shoreline - 20 m (4)	-	6	28	30	-	1	6	11	-	1	3	5	-	-	9	13	-	2	12	15
Shoreline - 20 m (5)	1	20	39	41	-	2	8	12	-	2	3	4	-	3	8	11	-	7	15	17

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	-	1	3	3	-	-	1	2	-	-	-	-	-	-	-	1	-	-	1	1
Shoreline - 20 m (7)	-	-	2	3	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1
Shoreline - 20 m (8)	-	-	2	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
Shoreline - 20 m (9)	-	-	3	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2
Shoreline - 20 m (10)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (12)	-	-	-	1	-	-	1	2	-	-	-	-	-	-	-	2	-	-	-	1
Shoreline - 20 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
20 m - 300 m (1)	-	-	1	1	-	-	7	23	-	-	10	22	-	-	4	24	-	-	6	18
20 m - 300 m (2)	-	1	14	16	-	2	19	32	-	1	21	36	-	-	27	46	-	1	20	33
20 m - 300 m (3)	1	20	36	39	1	11	28	37	-	11	23	32	-	14	39	47	-	14	32	39
20 m - 300 m (4)	17	52	63	65	4	16	30	35	3	7	10	12	5	20	29	32	7	24	33	36
20 m - 300 m (5)	-	3	7	8	-	-	2	3	-	-	-	-	-	1	2	2	-	1	3	3
20 m - 300 m (6)	-	2	8	10	-	-	2	3	-	-	-	-	-	-	1	2	-	1	3	4
20 m - 300 m (7)	-	2	9	11	-	-	2	3	-	-	-	-	-	-	1	1	-	-	3	4
20 m - 300 m (8)	-	1	7	10	-	-	1	2	-	-	-	-	-	-	1	1	-	-	2	4
20 m - 300 m (9)	-	-	1	6	-	-	2	5	-	-	-	-	-	-	1	1	-	-	1	3
20 m - 300 m (10)	-	-	-	3	-	-	2	4	-	-	-	1	-	-	1	4	-	-	1	3
20 m - 300 m (11)	-	-	-	1	-	-	1	3	-	-	-	1	-	-	-	2	-	-	-	2
20 m - 300 m (12)	-	-	-	1	-	-	-	2	-	-	-	1	-	-	-	2	-	-	-	1
20 m - 300 m (13)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	-	-	-	1	-	-	8	20	-	-	11	25	-	-	4	20	-	-	6	17
300 m - outer jurisdiction (2)	-	-	-	2	-	-	9	22	-	-	13	27	-	-	4	17	-	-	7	17
300 m - outer jurisdiction (3)	-	-	3	5	-	-	9	19	-	1	18	31	-	-	12	25	-	-	11	20
300 m - outer jurisdiction (4)	-	-	1	3	-	1	16	28	-	1	23	38	-	-	12	28	-	1	13	24
300 m - outer jurisdiction (5)	-	-	1	3	-	1	14	26	-	2	17	30	-	-	9	23	-	1	10	21
300 m - outer jurisdiction (6)	-	6	12	14	-	3	19	27	-	10	27	38	-	8	31	42	-	6	22	30
300 m - outer jurisdiction (7)	-	4	11	14	-	7	27	34	-	13	36	44	-	5	30	40	-	7	26	33
300 m - outer jurisdiction (8)	-	2	8	11	-	10	27	36	-	15	37	45	-	3	23	31	-	7	24	31
300 m - outer jurisdiction (9)	20	37	45	46	9	26	39	43	9	20	26	31	10	34	47	50	12	29	39	43
300 m - outer jurisdiction (10)	24	37	44	45	32	50	63	66	42	55	63	67	39	59	67	71	34	50	59	62
300 m - outer jurisdiction (11)	3	13	19	21	6	30	44	48	17	44	60	63	8	29	44	47	8	29	42	45
300 m - outer jurisdiction (12)	42	56	61	63	14	26	35	38	8	12	13	14	18	27	32	34	21	31	35	37
300 m - outer jurisdiction (13)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
300 m - outer jurisdiction (14)	18	23	26	27	29	42	47	49	48	60	63	64	36	47	50	52	33	43	47	48
300 m - outer jurisdiction (15)	2	7	14	17	-	1	6	7	-	-	-	-	-	1	4	5	-	3	6	7
300 m - outer jurisdiction (16)	4	17	22	23	6	17	26	27	-	2	2	3	4	10	14	16	3	11	16	17

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	3	13	19	19	9	20	27	29	2	8	14	17	6	14	19	21	5	14	20	22
300 m - outer jurisdiction (18)	-	4	10	12	-	5	10	12	-	1	1	2	-	1	3	5	-	3	6	8
300 m - outer jurisdiction (19)	-	2	5	9	-	2	6	8	-	-	1	1	-	1	3	4	-	1	4	5
300 m - outer jurisdiction (20)	-	2	5	8	-	5	10	12	-	1	5	8	-	5	9	10	-	3	7	10
300 m - outer jurisdiction (21)	-	-	3	6	-	1	3	5	-	-	-	1	-	-	2	3	-	-	2	3
300 m - outer jurisdiction (22)	-	1	7	12	-	-	3	5	-	-	-	1	-	-	2	2	-	-	3	5
300 m - outer jurisdiction (23)	-	-	1	5	-	-	4	7	-	-	-	1	-	-	1	3	-	-	2	4
300 m - outer jurisdiction (24)	-	1	5	9	-	3	11	13	-	1	5	8	-	4	9	11	-	2	7	10
300 m - outer jurisdiction (25)	-	-	1	3	-	-	2	5	-	-	1	2	-	-	2	6	-	-	2	4
300 m - outer jurisdiction (26)	-	-	2	4	-	-	3	5	-	-	2	3	-	1	5	8	-	-	3	5
300 m - outer jurisdiction (27)	-	-	-	1	-	-	1	3	-	-	-	2	-	-	-	1	-	-	-	2
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Atlantic Right Whale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	8	-	-	-	2
Sargassum (May/June)	-	3	8	10	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3
Sargassum (July/August)	1	1	1	1	66	66	66	66	-	-	-	-	-	-	-	-	17	17	17	17
Seagrass-Wakulla County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Dixie County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Levy County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (1)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (3)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (5)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (6)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Topographic Features (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (8)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (10)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (12)	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	1	-	-	-	1
Stetson Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Topographic Features (13)	-	-	-	-	-	-	1	1	-	-	1	1	-	-	1	1	-	-	1	1
Topographic Features (14)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1
Topographic Features (15)	-	-	1	1	-	-	1	2	-	-	2	3	-	-	2	3	-	-	1	2
East Flower Garden Bank	-	-	1	1	-	-	1	2	-	-	3	5	-	-	3	5	-	-	2	3
West Flower Garden Bank	-	-	1	1	-	-	1	2	-	-	3	4	-	-	3	5	-	-	2	3
Topographic Features (16)	-	-	-	1	-	-	-	-	-	-	2	2	-	-	2	3	-	-	1	1
Topographic Features (17)	-	-	-	1	-	-	-	1	-	-	1	2	-	-	1	2	-	-	1	1
Topographic Features (18)	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	2	-	-	1	1
Topographic Features (19)	-	-	1	1	-	-	-	1	-	-	1	2	-	-	2	3	-	-	1	2
Topographic Features (20)	-	-	1	1	-	-	1	1	-	-	2	3	-	-	2	3	-	-	1	2
Topographic Features (21)	-	-	-	1	-	-	2	3	-	-	3	4	-	-	2	4	-	-	2	3

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1
Topographic Features (23)	-	-	1	1	-	-	1	2	-	-	2	2	-	-	2	2	-	-	1	2
Sonnier Bank	-	-	1	1	-	-	1	1	-	-	1	1	-	-	1	2	-	-	1	1
Topographic Features (24)	-	1	1	2	-	-	1	1	-	-	2	2	-	-	3	3	-	-	2	2
Topographic Features (25)	-	-	1	1	-	-	1	2	-	1	2	2	-	1	2	3	-	-	2	2
Topographic Features (26)	-	-	-	1	-	-	1	1	-	-	1	1	-	-	2	2	-	-	1	1
Topographic Features (27)	-	1	2	2	-	-	2	3	-	1	2	3	-	1	4	5	-	1	2	3
Topographic Features (28)	-	1	1	2	-	-	1	1	-	-	1	2	-	1	2	2	-	1	1	2
Topographic Features (29)	-	-	1	1	-	-	-	1	-	-	-	-	-	-	1	1	-	-	1	1
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1
Topographic Features (31)	-	1	1	1	-	-	1	2	-	-	1	1	-	-	1	1	-	-	1	1
Topographic Features (32)	-	2	2	3	-	1	2	3	-	1	1	1	-	-	2	2	-	1	2	2
Topographic Features (33)	-	1	2	2	-	-	2	2	-	-	-	-	-	-	1	1	-	1	1	1
Topographic Features (34)	-	1	2	2	-	-	1	1	-	-	-	-	-	1	1	2	-	1	1	1
Topographic Features (35)	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinnacle Trend	-	1	7	9	-	-	2	2	-	-	-	-	-	-	1	1	-	-	2	3
Chandeleur Islands	-	-	2	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulley Ridge	-	-	-	2	-	-	1	2	-	-	-	-	-	-	-	2	-	-	-	1
Madison Swanson	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steamboat Lumps	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dry Tortugas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Tortugas Ecological Reserve North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Tortugas Ecological Reserve South	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Florida Keys National Marine Sanctuary (Year Round)	-	-	-	1	-	-	1	3	-	-	-	-	-	-	-	2	-	-	-	2
FL State Waters	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Key Biscayne National Park	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Texas Clipper and South Texas Platform	-	-	-	-	-	-	1	5	-	-	1	1	-	-	-	-	-	-	-	2
Port Lavaca/Liberty Ship Reef	-	-	6	7	-	-	7	14	-	-	5	6	-	-	5	10	-	-	6	9
High Island	-	-	6	7	-	-	3	4	-	-	1	1	-	-	2	4	-	-	3	4
West Cameron	-	1	12	14	-	2	4	9	-	-	2	2	-	-	5	6	-	1	6	8
Galveston Area (GA 393)	-	-	1	1	-	-	1	2	-	-	-	1	-	-	1	2	-	-	1	1
Cognac Platform (MC 194)	-	1	2	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1
Horseshoe Rigs (MP 306)	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Vermilion Area	-	5	22	24	-	2	9	13	-	1	3	3	-	-	5	7	-	2	10	12
Vermilion Area, South Addition	-	6	13	15	-	3	12	16	-	4	9	9	-	-	6	8	-	3	10	12

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	1	3	3	-	-	-	1	-	-	-	-	-	-	-	1	-	-	1	1
South Timbalier	2	17	27	28	-	2	7	11	-	2	2	2	-	1	2	3	1	5	9	11
South Timbalier Area, South Addition	7	25	30	31	1	5	11	14	1	3	4	4	-	1	2	3	2	9	12	13
Panhandle FL	-	-	4	6	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2
Tampa	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE FL	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Daytona Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank (April-Nov)	-	-	1	1	-	-	1	2	-	-	2	2	-	-	1	2	-	-	1	2
West Flower Garden Bank (April-Nov)	-	-	1	1	-	-	1	2	-	-	2	2	-	-	1	2	-	-	1	2
Chandeleur Islands (April-Nov)	-	-	2	2	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1
Tortugas Ecological Reserve1 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve2 (April-Nov)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (April-Nov)	-	-	-	1	-	-	1	3	-	-	-	-	-	-	-	1	-	-	-	1
TX Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-10. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Three Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
MS Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	97	>99	>99	>99	88	>99	>99	>99	76	94	99	99	77	97	99	99	84	98	99	99
West LA State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East LA State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MS State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexican Waters	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	1	-	1	1	1

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
Texas East Waters (0-200 m) for EFH	1	2	2	2	4	5	5	5	1	5	6	6	1	5	6	6	2	4	5	5
Louisiana Waters West of Mississippi River (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Louisiana Waters East of Mississippi River (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alabama Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Panhandle Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Bend Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Southwest Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Southeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Northeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (1)	-	-	-	-	-	-	-	-	-	1	1	1	-	1	1	1	-	-	1	1
Shoreline - 20 m (2)	95	99	99	99	84	96	97	97	70	92	96	96	73	96	98	98	81	96	98	98
Shoreline - 20 m (3)	1	2	2	2	2	5	5	5	-	2	4	4	-	3	3	3	1	3	3	3
Shoreline - 20 m (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (1)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
20 m - 300 m (2)	1	1	1	1	3	4	4	4	1	5	6	7	1	5	5	5	1	3	4	4
20 m - 300 m (3)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
20 m - 300 m (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	-	-	-	-	-	-	-	-	1	3	5	5	1	2	3	3	1	2	2	2
300 m - outer jurisdiction (2)	-	-	-	-	-	-	-	-	-	1	2	2	-	1	2	2	-	-	1	1
300 m - outer jurisdiction (3)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-
300 m - outer jurisdiction (4)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	2	2	-	-	1	1
300 m - outer jurisdiction (5)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1
300 m - outer jurisdiction (6)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
300 m - outer jurisdiction (7)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	-
300 m - outer jurisdiction (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
300 m - outer jurisdiction (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
300 m - outer jurisdiction (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (16)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (18)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (20)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (21)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (22)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (25)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (26)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (27)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Atlantic Right Whale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum (May/June)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum (July/August)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Wakulla County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Dixie County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Levy County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (1)	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	-	-	-	-
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-
Topographic Features (3)	-	-	-	-	-	-	-	-	-	1	1	1	-	-	1	1	-	-	-	-
Topographic Features (4)	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	-	1	1	1
Topographic Features (5)	-	-	-	-	-	-	-	-	1	2	2	2	1	2	2	2	-	1	1	1
Topographic Features (6)	-	-	-	-	-	-	-	-	1	1	1	1	-	1	1	1	-	1	1	1
Topographic Features (7)	-	-	-	-	-	-	-	-	1	1	1	1	-	1	1	1	-	-	1	1
Topographic Features (8)	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	-	-	-	-	-	-	-	1	2	2	-	-	-	-	-	-	1	1
Topographic Features (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Flower Garden Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (16)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (17)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (18)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (20)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (21)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sonnier Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (24)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (25)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (26)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (27)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (29)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (31)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (32)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (33)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (34)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (35)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinnacle Trend	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulley Ridge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madison Swanson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steamboat Lumps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dry Tortugas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (Year Round)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Key Biscayne National Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas Clipper and South Texas Platform	-	1	1	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-
Port Lavaca/Liberty Ship Reef	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Galveston Area (GA 393)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cognac Platform (MC 194)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horseshoe Rigs (MP 306)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion Area, South Addition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Timbalier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Timbalier Area, South Addition	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tampa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daytona Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur Islands (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve1 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve2 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-11. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Four Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
MS Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	-	47	87	90	-	8	44	69	-	18	53	58	-	16	63	80	-	22	62	74
West LA State Waters	-	1	7	8	-	-	8	12	-	-	-	2	-	-	-	-	-	-	4	5
East LA State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MS State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL Panhandle State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
West FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northeast FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexican Waters	-	-	-	-	-	-	4	7	-	-	6	10	-	-	4	8	-	-	4	6

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	1	16	22	23	-	8	29	40	2	31	55	59	1	32	55	66	1	22	40	47
Texas East Waters (0-200 m) for EFH	60	86	92	94	30	54	67	73	36	54	60	62	38	60	67	73	41	63	72	75
Louisiana Waters West of Mississippi River (0-200 m)	1	9	13	15	2	27	42	43	-	3	5	7	-	2	5	9	1	10	16	18
Louisiana Waters East of Mississippi River (0-200 m)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Waters (0-200 m)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Alabama Waters (0-200 m)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Florida Panhandle Waters (0-200 m)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Florida Bend Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Southwest Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Southeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Northeast Waters (0-200 m)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (1)	-	-	-	-	-	-	3	6	-	-	4	7	-	-	3	6	-	-	3	5
Shoreline - 20 m (2)	-	12	20	20	-	3	20	32	-	9	37	42	-	8	45	58	-	8	31	38
Shoreline - 20 m (3)	-	49	75	77	-	10	33	45	-	12	20	23	-	10	22	28	-	20	38	43
Shoreline - 20 m (4)	-	3	8	10	-	1	15	20	-	-	1	2	-	-	-	1	-	1	6	8
Shoreline - 20 m (5)	-	-	-	1	-	-	3	5	-	-	-	1	-	-	-	-	-	-	1	2

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (1)	1	15	21	21	-	9	29	39	2	32	56	59	1	33	55	65	1	22	40	46
20 m - 300 m (2)	64	87	93	94	37	60	71	76	39	57	62	64	41	63	70	75	45	67	74	77
20 m - 300 m (3)	1	8	11	13	3	28	41	42	-	3	5	7	-	2	6	9	1	10	16	18
20 m - 300 m (4)	-	-	-	1	-	1	8	9	-	-	1	2	-	-	1	1	-	-	3	3
20 m - 300 m (5)	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (6)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (7)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (8)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 m - 300 m (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	15	27	31	32	5	18	32	38	28	64	76	78	20	47	59	65	17	39	49	53
300 m - outer jurisdiction (2)	10	18	22	22	10	24	34	38	43	66	73	75	23	40	50	53	21	37	45	47
300 m - outer jurisdiction (3)	85	92	93	93	72	81	85	85	63	67	69	70	69	77	80	82	72	79	82	83
300 m - outer jurisdiction (4)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
300 m - outer jurisdiction (5)	-	3	6	6	4	14	20	25	1	9	20	26	3	14	21	27	2	10	17	21
300 m - outer jurisdiction (6)	4	6	8	9	11	22	29	29	-	3	6	9	-	7	14	15	4	9	14	15
300 m - outer jurisdiction (7)	1	4	5	6	6	13	18	20	-	1	5	9	-	10	18	19	2	7	12	14
300 m - outer jurisdiction (8)	-	2	3	4	-	3	8	11	-	-	4	7	-	6	15	18	-	3	8	10
300 m - outer jurisdiction (9)	-	-	1	2	-	3	10	11	-	-	2	4	-	1	4	5	-	1	4	6
300 m - outer jurisdiction (10)	-	1	2	3	-	4	9	10	-	-	3	5	-	2	8	9	-	2	6	7
300 m - outer jurisdiction (11)	-	-	1	2	-	1	4	6	-	-	2	5	-	2	10	12	-	1	4	6
300 m - outer jurisdiction (12)	-	-	-	1	-	-	4	5	-	-	1	2	-	-	1	1	-	-	1	2
300 m - outer jurisdiction (13)	-	-	-	1	-	-	3	4	-	-	1	1	-	-	1	2	-	-	1	2
300 m - outer jurisdiction (14)	-	-	-	1	-	-	2	3	-	-	1	1	-	-	1	2	-	-	1	2
300 m - outer jurisdiction (15)	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	1
300 m - outer jurisdiction (16)	-	-	-	-	-	-	2	3	-	-	-	1	-	-	-	-	-	-	1	1

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	-	-	-	-	-	-	2	3	-	-	-	1	-	-	1	1	-	-	1	1
300 m - outer jurisdiction (18)	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	1
300 m - outer jurisdiction (19)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (20)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1
300 m - outer jurisdiction (21)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (22)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (23)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (24)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
300 m - outer jurisdiction (25)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (26)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (27)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
300 m - outer jurisdiction (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Atlantic Right Whale	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	1	1	-	-	-	-	-	-	-	-	-	2	7	9	-	1	2	3
Sargassum (May/June)	67	67	67	67	-	-	-	-	-	-	-	-	-	-	-	-	17	17	17	17
Sargassum (July/August)	1	1	1	1	66	66	66	66	-	-	-	-	-	-	-	-	17	17	17	17
Seagrass-Wakulla County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Dixie County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Levy County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (1)	-	-	-	-	-	-	-	1	-	-	2	2	-	-	2	2	-	-	1	1
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	-	1
Topographic Features (3)	-	-	-	-	-	-	-	-	-	-	1	2	-	-	1	2	-	-	1	1
Topographic Features (4)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	2	-	-	1	1
Topographic Features (5)	-	-	-	-	-	-	1	1	-	1	2	2	-	-	2	3	-	-	1	2
Topographic Features (6)	-	-	1	1	-	-	-	1	-	-	1	2	-	-	1	2	-	-	1	1
Topographic Features (7)	-	-	-	-	-	-	1	1	-	-	1	1	-	-	1	1	-	-	1	1
Topographic Features (8)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	1	-	-	1	1

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	1	1	-	-	1	1	-	1	2	2	-	1	2	2	-	1	1	1
Topographic Features (10)	-	-	1	1	-	-	1	1	-	-	1	1	-	1	1	2	-	-	1	1
Topographic Features (11)	-	-	-	-	-	-	1	1	-	-	1	1	-	1	2	2	-	-	1	1
Topographic Features (12)	1	3	3	3	1	2	2	2	1	2	2	3	-	2	3	3	1	2	3	3
Stetson Bank	-	2	2	2	-	1	1	1	-	-	-	1	-	-	1	1	-	1	1	1
Topographic Features (13)	-	1	1	1	-	1	2	3	-	-	1	1	-	-	1	1	-	1	1	1
Topographic Features (14)	-	1	1	1	1	1	2	2	-	1	1	1	-	1	1	1	-	1	1	1
Topographic Features (15)	1	2	2	2	-	3	4	4	-	1	1	1	-	1	1	2	-	2	2	2
East Flower Garden Bank	1	2	2	2	4	7	8	8	1	1	2	3	-	1	3	4	1	3	4	4
West Flower Garden Bank	-	1	1	2	2	7	8	9	-	-	1	2	-	-	2	3	1	2	3	4
Topographic Features (16)	-	-	-	-	-	3	4	4	-	-	-	1	-	-	-	1	-	1	1	2
Topographic Features (17)	-	1	1	1	-	1	1	2	-	-	-	-	-	-	-	1	-	1	1	1
Topographic Features (18)	-	-	1	1	-	1	2	2	-	-	-	-	-	-	-	1	-	1	1	1
Topographic Features (19)	-	-	-	1	-	2	3	3	-	-	-	1	-	-	-	1	-	1	1	1
Topographic Features (20)	-	1	1	1	-	3	4	4	-	1	1	1	-	-	-	1	-	1	2	2
Topographic Features (21)	-	-	-	-	-	3	4	5	-	-	1	1	-	-	1	1	-	1	1	2

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (23)	-	-	-	-	-	-	2	2	-	-	1	1	-	-	1	1	-	-	1	1
Sonnier Bank	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (24)	-	-	-	-	-	1	2	2	-	-	1	1	-	-	-	-	-	-	1	1
Topographic Features (25)	-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	1	1
Topographic Features (26)	-	-	-	-	-	1	2	2	-	-	1	1	-	-	-	-	-	-	1	1
Topographic Features (27)	-	-	-	-	-	-	2	2	-	-	-	1	-	-	-	-	-	-	1	1
Topographic Features (28)	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (29)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (31)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (32)	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (33)	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (34)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (35)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinnacle Trend	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pulley Ridge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madison Swanson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Steamboat Lumps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dry Tortugas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (Year Round)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL State Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Key Biscayne National Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas Clipper and South Texas Platform	-	-	-	-	-	1	5	8	-	2	5	6	-	-	-	-	-	1	3	4
Port Lavaca/Liberty Ship Reef	6	27	34	35	-	7	18	23	1	7	8	8	-	1	2	3	2	10	15	17
High Island	-	7	19	20	-	2	9	15	-	1	1	1	-	-	-	-	-	3	7	9
West Cameron	-	4	7	9	-	5	17	22	-	-	-	-	-	-	-	1	-	2	6	8
Galveston Area (GA 393)	-	2	3	3	-	1	2	3	-	-	1	1	-	-	1	1	-	1	2	2
Cognac Platform (MC 194)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Horseshoe Rigs (MP 306)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion Area	-	-	3	4	-	1	12	14	-	-	-	-	-	-	-	-	-	-	4	5
Vermilion Area, South Addition	-	1	3	4	-	8	17	18	-	-	-	-	-	-	-	-	-	2	5	6

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Timbalier	-	-	-	-	-	-	3	4	-	-	-	-	-	-	-	-	-	-	1	1
South Timbalier Area, South Addition	-	-	-	1	-	-	5	5	-	-	-	-	-	-	-	-	-	-	1	1
Panhandle FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tampa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SE FL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Daytona Beach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	2	2	2	-	1	1	1	-	-	-	-	-	-	-	-	-	1	1	1
East Flower Garden Bank (April-Nov)	1	2	2	2	4	7	8	8	-	-	1	1	-	-	-	-	1	2	3	3
West Flower Garden Bank (April-Nov)	-	1	1	2	2	7	8	9	-	-	-	-	-	-	-	-	1	2	3	3
Chandeleur Islands (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve1 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tortugas Ecological Reserve2 (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys National Marine Sanctuary (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-12. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Five Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
MS Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	-	-	-	1	-	-	1	11	-	-	1	10	-	-	-	10	-	-	-	8
West LA State Waters	-	-	5	10	-	1	8	15	-	1	6	13	-	-	6	14	-	1	6	13
East LA State Waters	-	-	2	5	-	1	8	11	-	1	3	4	-	-	3	5	-	1	4	6
MS State Waters	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
AL State Waters	-	-	3	5	-	-	-	1	-	-	1	2	-	-	1	2	-	-	1	2
FL Panhandle State Waters	-	-	15	22	-	-	1	2	-	-	1	1	-	-	3	7	-	-	5	8
West FL State Waters	-	-	8	24	-	-	3	7	-	-	-	1	-	-	3	8	-	-	4	10
Tortugas State Waters	-	-	2	6	-	-	-	3	-	-	-	1	-	-	2	5	-	-	1	4
Southeast FL State Waters	-	-	1	5	-	-	1	4	-	-	1	2	-	-	3	10	-	-	1	5
Northeast FL State Waters	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mexican Waters	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	-	-	-	-	-	-	1	10	-	-	1	7	-	-	-	5	-	-	1	6
Texas East Waters (0-200m) for EFH	-	-	-	1	-	-	2	13	-	-	5	15	-	-	1	14	-	-	2	11
Louisiana Waters West of Mississippi River (0-200 m)	-	-	7	12	-	3	18	32	-	5	25	33	-	1	18	33	-	2	17	27
Louisiana Waters East of Mississippi River (0-200 m)	-	1	4	8	-	2	11	16	-	2	6	9	-	-	6	9	-	1	7	10
Mississippi Waters (0-200 m)	-	1	6	8	-	2	8	12	-	2	6	8	-	-	6	10	-	1	6	9
Alabama Waters (0-200 m)	-	3	12	16	-	1	6	8	-	2	8	10	-	1	6	10	-	2	8	11
Florida Panhandle Waters (0-200 m)	-	10	35	41	-	1	7	11	-	-	6	8	-	2	9	14	-	3	14	18
Florida Bend Waters (0-200 m)	-	8	30	39	-	5	16	19	-	-	2	2	-	5	11	14	-	4	15	18
Florida Southwest Waters (0-200 m)	-	-	12	23	-	-	9	14	-	-	2	3	-	1	12	18	-	-	9	15
Florida Keys Waters (0-200 m)	-	-	5	13	-	-	2	6	-	-	1	3	-	-	6	12	-	-	3	9
Florida Southeast Waters (0-200 m)	-	-	2	7	-	-	1	6	-	-	1	3	-	-	4	12	-	-	2	7
Florida Northeast Waters (0-200 m)	-	-	-	2	-	-	-	1	-	-	-	1	-	-	-	2	-	-	-	1
Shoreline - 20 m (1)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (2)	-	-	-	-	-	-	-	7	-	-	1	4	-	-	-	4	-	-	-	4
Shoreline - 20 m (3)	-	-	-	-	-	-	-	6	-	-	2	10	-	-	-	9	-	-	1	6
Shoreline - 20 m (4)	-	-	1	3	-	-	3	6	-	-	5	9	-	-	2	8	-	-	3	6
Shoreline - 20 m (5)	-	-	6	8	-	1	10	18	-	2	9	14	-	-	7	15	-	1	8	14

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	-	-	3	5	-	1	8	11	-	1	3	4	-	-	3	5	-	1	4	6
Shoreline - 20 m (7)	-	-	3	5	-	-	3	3	-	-	2	3	-	-	2	4	-	-	2	4
Shoreline - 20 m (8)	-	-	4	6	-	-	1	1	-	-	1	2	-	-	1	3	-	-	2	3
Shoreline - 20 m (9)	-	-	15	22	-	-	1	2	-	-	-	1	-	-	3	6	-	-	5	8
Shoreline - 20 m (10)	-	-	6	16	-	-	2	4	-	-	-	-	-	-	-	1	-	-	2	5
Shoreline - 20 m (11)	-	-	1	6	-	-	2	3	-	-	-	-	-	-	1	3	-	-	1	3
Shoreline - 20 m (12)	-	-	4	13	-	-	2	7	-	-	1	2	-	-	5	13	-	-	3	9
Shoreline - 20 m (13)	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Shoreline - 20 m (14)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Shoreline - 20 m (15)	-	-	1	3	-	-	-	2	-	-	-	-	-	-	1	3	-	-	1	2
20 m - 300 m (1)	-	-	-	-	-	-	1	10	-	-	1	7	-	-	-	5	-	-	1	5
20 m - 300 m (2)	-	-	-	-	-	-	2	13	-	-	5	15	-	-	1	13	-	-	2	10
20 m - 300 m (3)	-	-	1	3	-	-	7	16	-	-	14	19	-	-	8	20	-	-	8	14
20 m - 300 m (4)	-	-	7	11	-	3	18	29	-	6	24	30	-	1	17	28	-	3	16	25
20 m - 300 m (5)	-	-	3	6	-	2	10	15	-	2	6	8	-	-	5	9	-	1	6	9
20 m - 300 m (6)	-	1	6	9	-	3	9	13	-	2	7	8	-	-	6	10	-	1	7	10
20 m - 300 m (7)	-	3	12	16	-	2	7	8	-	2	9	11	-	1	6	10	-	2	9	11
20 m - 300 m (8)	-	18	40	47	-	3	11	15	-	1	8	9	1	7	14	18	-	7	18	22
20 m - 300 m (9)	-	13	37	45	-	7	21	24	-	1	3	4	-	10	18	21	-	8	20	24
20 m - 300 m (10)	-	-	13	24	-	-	10	16	-	-	3	4	-	2	14	20	-	1	10	16
20 m - 300 m (11)	-	-	5	14	-	-	2	7	-	-	1	3	-	-	7	14	-	-	4	10
20 m - 300 m (12)	-	-	2	10	-	-	1	6	-	-	1	4	-	-	4	13	-	-	2	8
20 m - 300 m (13)	-	-	-	2	-	-	-	2	-	-	-	1	-	-	-	3	-	-	-	2
20 m - 300 m (14)	-	-	-	2	-	-	-	1	-	-	-	1	-	-	-	2	-	-	-	2

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	-	-	-	-	-	-	1	9	-	-	2	8	-	-	-	5	-	-	1	6
300 m - outer jurisdiction (2)	-	-	-	-	-	-	1	10	-	-	2	9	-	-	-	4	-	-	1	6
300 m - outer jurisdiction (3)	-	-	-	-	-	-	2	11	-	-	3	10	-	-	1	7	-	-	1	7
300 m - outer jurisdiction (4)	-	-	-	-	-	-	5	14	-	-	4	14	-	-	1	7	-	-	3	9
300 m - outer jurisdiction (5)	-	-	-	-	-	-	5	11	-	-	3	11	-	-	1	6	-	-	2	7
300 m - outer jurisdiction (6)	-	-	-	-	-	-	5	13	-	-	9	15	-	-	3	12	-	-	4	10
300 m - outer jurisdiction (7)	-	-	-	1	-	-	7	16	-	-	9	18	-	-	4	12	-	-	5	12
300 m - outer jurisdiction (8)	-	-	-	1	-	-	9	15	-	-	9	20	-	-	3	10	-	-	5	12
300 m - outer jurisdiction (9)	-	-	1	3	-	-	8	14	-	1	14	18	-	1	10	19	-	-	8	14
300 m - outer jurisdiction (10)	-	-	3	6	-	-	13	22	-	2	17	25	-	1	11	20	-	1	11	18
300 m - outer jurisdiction (11)	-	-	3	6	-	1	14	22	-	3	20	32	-	-	8	16	-	1	11	19
300 m - outer jurisdiction (12)	-	-	8	12	-	4	18	28	-	11	31	37	-	2	19	29	-	4	19	26
300 m - outer jurisdiction (13)	-	1	10	14	-	5	22	33	-	17	36	42	-	6	25	34	-	7	23	31
300 m - outer jurisdiction (14)	-	2	11	15	-	7	24	35	-	17	41	49	-	4	20	31	-	8	24	33
300 m - outer jurisdiction (15)	-	3	14	18	-	7	19	27	-	8	20	25	-	2	13	19	-	5	17	22
300 m - outer jurisdiction (16)	-	7	21	26	1	16	35	48	1	36	56	61	-	14	36	43	1	18	37	45

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	-	14	27	32	4	28	51	66	13	62	79	85	2	30	53	61	5	34	53	61
300 m - outer jurisdiction (18)	3	21	34	37	10	30	47	56	29	65	73	77	10	35	49	53	13	38	51	56
300 m - outer jurisdiction (19)	30	41	49	52	38	53	65	71	77	88	92	93	47	57	66	68	48	60	68	71
300 m - outer jurisdiction (20)	5	11	20	26	5	21	35	44	9	26	35	43	8	23	41	47	7	20	33	40
300 m - outer jurisdiction (21)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
300 m - outer jurisdiction (22)	48	66	73	76	30	41	47	51	16	26	32	32	37	49	54	56	33	45	51	54
300 m - outer jurisdiction (23)	8	30	39	44	8	27	37	39	2	6	10	13	11	26	38	40	7	22	31	34
300 m - outer jurisdiction (24)	37	47	56	58	44	55	62	63	14	26	38	43	36	52	64	67	33	45	55	58
300 m - outer jurisdiction (25)	-	1	15	20	-	1	9	15	-	-	6	10	-	3	21	29	-	1	12	19
300 m - outer jurisdiction (26)	-	5	17	21	-	3	11	16	-	3	14	20	-	10	28	35	-	5	17	23
300 m - outer jurisdiction (27)	-	-	5	13	-	-	2	8	-	-	2	6	-	-	9	18	-	-	5	11
300 m - outer jurisdiction (28)	-	-	2	8	-	-	1	4	-	-	1	4	-	-	4	12	-	-	2	7
300 m - outer jurisdiction (28)	-	-	1	5	-	-	-	1	-	-	-	2	-	-	1	5	-	-	-	3
300 m - outer jurisdiction (30)	-	-	1	4	-	-	-	1	-	-	-	1	-	-	-	4	-	-	-	3
North Atlantic Right Whale	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Sargassum (May/June)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sargassum (July/August)	1	1	1	1	66	66	66	66	-	-	-	-	-	-	-	-	17	17	17	17
Seagrass-Wakulla County	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Seagrass-Dixie County	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Seagrass-Levy County	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Topographic Features (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (12)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Stetson Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (13)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Topographic Features (14)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (15)	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	1	-	-	-	1
East Flower Garden Bank	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-	-	1
West Flower Garden Bank	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (16)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (17)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (18)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (19)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (20)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1
Topographic Features (21)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2	-	-	-	1

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (23)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	1
Sonnier Bank	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (24)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (25)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
Topographic Features (26)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
Topographic Features (27)	-	-	-	-	-	-	-	1	-	-	1	2	-	-	-	1	-	-	-	1
Topographic Features (28)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
Topographic Features (29)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (31)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (32)	-	-	-	-	-	-	1	1	-	-	2	2	-	-	1	1	-	-	1	1
Topographic Features (33)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
Topographic Features (34)	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-
Topographic Features (35)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Pinnacle Trend	-	3	11	14	-	1	6	8	-	2	8	10	-	1	6	9	-	2	8	10
Chandeleur Islands	-	-	2	3	-	-	3	5	-	-	1	2	-	-	2	3	-	-	2	3

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	5	8	-	-	2	4	-	-	-	-	-	-	1	2	-	-	2	4
Pulley Ridge	-	-	6	13	-	-	3	8	-	-	1	2	-	1	6	11	-	-	4	8
Madison Swanson	-	1	9	11	-	-	1	2	-	-	-	1	-	-	2	3	-	-	3	4
Steamboat Lumps	-	1	4	6	-	-	2	3	-	-	-	-	-	1	2	3	-	-	2	3
Dry Tortugas	-	-	1	3	-	-	-	2	-	-	-	-	-	-	1	3	-	-	1	2
Tortugas Ecological Reserve North	-	-	1	2	-	-	-	2	-	-	-	-	-	-	1	3	-	-	1	2
Tortugas Ecological Reserve South	-	-	3	6	-	-	1	3	-	-	1	1	-	-	3	6	-	-	2	4
Florida Keys National Marine Sanctuary (Year Round)	-	-	5	14	-	-	2	8	-	-	1	3	-	-	7	15	-	-	4	10
FL State Waters	-	-	2	6	-	-	-	3	-	-	-	1	-	-	2	5	-	-	1	4
Key Biscayne National Park	-	-	-	1	-	-	-	1	-	-	-	1	-	-	1	2	-	-	-	1
Texas Clipper and South Texas Platform	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	1
Port Lavaca/Liberty Ship Reef	-	-	-	-	-	-	-	3	-	-	-	4	-	-	-	2	-	-	-	2
High Island	-	-	-	-	-	-	-	1	-	-	1	3	-	-	-	2	-	-	-	1
West Cameron	-	-	-	-	-	-	-	4	-	-	3	5	-	-	-	3	-	-	1	3
Galveston Area (GA 393)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cognac Platform (MC 194)	-	-	1	2	-	-	1	2	-	-	1	1	-	-	-	1	-	-	1	1
Horseshoe Rigs (MP 306)	-	-	1	1	-	-	1	2	-	-	-	-	-	-	-	1	-	-	1	1
Vermilion Area	-	-	1	2	-	-	1	6	-	-	4	5	-	-	-	3	-	-	1	4
Vermilion Area, South Addition	-	-	-	-	-	-	3	9	-	-	7	8	-	-	1	3	-	-	3	5

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
South Timbalier	-	-	4	5	-	-	7	13	-	1	5	5	-	-	2	5	-	-	4	7
South Timbalier Area, South Addition	-	-	2	3	-	-	5	8	-	1	8	9	-	-	1	4	-	-	4	6
Panhandle FL	-	2	19	25	-	-	2	3	-	-	-	-	-	-	4	7	-	1	6	9
Tampa	-	-	1	3	-	-	1	2	-	-	-	-	-	-	-	1	-	-	-	1
SE FL	-	-	1	7	-	-	1	4	-	-	-	-	-	-	-	2	-	-	1	3
Daytona Beach	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-
West Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Chandeleur Islands (April-Nov)	-	-	2	3	-	-	3	5	-	-	-	-	-	-	1	2	-	-	2	3
Tortugas Ecological Reserve1 (April-Nov)	-	-	1	2	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	1
Tortugas Ecological Reserve2 (April-Nov)	-	-	3	6	-	-	1	3	-	-	-	-	-	-	-	2	-	-	1	3
Florida Keys National Marine Sanctuary (April-Nov)	-	-	5	14	-	-	2	8	-	-	-	-	-	-	1	5	-	-	2	7
TX Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-13. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Six Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
MS Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Offshore Environmental Resource within the Specified Number of Days.

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Cayman Islands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bahamas5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jamaica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TX State Waters	-	-	1	2	-	-	2	14	-	-	1	6	-	-	-	13	-	-	1	9
West LA State Waters	-	-	7	12	-	-	6	12	-	-	3	5	-	-	3	9	-	-	5	10
East LA State Waters	-	-	1	3	-	-	1	2	-	-	1	1	-	-	1	2	-	-	1	2
MS State Waters	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
AL State Waters	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
FL Panhandle State Waters	-	-	4	8	-	-	-	-	-	-	-	-	-	-	1	3	-	-	1	3
West FL State Waters	-	1	8	22	-	-	4	9	-	-	1	3	-	-	6	12	-	-	5	11
Tortugas State Waters	-	-	2	6	-	-	2	4	-	-	-	1	-	-	3	7	-	-	2	5
Southeast FL State Waters	-	-	4	12	-	-	5	10	-	-	2	5	-	-	6	14	-	-	4	10
Northeast FL State Waters	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Mexican Waters	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Texas West Waters (0-200 m) for EFH	-	-	-	-	-	-	1	10	-	-	1	5	-	-	-	4	-	-	-	5
Texas East Waters (0-200 m) for EFH	-	-	1	2	-	-	3	17	-	-	5	12	-	-	2	14	-	-	3	11
Louisiana Waters West of Mississippi River (0-200 m)	-	1	11	16	-	2	16	30	-	1	12	17	-	-	11	22	-	1	13	21
Louisiana Waters East of Mississippi River (0-200 m)	-	-	3	5	-	-	2	4	-	-	2	2	-	-	1	3	-	-	2	4
Mississippi Waters (0-200 m)	-	-	3	6	-	-	1	3	-	-	2	2	-	-	1	3	-	-	2	3
Alabama Waters (0-200 m)	-	-	5	8	-	-	1	2	-	1	2	3	-	-	1	4	-	-	2	4
Florida Panhandle Waters (0-200 m)	-	-	11	17	-	-	1	2	-	-	1	1	-	-	2	7	-	-	4	7
Florida Bend Waters (0-200 m)	-	2	17	28	-	1	6	8	-	-	-	1	-	2	7	11	-	2	7	12
Florida Southwest Waters (0-200 m)	-	3	16	30	-	3	13	18	-	1	4	6	-	2	16	23	-	2	12	19
Florida Keys Waters (0-200 m)	-	2	10	22	-	-	8	13	-	-	3	6	-	-	10	17	-	1	8	14
Florida Southeast Waters (0-200 m)	-	-	6	16	-	-	7	12	-	-	2	7	-	-	9	18	-	-	6	13
Florida Northeast Waters (0-200 m)	-	-	1	3	-	-	2	3	-	-	-	1	-	-	2	4	-	-	1	3
Shoreline - 20 m (1)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Shoreline - 20 m (2)	-	-	-	-	-	-	-	6	-	-	1	3	-	-	-	4	-	-	-	3
Shoreline - 20 m (3)	-	-	1	2	-	-	2	9	-	-	1	6	-	-	1	10	-	-	1	7
Shoreline - 20 m (4)	-	-	3	5	-	-	4	8	-	-	1	2	-	-	2	7	-	-	2	6
Shoreline - 20 m (5)	-	-	7	10	-	-	7	15	-	-	4	5	-	-	4	9	-	-	5	10

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Shoreline - 20 m (6)	-	-	2	3	-	-	1	2	-	-	1	1	-	-	-	2	-	-	1	2
Shoreline - 20 m (7)	-	-	2	3	-	-	-	1	-	-	1	1	-	-	-	1	-	-	1	1
Shoreline - 20 m (8)	-	-	2	3	-	-	-	-	-	-	-	1	-	-	-	1	-	-	1	1
Shoreline - 20 m (9)	-	-	4	8	-	-	-	-	-	-	-	-	-	-	1	3	-	-	1	3
Shoreline - 20 m (10)	-	-	2	8	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2
Shoreline - 20 m (11)	-	-	2	10	-	-	2	4	-	-	1	1	-	-	1	4	-	-	2	5
Shoreline - 20 m (12)	-	1	9	20	-	-	8	15	-	-	3	6	-	-	10	18	-	-	7	15
Shoreline - 20 m (13)	-	-	1	2	-	-	1	1	-	-	-	1	-	-	1	3	-	-	1	2
Shoreline - 20 m (14)	-	-	-	1	-	-	-	1	-	-	-	1	-	-	1	1	-	-	-	1
Shoreline - 20 m (15)	-	-	1	4	-	-	1	3	-	-	-	1	-	-	2	4	-	-	1	3
20 m - 300 m (1)	-	-	-	-	-	-	1	10	-	-	1	6	-	-	-	4	-	-	-	5
20 m - 300 m (2)	-	-	1	1	-	-	2	17	-	-	5	13	-	-	2	12	-	-	3	11
20 m - 300 m (3)	-	-	3	5	-	-	9	18	-	-	6	12	-	-	6	15	-	-	6	13
20 m - 300 m (4)	-	-	11	15	-	2	15	26	-	2	10	13	-	-	10	17	-	1	11	18
20 m - 300 m (5)	-	-	4	5	-	-	3	4	-	-	2	3	-	-	1	3	-	-	2	4
20 m - 300 m (6)	-	-	3	6	-	-	2	4	-	-	2	3	-	-	1	3	-	-	2	4
20 m - 300 m (7)	-	-	5	8	-	-	1	2	-	1	3	3	-	-	1	4	-	-	2	4
20 m - 300 m (8)	-	1	14	20	-	-	2	3	-	-	1	2	-	1	3	8	-	1	5	8
20 m - 300 m (9)	-	7	23	34	-	3	10	14	-	1	2	3	1	7	14	20	-	4	12	18
20 m - 300 m (10)	-	5	17	29	-	4	14	19	-	1	4	7	-	4	17	25	-	4	13	20
20 m - 300 m (11)	-	2	12	23	-	-	9	15	-	-	3	7	-	-	11	20	-	1	9	16
20 m - 300 m (12)	-	1	7	17	-	-	8	13	-	-	3	7	-	-	9	18	-	-	7	14
20 m - 300 m (13)	-	-	2	5	-	-	2	3	-	-	1	2	-	-	3	6	-	-	2	4
20 m - 300 m (14)	-	-	1	4	-	-	2	4	-	-	-	1	-	-	1	4	-	-	1	3

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (1)	-	-	-	-	-	-	1	10	-	-	3	8	-	-	-	5	-	-	1	6
300 m - outer jurisdiction (2)	-	-	-	-	-	-	2	10	-	-	3	9	-	-	-	4	-	-	1	6
300 m - outer jurisdiction (3)	-	-	-	-	-	-	2	11	-	-	5	14	-	-	1	7	-	-	2	8
300 m - outer jurisdiction (4)	-	-	-	-	-	-	4	15	-	-	6	18	-	-	1	6	-	-	3	10
300 m - outer jurisdiction (5)	-	-	-	-	-	-	3	13	-	-	2	10	-	-	1	5	-	-	2	7
300 m - outer jurisdiction (6)	-	-	1	2	-	-	5	13	-	-	8	17	-	-	4	10	-	-	5	10
300 m - outer jurisdiction (7)	-	-	1	2	-	-	9	18	-	-	10	21	-	-	4	10	-	-	6	13
300 m - outer jurisdiction (8)	-	-	1	2	-	-	9	18	-	-	8	20	-	-	3	8	-	-	5	12
300 m - outer jurisdiction (9)	-	1	4	7	-	-	9	14	-	-	10	14	-	-	7	13	-	-	8	12
300 m - outer jurisdiction (10)	-	2	6	10	-	1	15	24	-	2	20	28	-	-	12	18	-	1	13	20
300 m - outer jurisdiction (11)	-	3	7	9	-	4	21	31	-	2	20	32	-	-	11	18	-	2	15	23
300 m - outer jurisdiction (12)	-	1	10	15	-	5	17	28	-	5	16	19	-	2	13	19	-	3	14	20
300 m - outer jurisdiction (13)	-	4	13	19	-	11	25	37	-	12	29	34	-	7	21	29	-	8	22	30
300 m - outer jurisdiction (14)	-	10	19	27	-	17	33	43	-	16	43	54	-	11	29	40	-	14	31	41
300 m - outer jurisdiction (15)	-	1	8	13	-	1	7	11	-	4	9	11	-	-	5	9	-	2	7	11
300 m - outer jurisdiction (16)	-	5	16	23	-	10	24	33	-	20	31	35	-	8	18	26	-	11	22	29

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
300 m - outer jurisdiction (17)	7	24	39	48	9	42	59	70	12	58	76	81	7	28	51	58	9	38	56	64
300 m - outer jurisdiction (18)	2	15	25	31	3	14	23	28	10	26	33	36	2	11	21	27	4	16	25	30
300 m - outer jurisdiction (19)	13	24	34	39	8	20	26	30	15	25	30	33	7	15	24	30	11	21	29	33
300 m - outer jurisdiction (20)	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99	>99
300 m - outer jurisdiction (21)	9	20	29	33	3	12	17	20	4	10	14	16	5	11	18	24	5	13	20	23
300 m - outer jurisdiction (22)	1	14	25	30	-	4	8	11	2	5	10	11	2	7	12	19	1	8	14	18
300 m - outer jurisdiction (23)	4	20	33	38	2	11	22	25	4	7	12	14	6	21	29	35	4	15	24	28
300 m - outer jurisdiction (24)	75	82	85	86	67	75	78	79	51	57	63	65	75	82	84	85	67	74	77	79
300 m - outer jurisdiction (25)	1	12	28	35	-	10	22	27	1	4	13	19	2	13	33	41	1	10	24	31
300 m - outer jurisdiction (26)	10	27	42	46	4	18	30	34	3	15	30	37	6	30	47	53	6	22	37	42
300 m - outer jurisdiction (27)	-	2	14	24	-	1	10	16	-	-	6	12	-	-	14	23	-	1	11	19
300 m - outer jurisdiction (28)	-	-	6	15	-	-	5	9	-	-	2	8	-	-	8	16	-	-	6	12
300 m - outer jurisdiction (28)	-	-	3	9	-	-	2	4	-	-	1	2	-	-	3	7	-	-	2	6
300 m - outer jurisdiction (30)	-	-	2	7	-	-	2	4	-	-	-	2	-	-	1	5	-	-	1	5
North Atlantic Right Whale	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Southeastern SMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Sargassum (March/April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Sargassum (May/June)	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Sargassum (July/August)	1	1	1	1	66	66	66	66	-	-	-	-	-	-	-	-	17	17	17	17
Seagrass-Wakulla County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Jefferson County	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Taylor County	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Dixie County	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seagrass-Levy County	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (7)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (8)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (11)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (13)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (14)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (15)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
East Flower Garden Bank	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	1	-	-	-	1
West Flower Garden Bank	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	1	-	-	-	1
Topographic Features (16)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (17)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (18)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (19)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (20)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (21)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Topographic Features (22)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Topographic Features (23)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sonnier Bank	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	1	-	-	-	-
Topographic Features (24)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (25)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (26)	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
Topographic Features (27)	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	-	-	-	1
Topographic Features (28)	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	1
Topographic Features (29)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (30)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (31)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (32)	-	-	-	1	-	-	1	1	-	-	-	-	-	-	1	1	-	-	1	1
Topographic Features (33)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (34)	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Topographic Features (35)	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
Pinnacle Trend	-	-	4	7	-	-	1	2	-	1	3	3	-	-	1	3	-	-	2	4
Chandeleur Islands	-	-	1	2	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Florida Middle Ground	-	-	3	6	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2
Pulley Ridge	-	2	7	17	-	2	8	11	-	-	1	3	-	1	6	12	-	1	6	11
Madison Swanson	-	-	2	4	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1	2
Steamboat Lumps	-	-	3	6	-	-	-	1	-	-	-	-	-	-	2	2	-	-	1	2
Dry Tortugas	-	-	1	4	-	-	1	2	-	-	-	1	-	-	2	3	-	-	1	2
Tortugas Ecological Reserve North	-	-	1	2	-	-	-	2	-	-	-	1	-	-	1	3	-	-	1	2
Tortugas Ecological Reserve South	-	1	4	9	-	-	3	6	-	-	1	1	-	-	5	9	-	-	3	6
Florida Keys National Marine Sanctuary (Year Round)	-	1	11	23	-	-	9	16	-	-	3	6	-	-	11	20	-	-	8	16
FL State Waters	-	-	2	6	-	-	2	4	-	-	-	2	-	-	3	7	-	-	2	5
Key Biscayne National Park	-	-	1	2	-	-	1	2	-	-	-	1	-	-	1	2	-	-	1	2
Texas Clipper and South Texas Platform	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1
Port Lavaca/Liberty Ship Reef	-	-	1	1	-	-	1	5	-	-	1	2	-	-	-	2	-	-	1	3
High Island	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	2	-	-	-	1
West Cameron	-	-	1	1	-	-	3	7	-	-	-	-	-	-	1	3	-	-	1	3
Galveston Area (GA 393)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cognac Platform (MC 194)	-	-	1	1	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1
Horseshoe Rigs (MP 306)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion Area	-	-	2	3	-	-	4	9	-	-	-	-	-	-	1	3	-	-	2	4
Vermilion Area, South Addition	-	-	1	2	-	-	4	8	-	-	1	1	-	-	1	3	-	-	2	3

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
Bay Marchand	-	-	-	1	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1
South Timbalier	-	-	4	7	-	-	6	13	-	-	1	1	-	-	1	3	-	-	3	6
South Timbalier Area, South Addition	-	-	3	5	-	-	5	9	-	-	2	2	-	-	2	4	-	-	3	5
Panhandle FL	-	-	4	9	-	-	-	-	-	-	-	-	-	-	1	3	-	-	1	3
Tampa	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
SE FL	-	-	5	13	-	-	4	8	-	-	-	-	-	-	1	4	-	-	3	6
Daytona Beach	-	-	-	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
Jacksonville	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank (April-Nov)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	2	-	-	1	1	-	-	-	1	-	-	-	1
West Flower Garden Bank (April-Nov)	-	-	-	-	-	-	-	2	-	-	1	1	-	-	-	-	-	-	-	1
Chandeleur Islands (April-Nov)	-	-	1	2	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	1
Tortugas Ecological Reserve1 (April-Nov)	-	-	1	2	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	1
Tortugas Ecological Reserve2 (April-Nov)	-	1	4	9	-	-	3	6	-	-	-	-	-	-	1	3	-	-	2	5
Florida Keys National Marine Sanctuary (April-Nov)	-	1	11	23	-	-	9	16	-	-	-	-	-	-	2	7	-	-	6	11
TX Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LA Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2-14. Conditional Probabilities (expressed as percent chance) that an Oil Spill Occurring at Launch Point Seven Will Make Contact with an Onshore Environmental Resource within the Specified Number of Days (continued).

Season	Spring				Summer				Fall				Winter				Annual			
Days	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
Resource	Percent Chance																			
MS Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
AL Gulf_State Waters (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)1 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)2 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)3 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)4 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FL (East Coast and Gulf)5 (Nov-April)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: Values of <0.5% are indicated by “-”

The Department of the Interior Mission

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) is responsible for managing development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.