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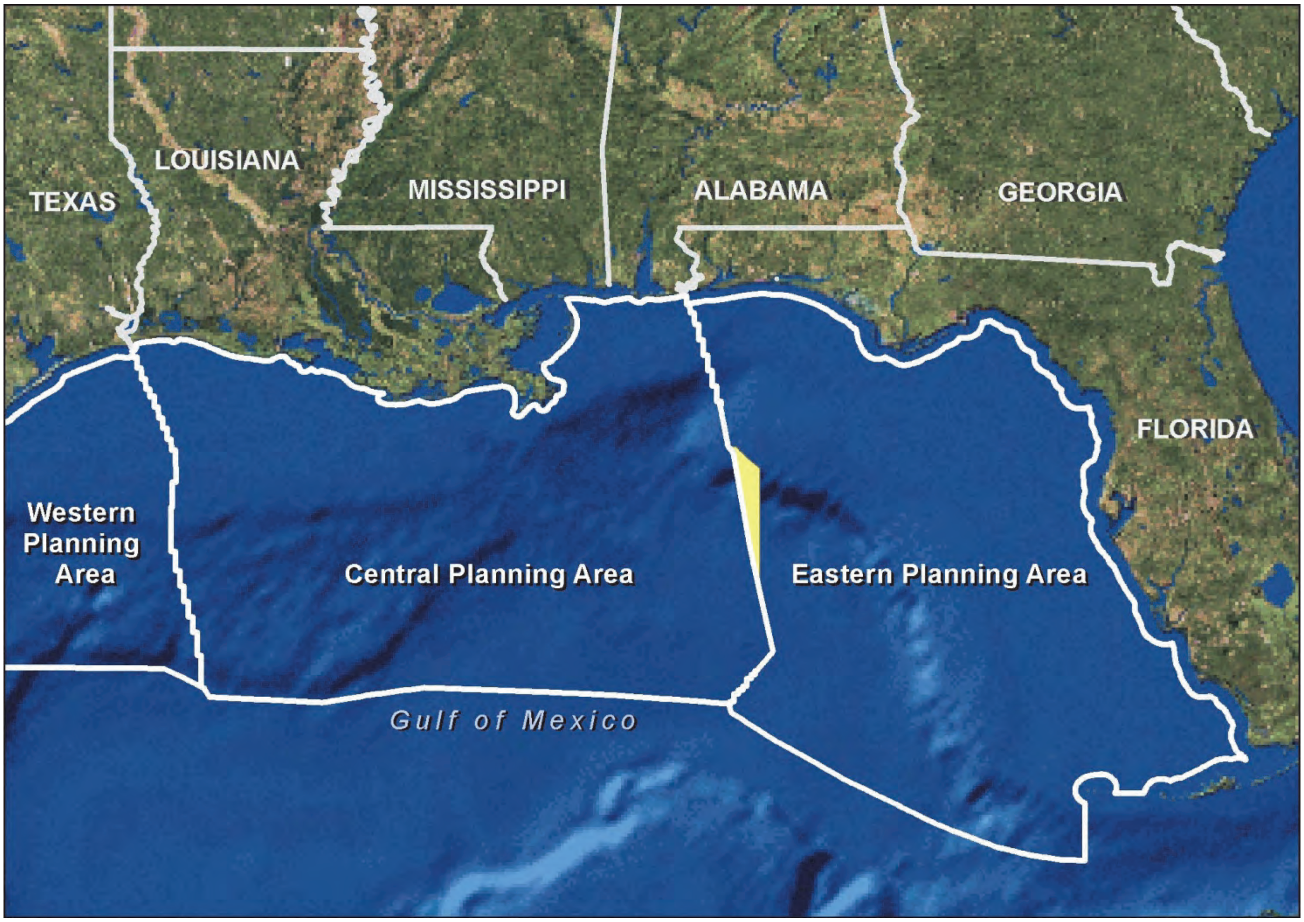
Gulf of Mexico OCS
Oil and Gas Lease Sales: 2014 and 2016

Eastern Planning Area Lease Sales 225 and 226

Final Environmental Impact Statement

Volume II: Figures, Tables, and Appendices



U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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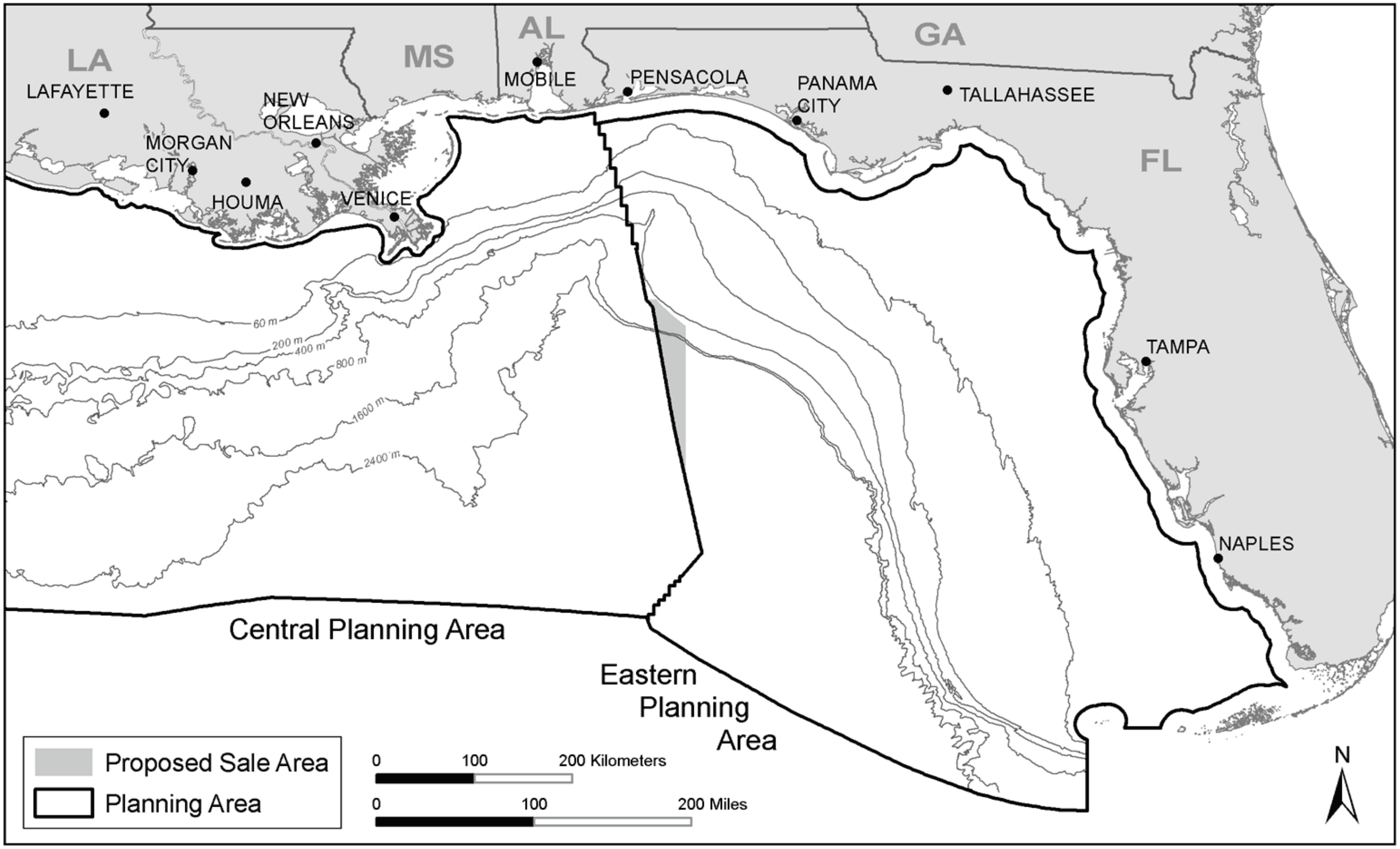

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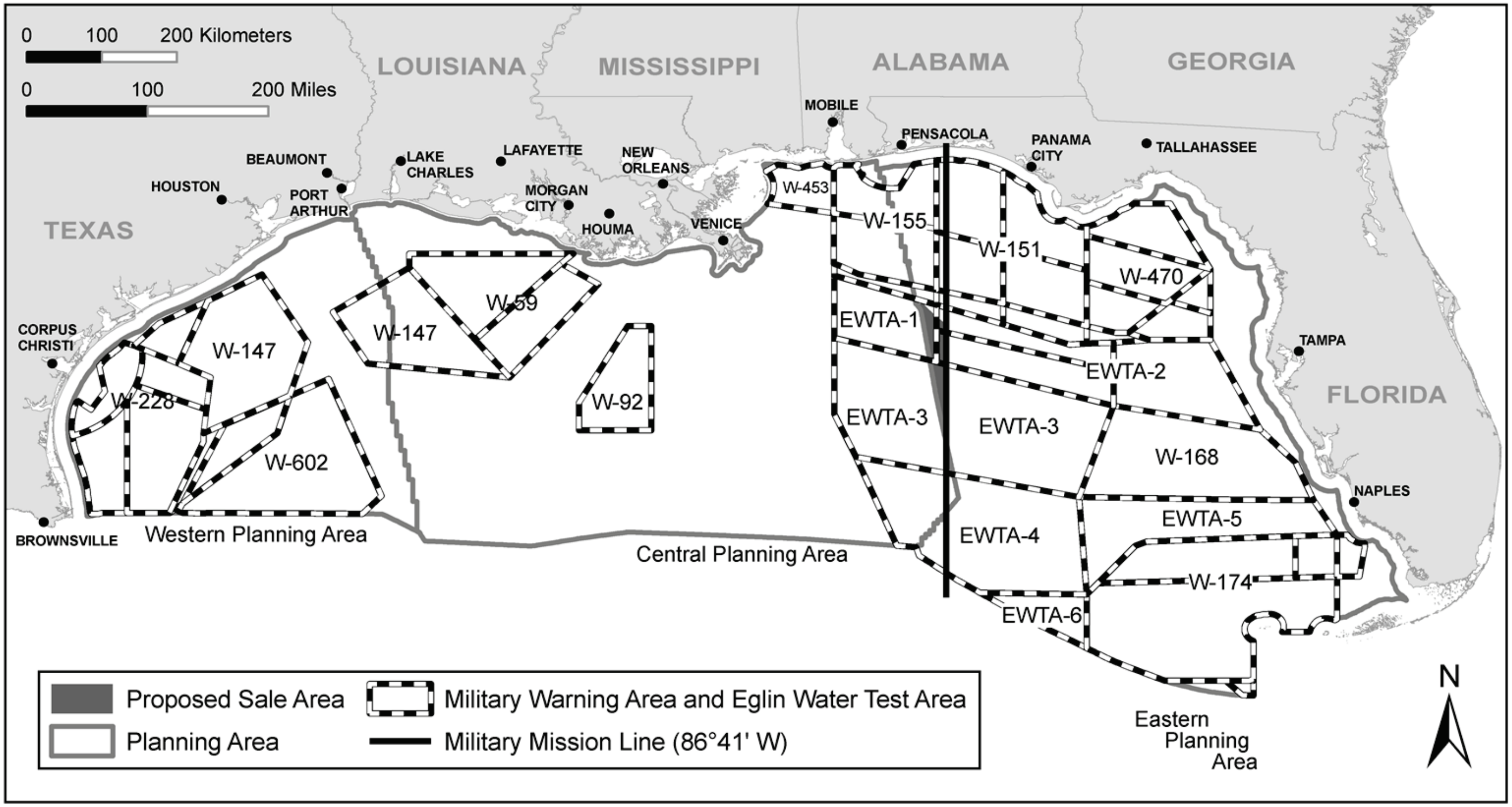

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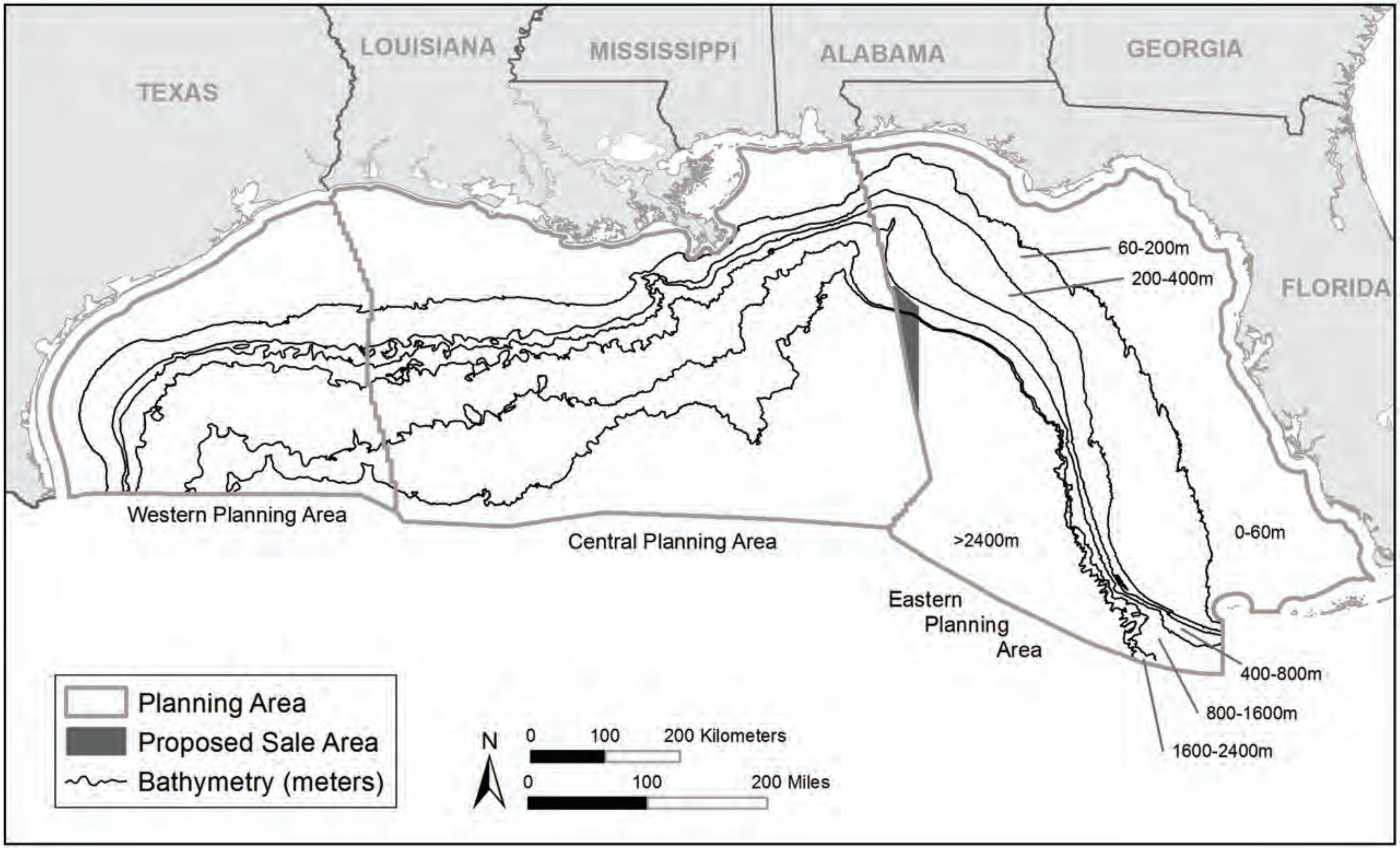

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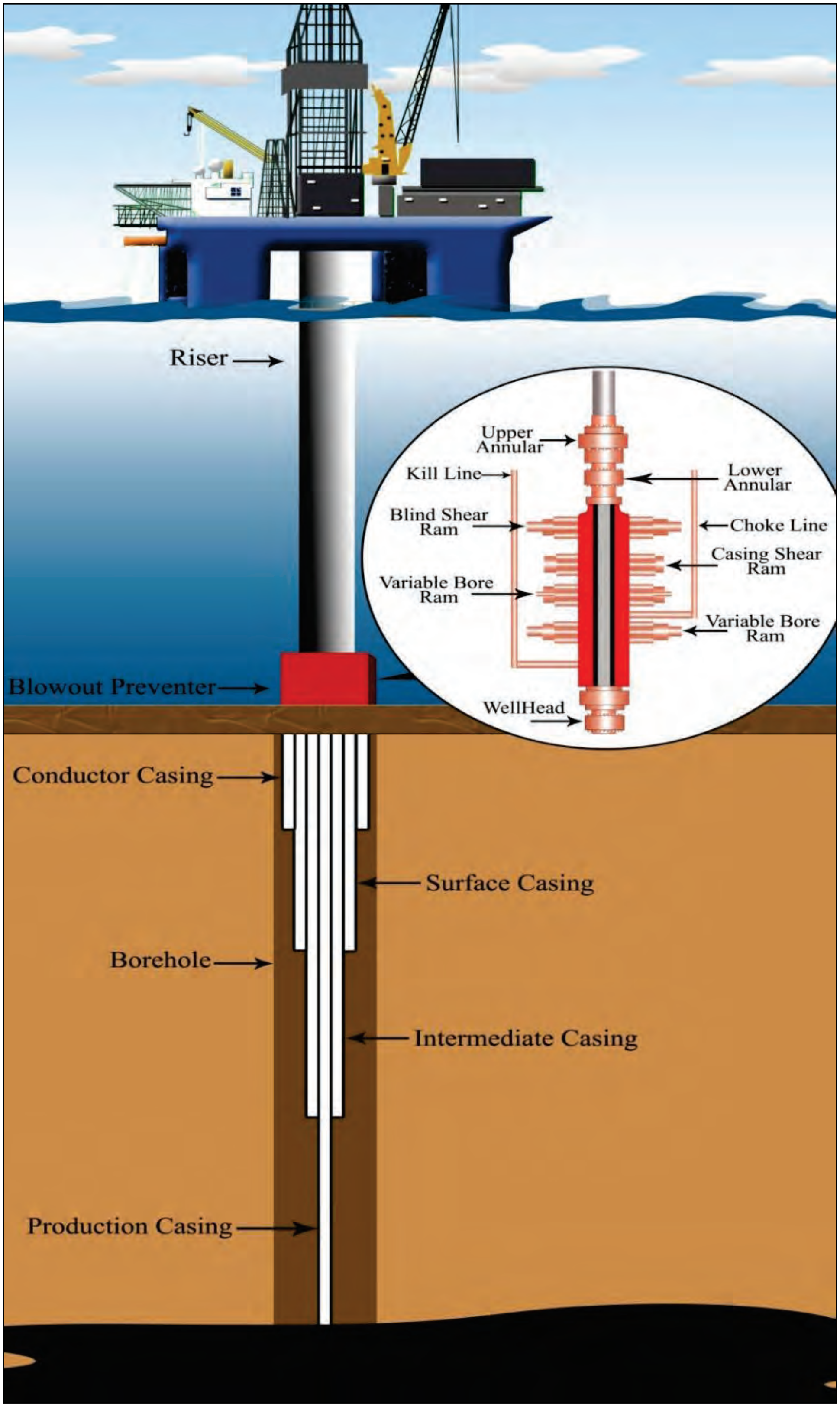

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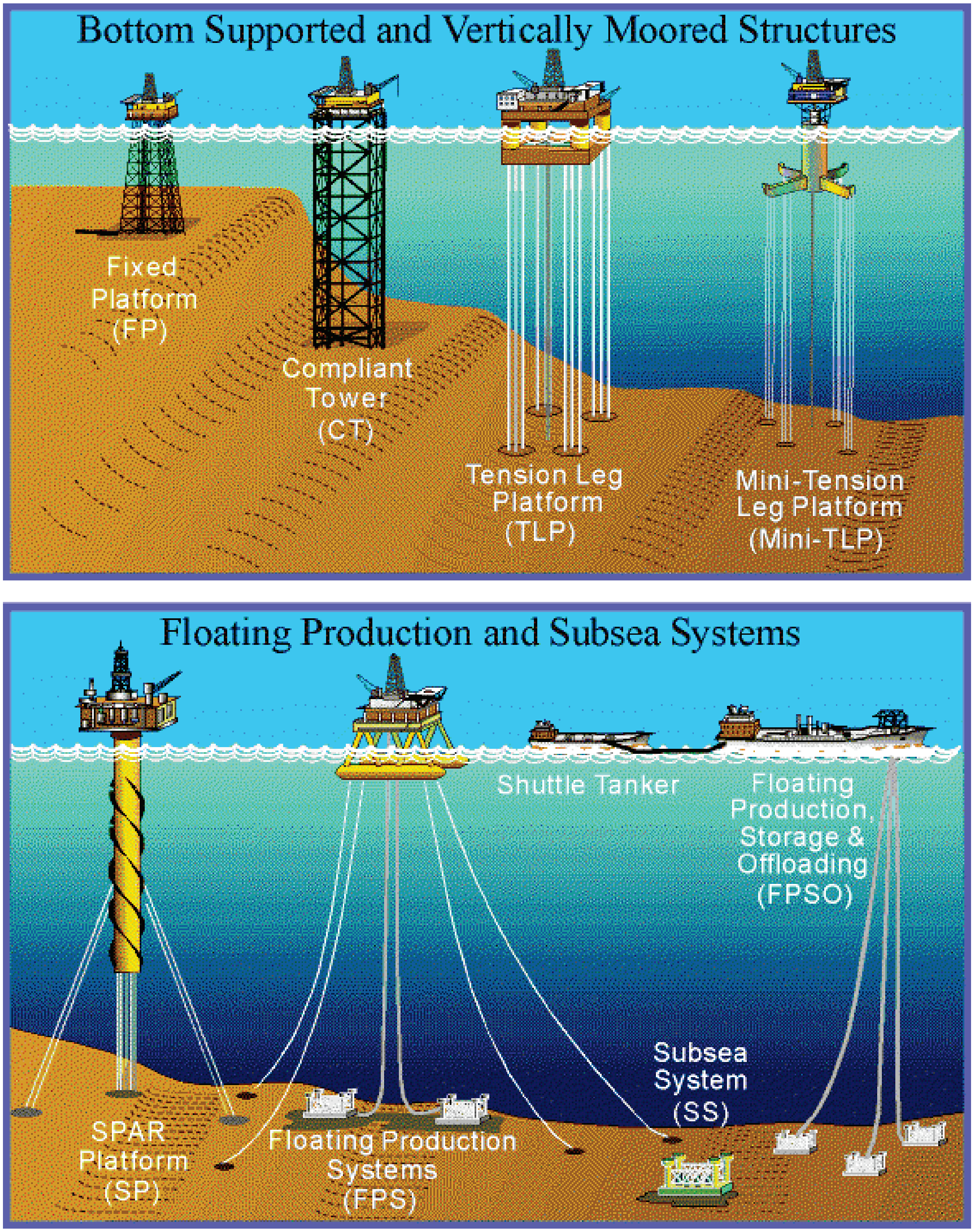

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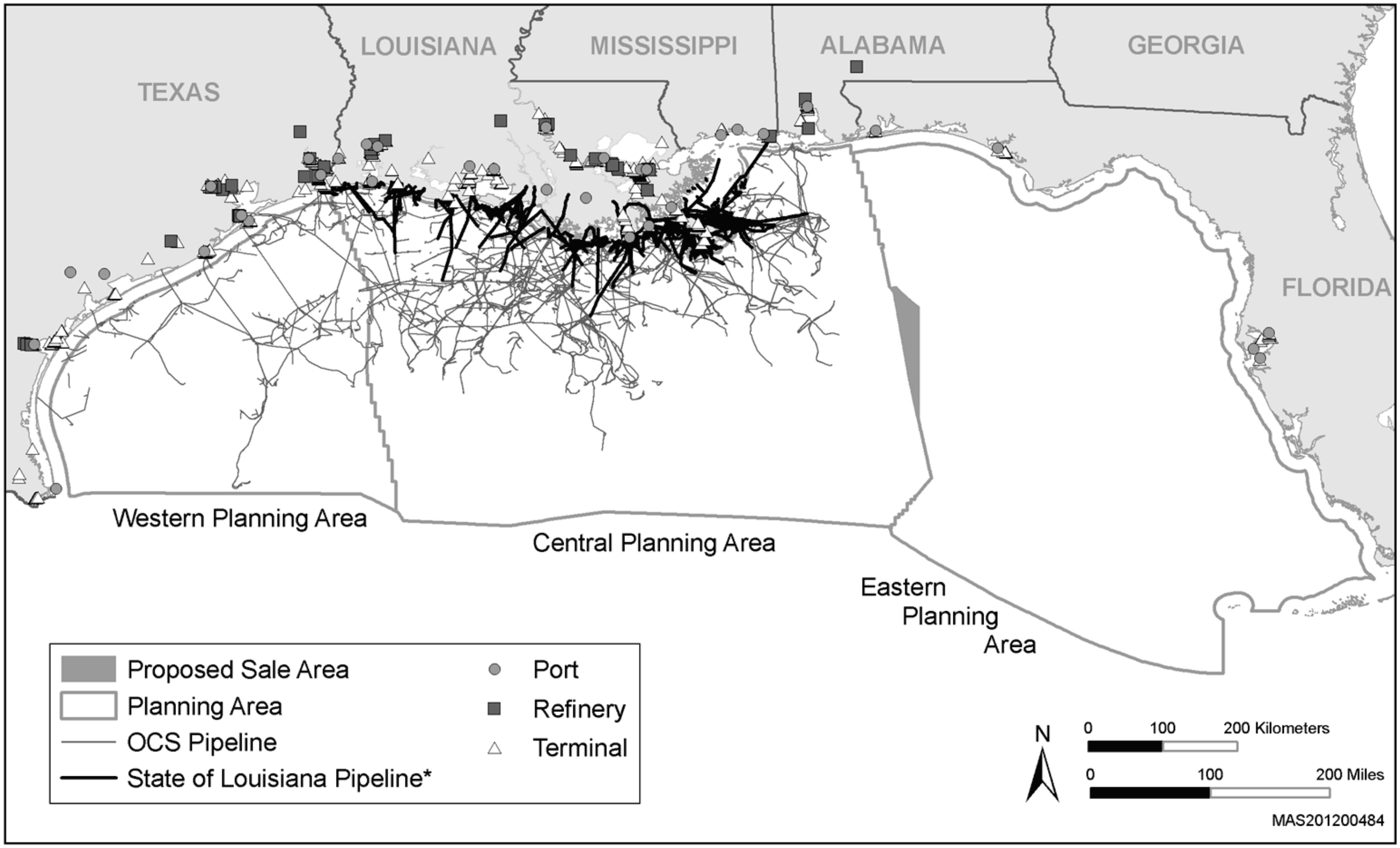

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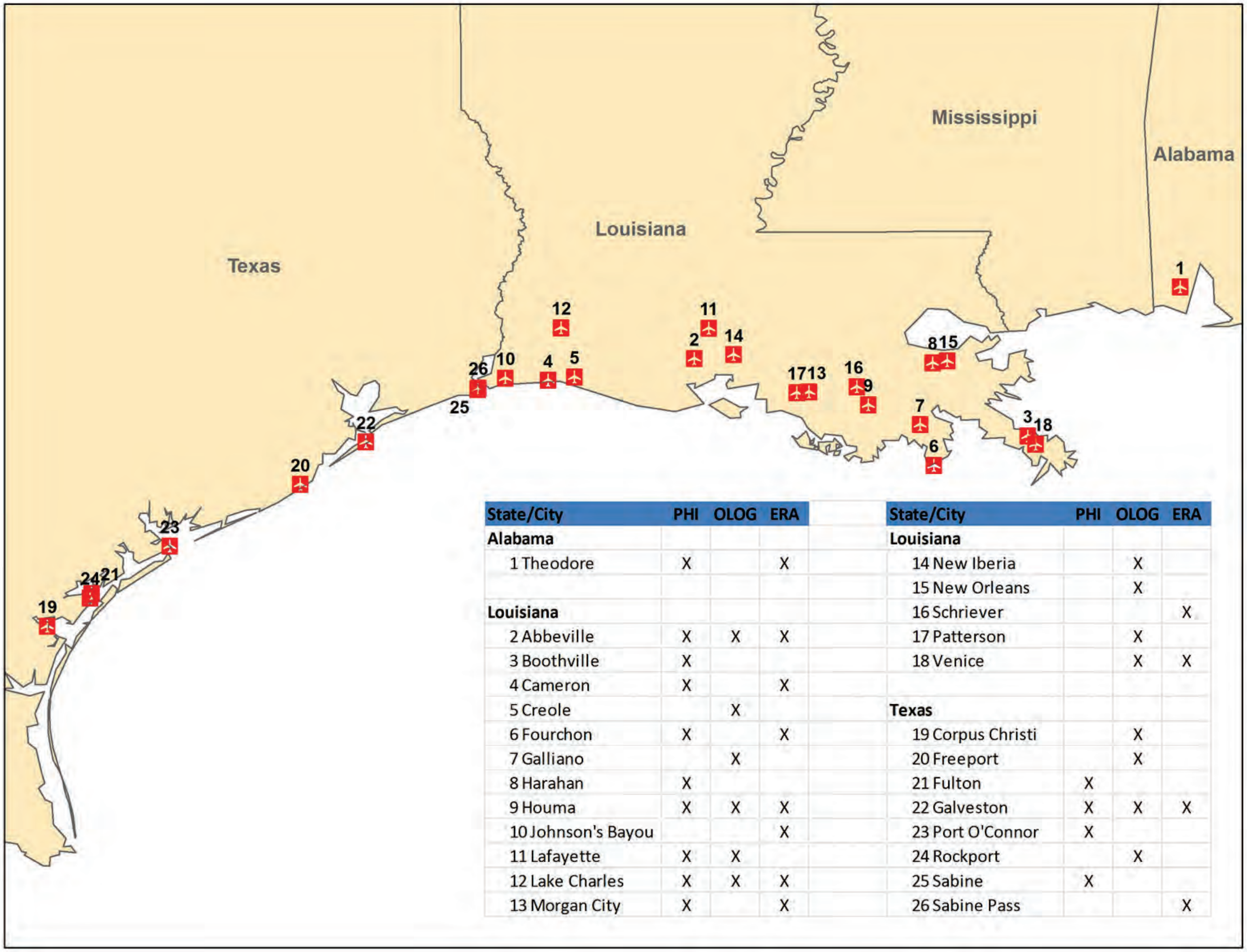

State/City	PHI	OLOG	ERA
Alabama			
1 Theodore	X		X
Louisiana			
2 Abbeville	X	X	X
3 Boothville	X		
4 Cameron	X		X
5 Creole		X	
6 Fourchon	X		X
7 Galliano		X	
8 Harahan	X		
9 Houma	X	X	X
10 Johnson's Bayou			X
11 Lafayette	X	X	
12 Lake Charles	X	X	X
13 Morgan City	X		X

State/City	PHI	OLOG	ERA
Louisiana			
14 New Iberia		X	
15 New Orleans		X	
16 Schriever			X
17 Patterson		X	
18 Venice		X	X
Texas			
19 Corpus Christi		X	
20 Freeport		X	
21 Fulton	X		
22 Galveston	X	X	X
23 Port O'Connor	X		
24 Rockport		X	
25 Sabine	X		
26 Sabine Pass			X

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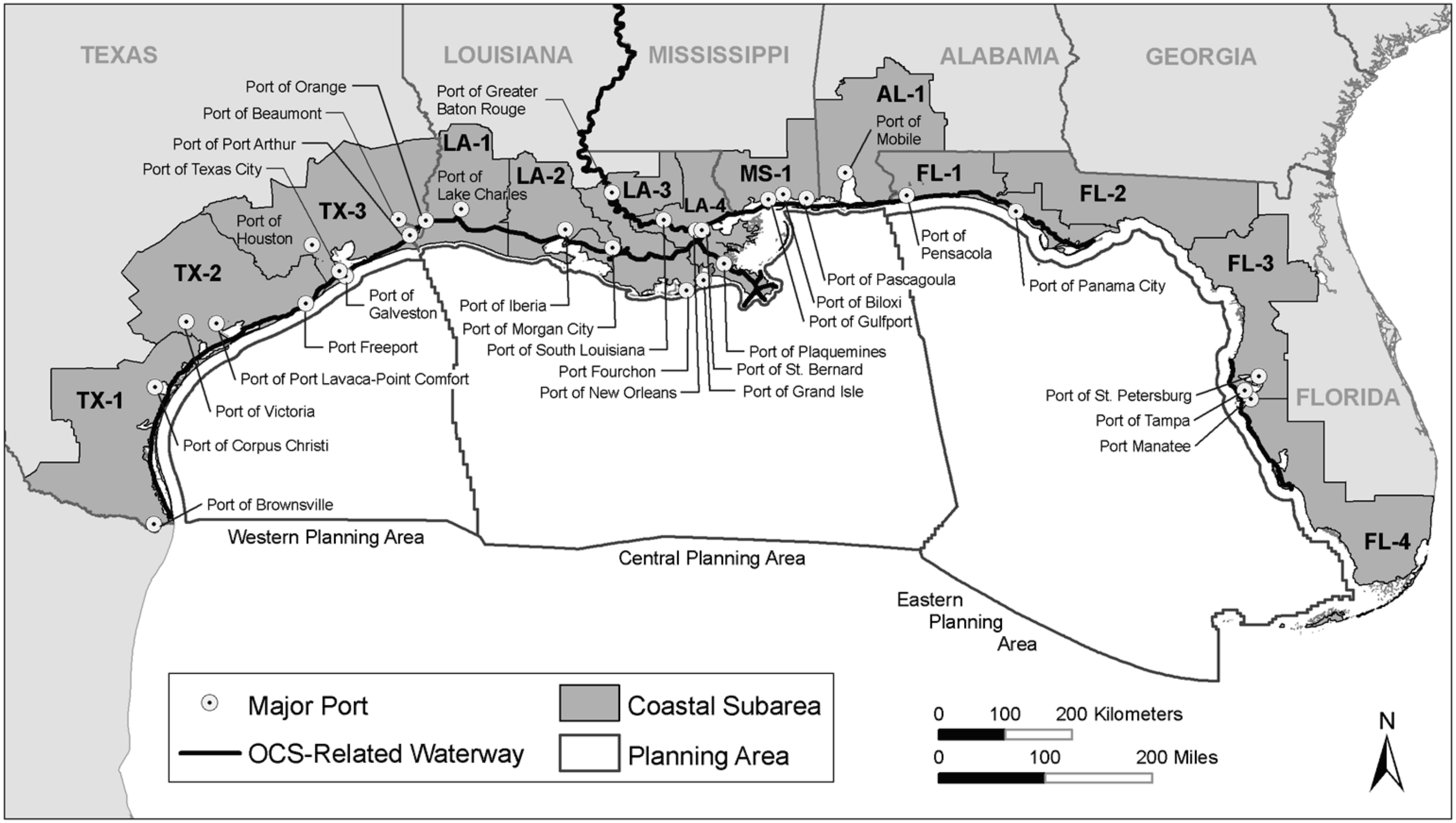

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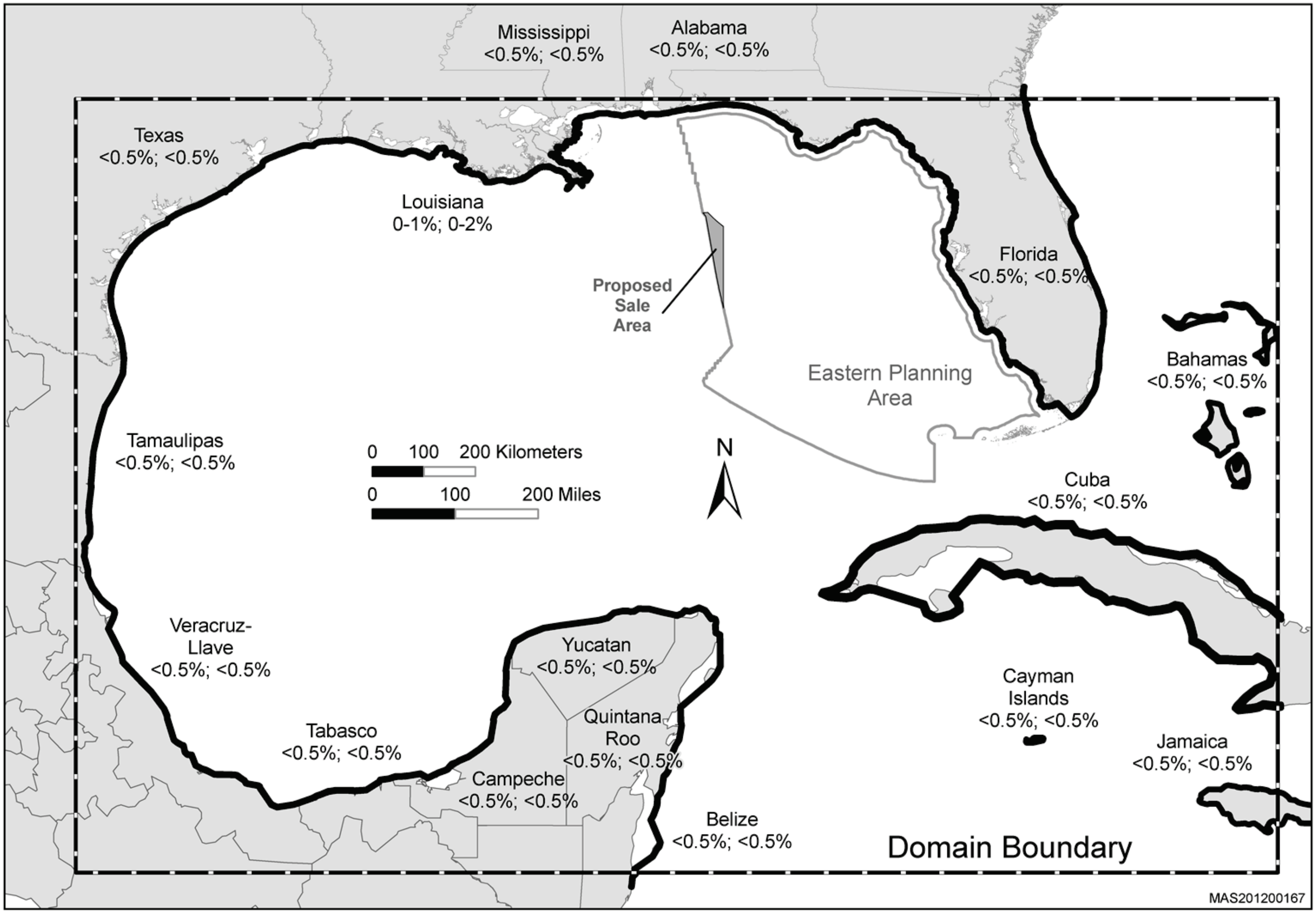

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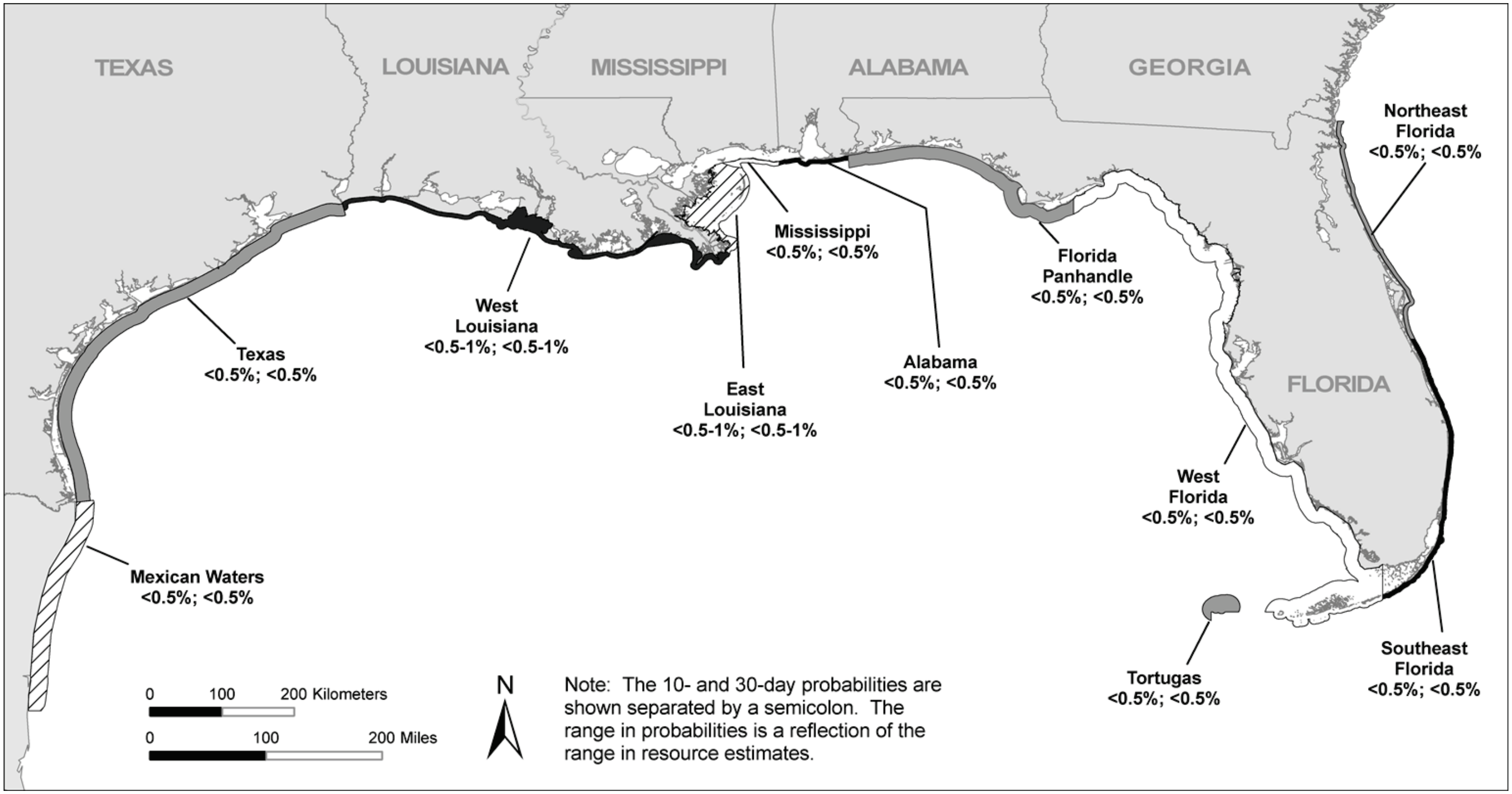

Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

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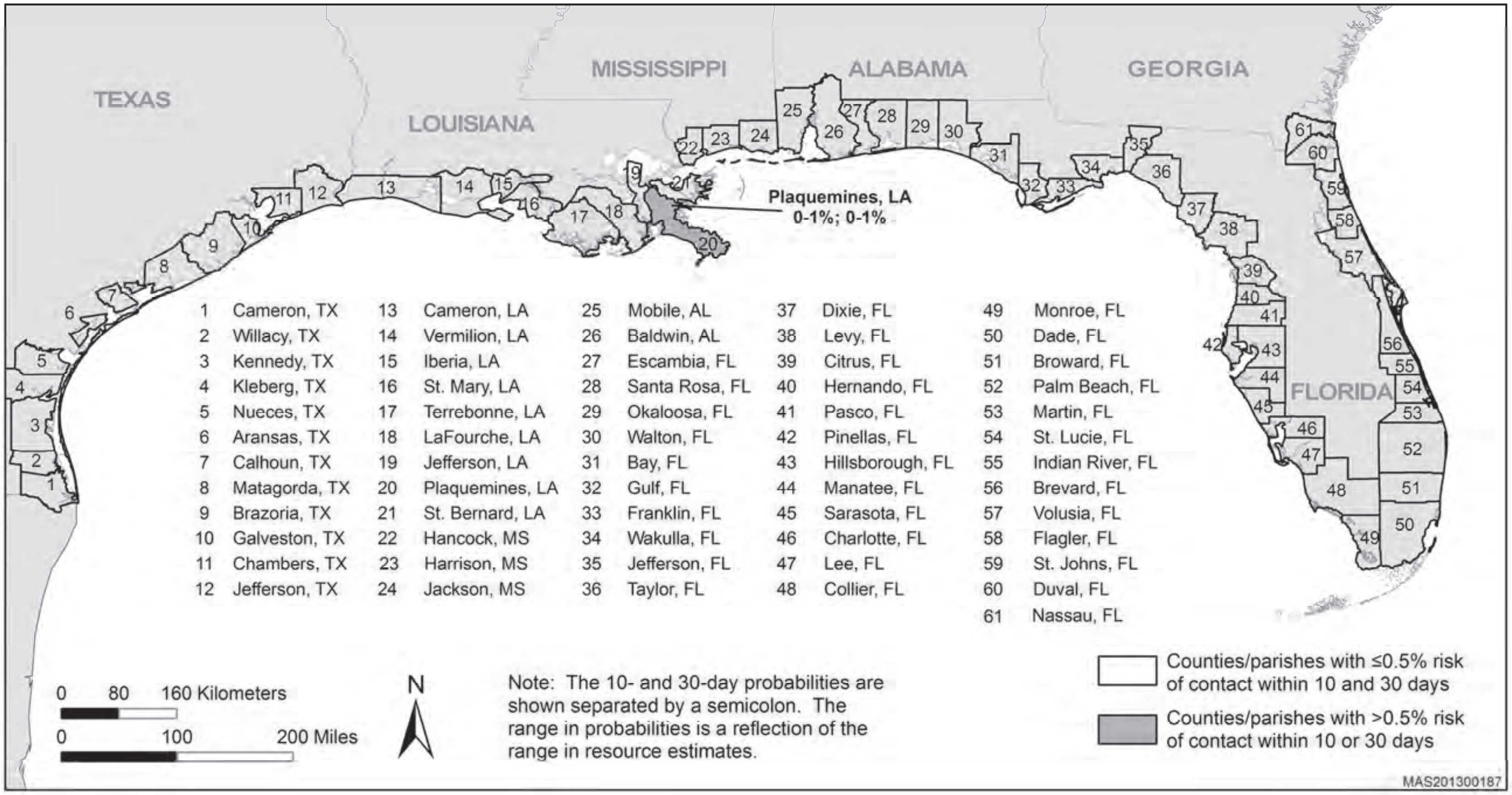
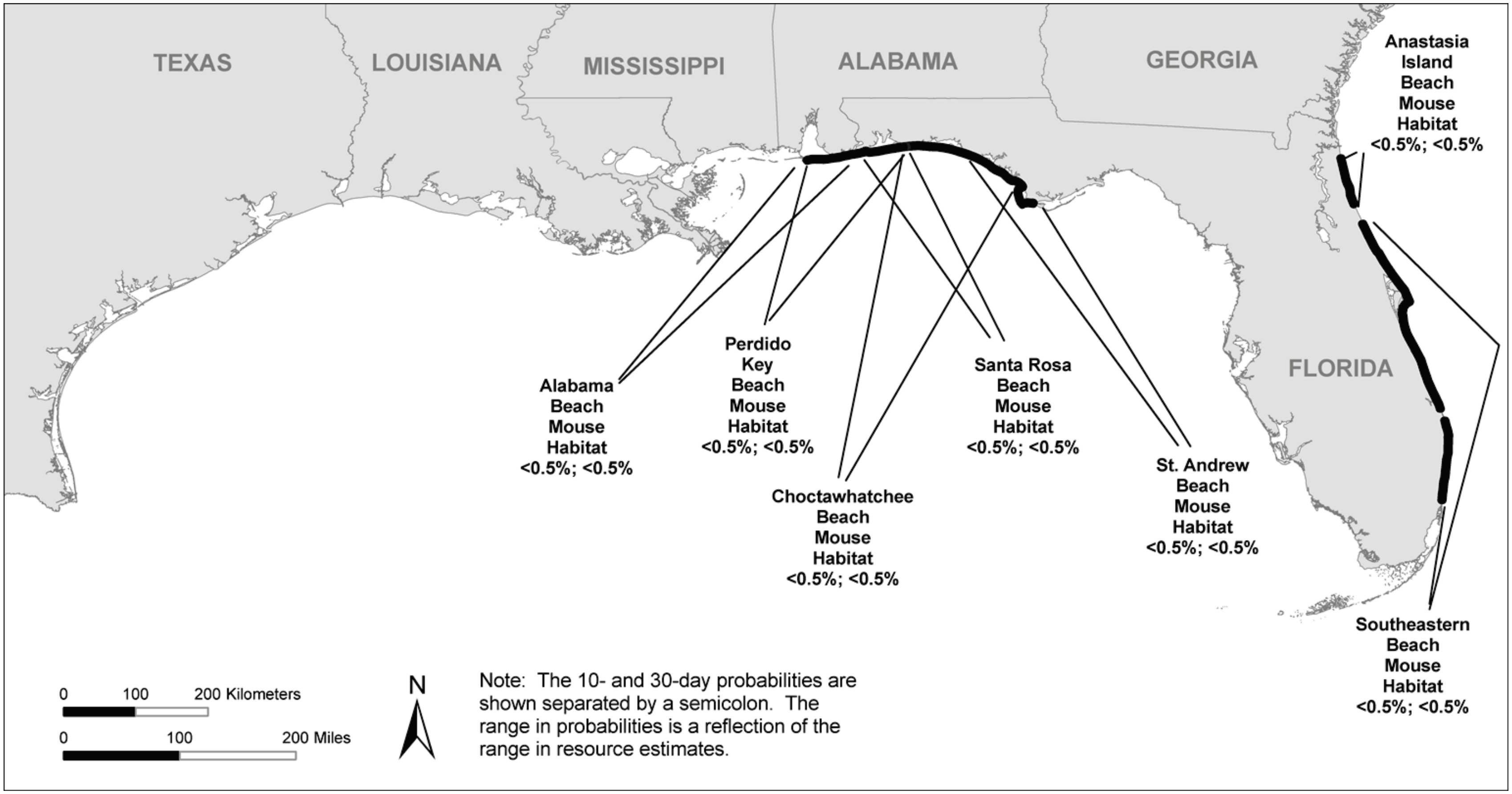


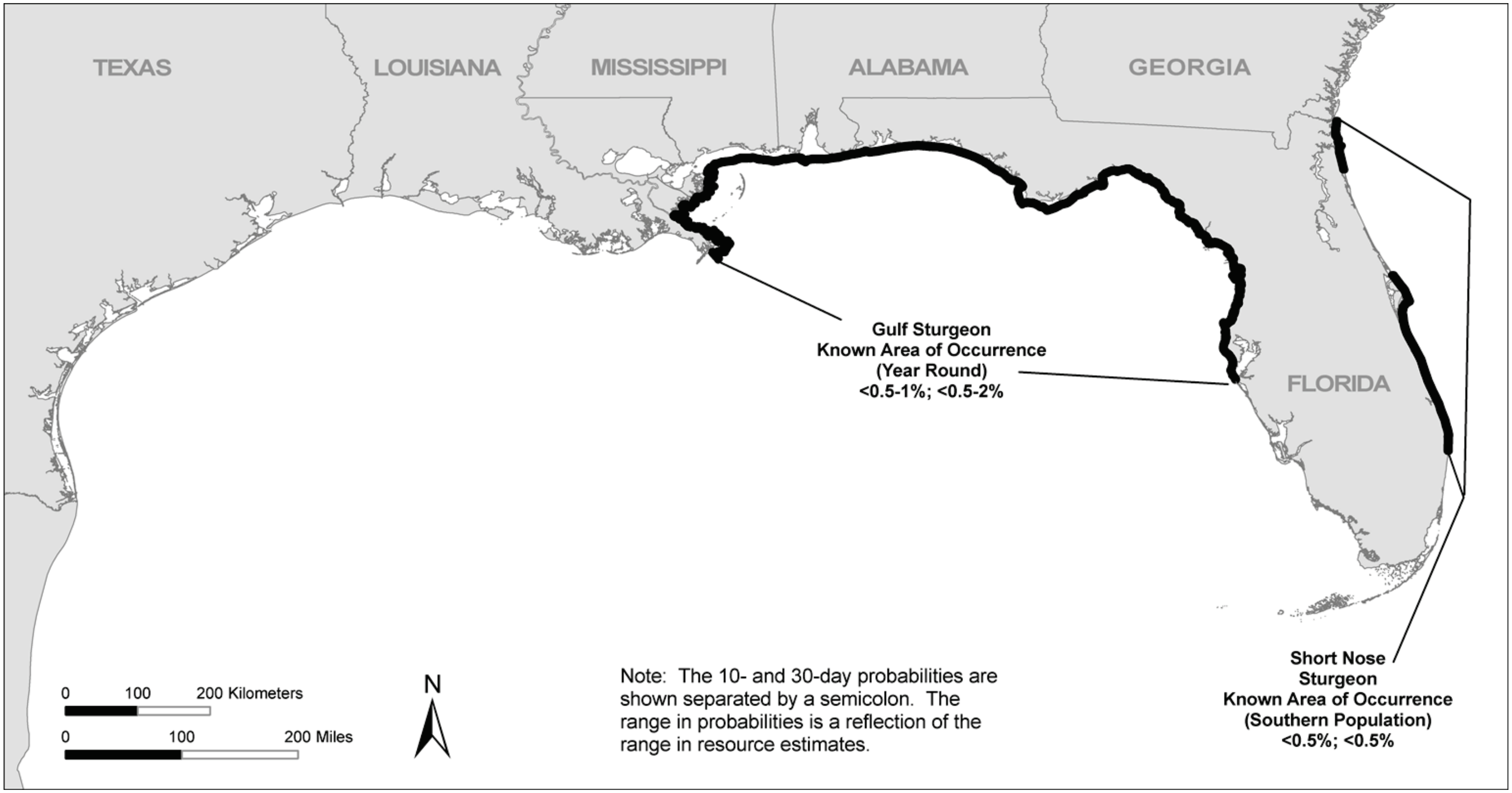
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-9. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days the Shoreline (counties and parishes) as a Result of an EPA Proposed Action.



Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-10. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Beach Mice Habitats as a Result of an EPA Proposed Action.

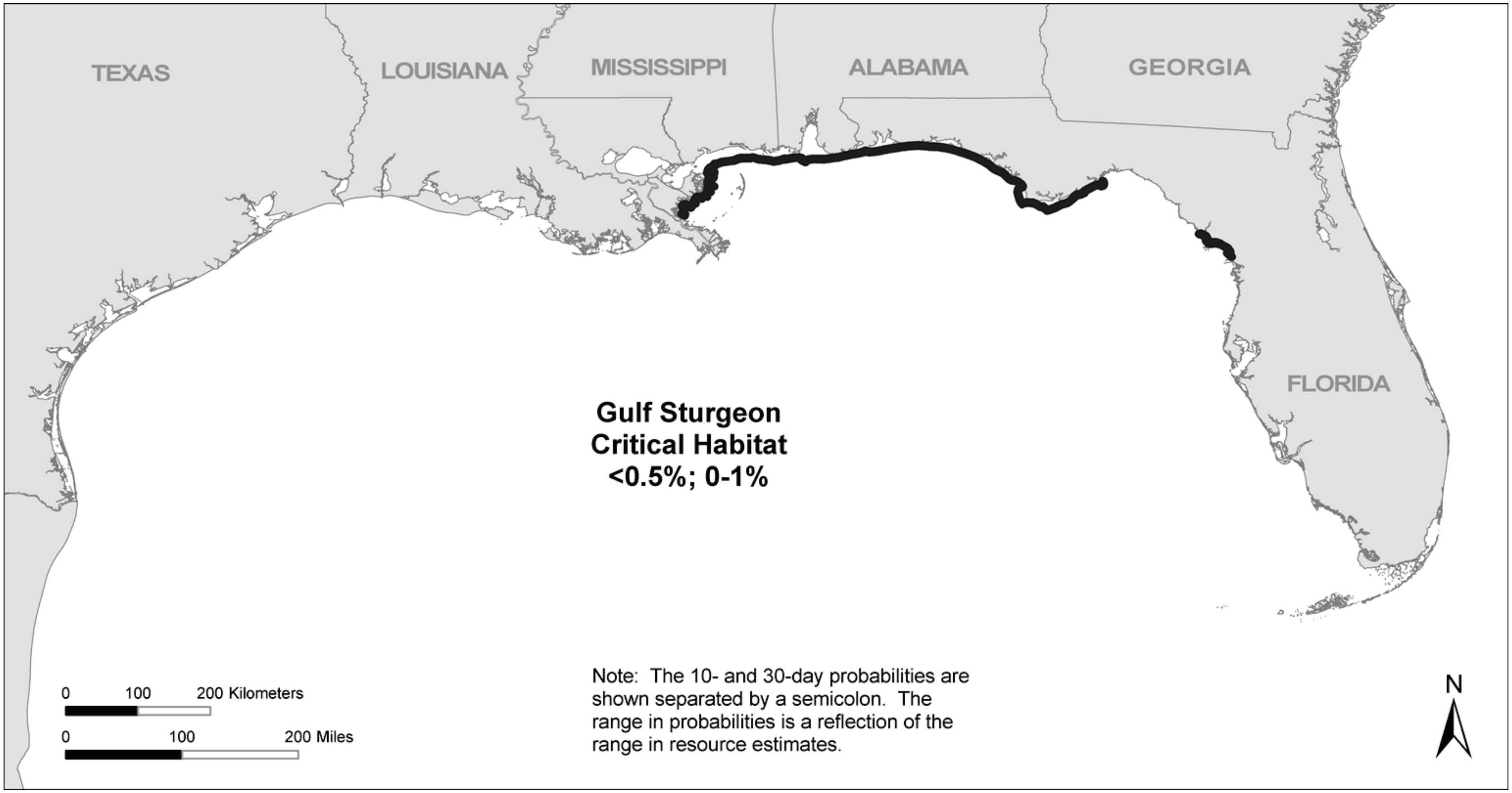


Gulf Sturgeon
Known Area of Occurrence
(Year Round)
<0.5-1%; <0.5-2%

Short Nose
Sturgeon
Known Area of Occurrence
(Southern Population)
<0.5%; <0.5%

Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

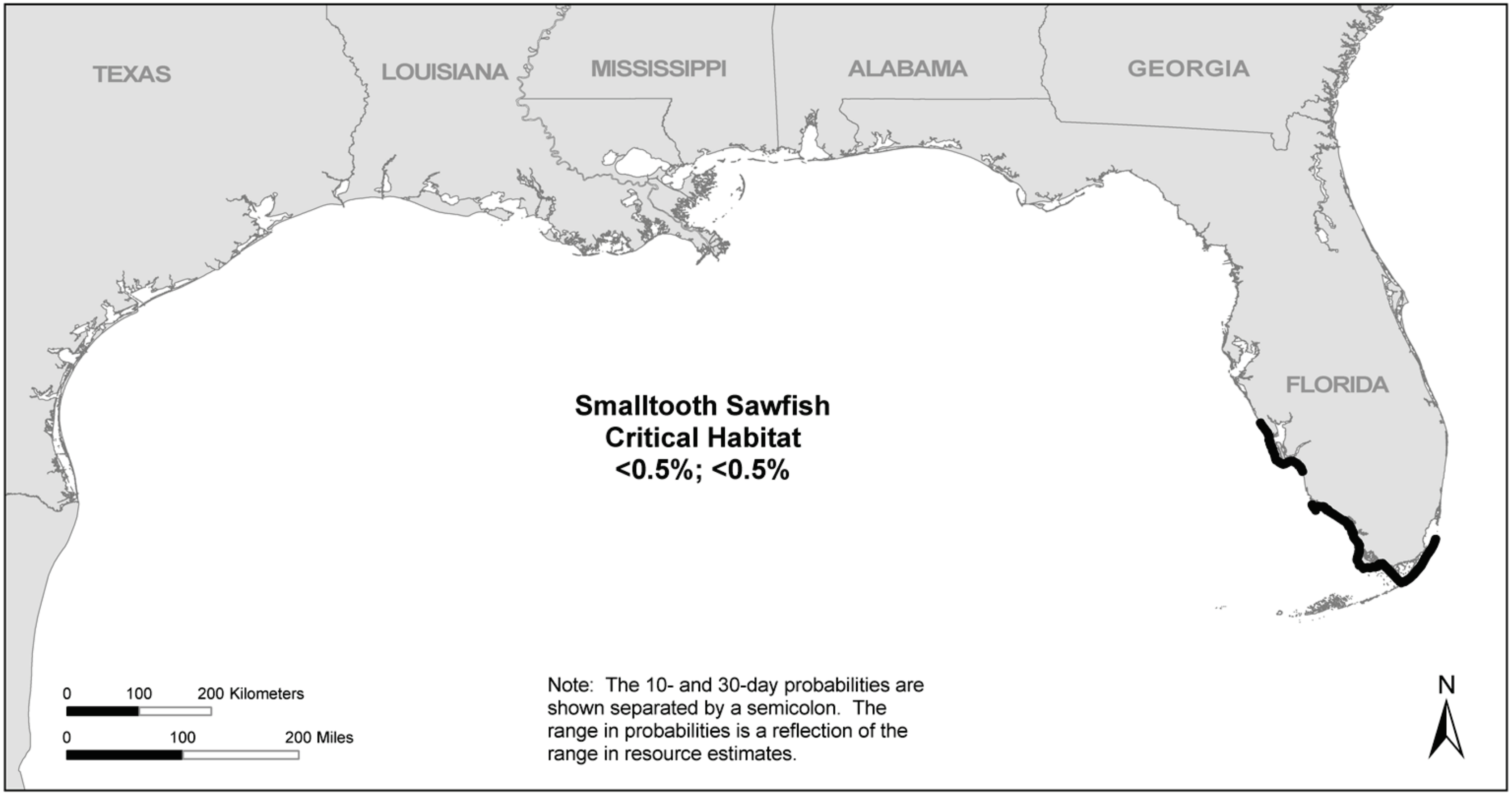
Figure 3-11. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Sturgeon Known Areas of Occurrence as a Result of an EPA Proposed Action.



Gulf Sturgeon Critical Habitat <0.5%; 0-1%

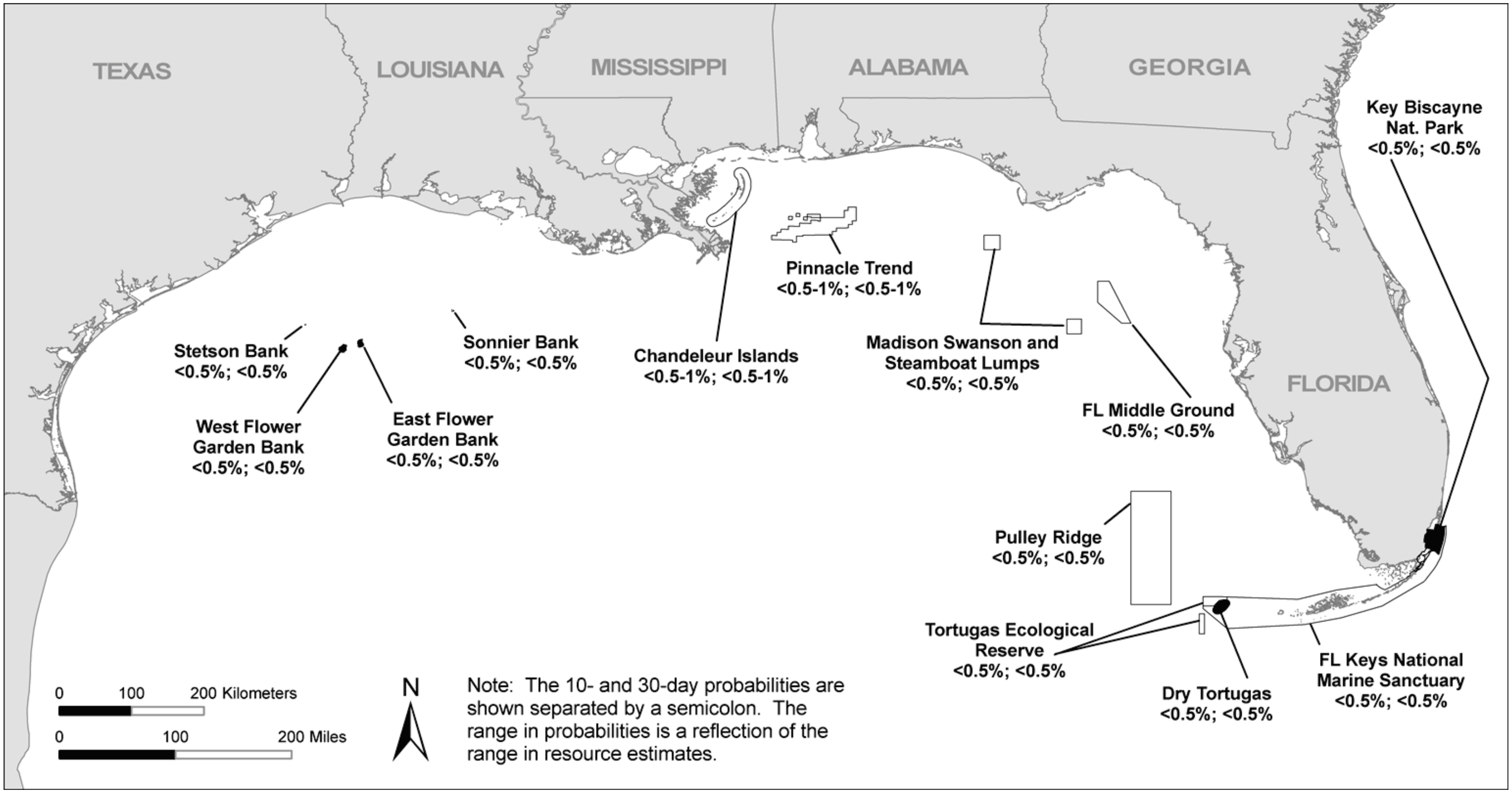
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-12. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Gulf Sturgeon Critical Habitats as a Result of an EPA Proposed Action.



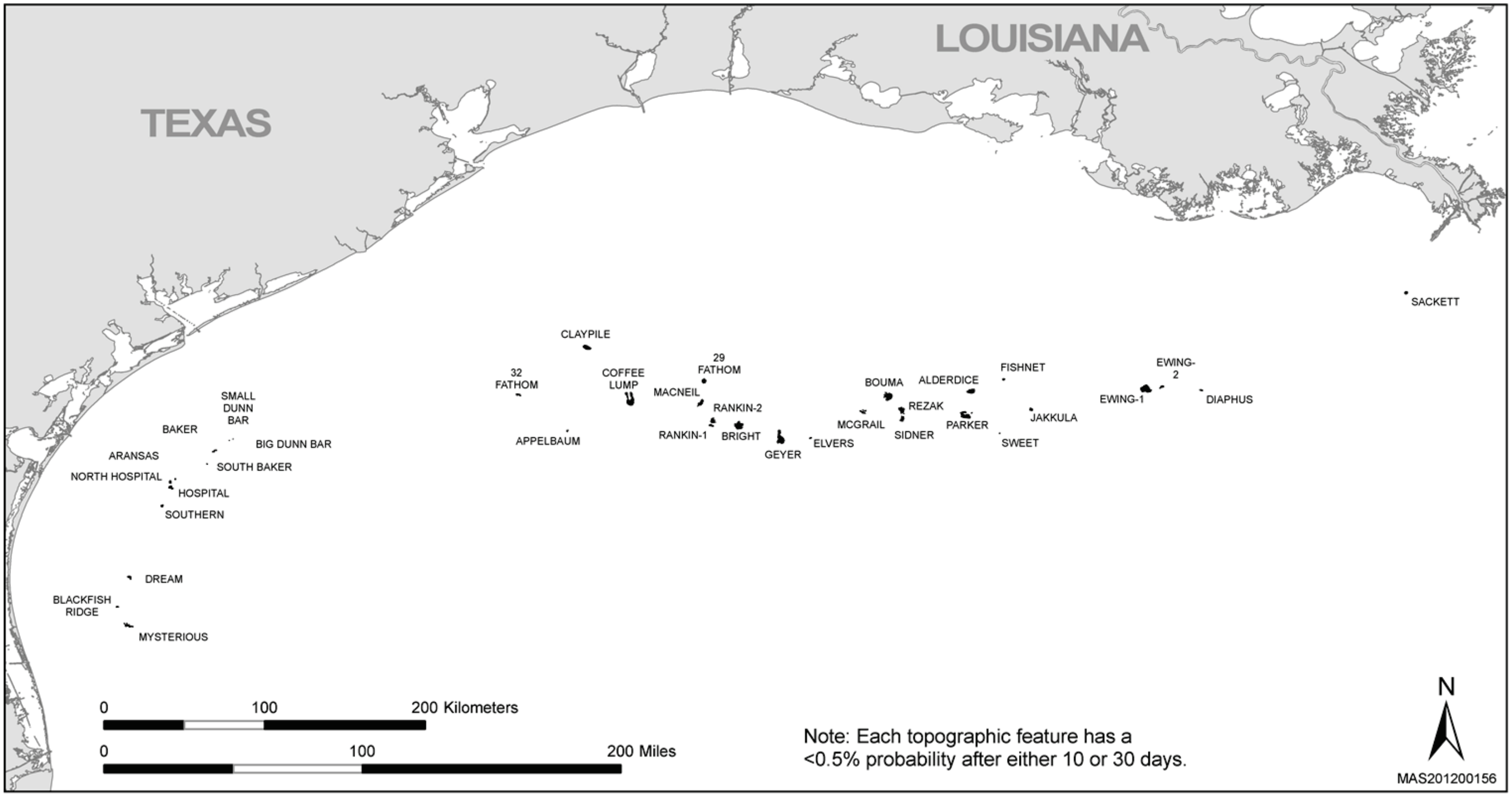
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-13. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Smalltooth Sawfish Critical Habitat as a Result of an EPA Proposed Action.



Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-14. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days the Surface Waters Overlying and Surrounding Offshore Environmental Features or Boundary Targets as a Result of an EPA Proposed Action.



Note: Each topographic feature has a <0.5% probability after either 10 or 30 days.

Figure 3-15. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Topographic Features as a Result of an EPA Proposed Action.

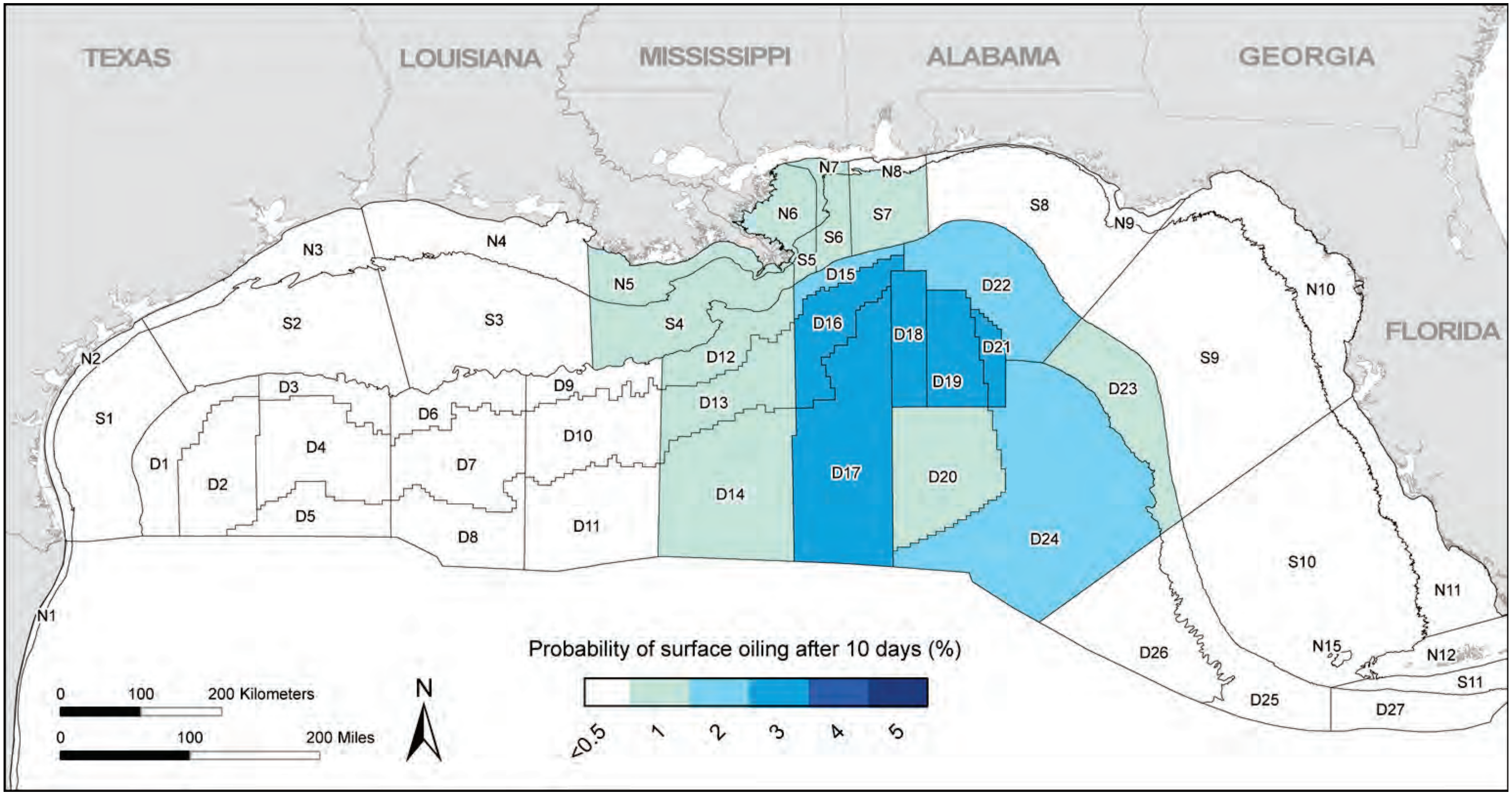


Figure 3-16. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 Days the Surface Waters Overlying Seafloor Habitats as a Result of an EPA Proposed Action. (Locations of seafloor polygons correspond to nearshore [“N” − 0-20 m], shelf [“S” − 20-300 m], and deepwater [“D” − 300 m to outer jurisdiction].)

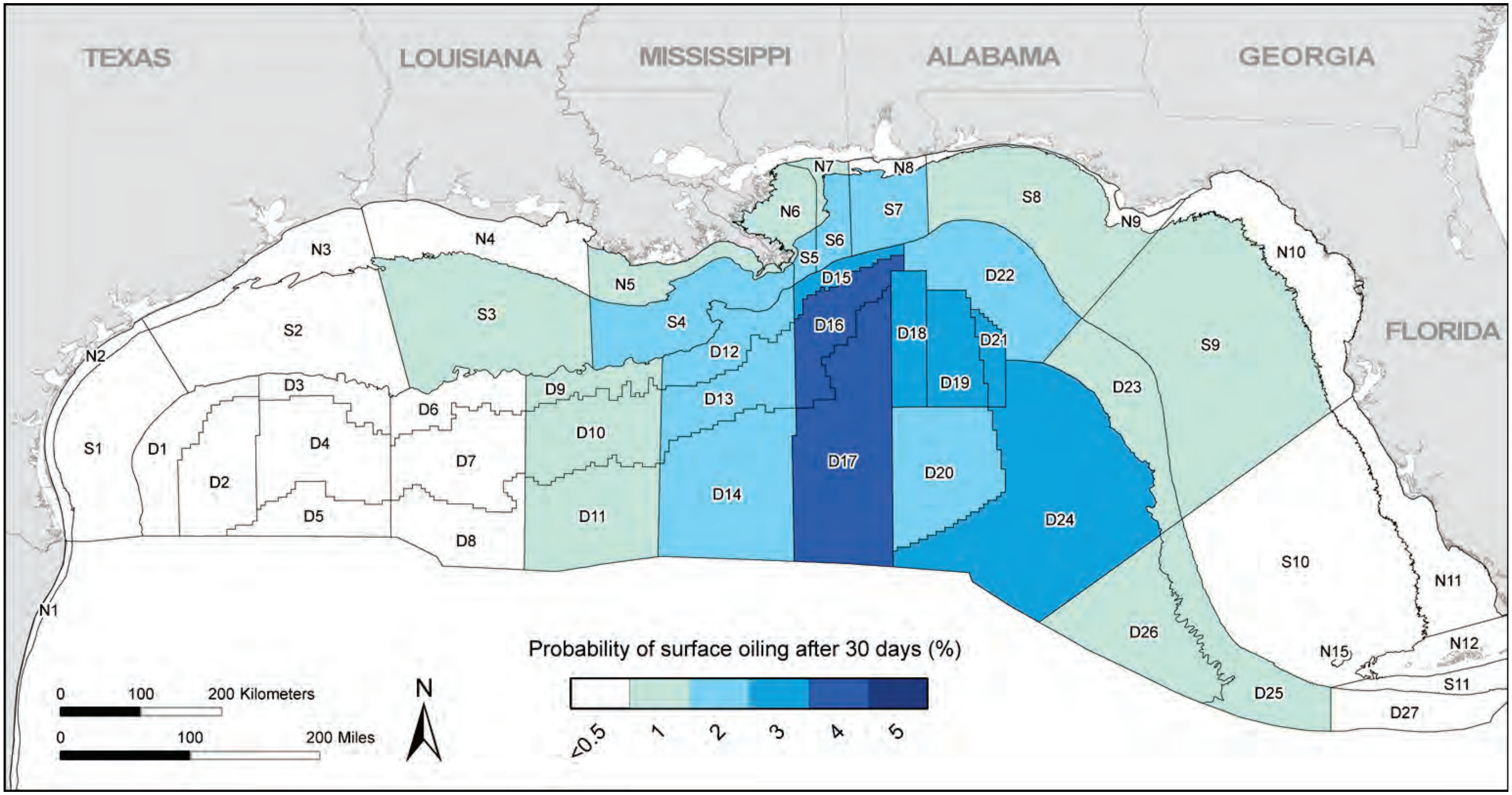
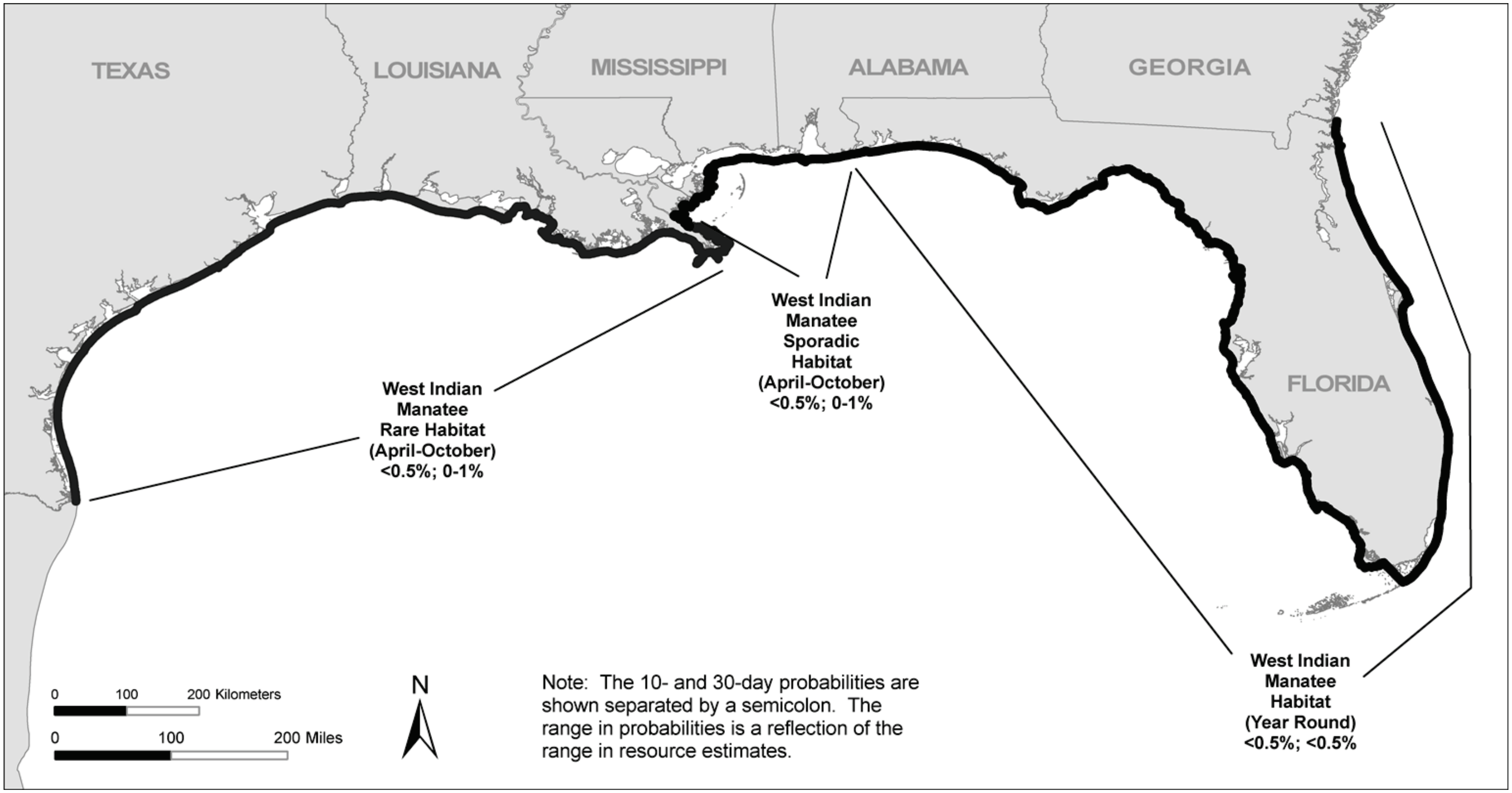
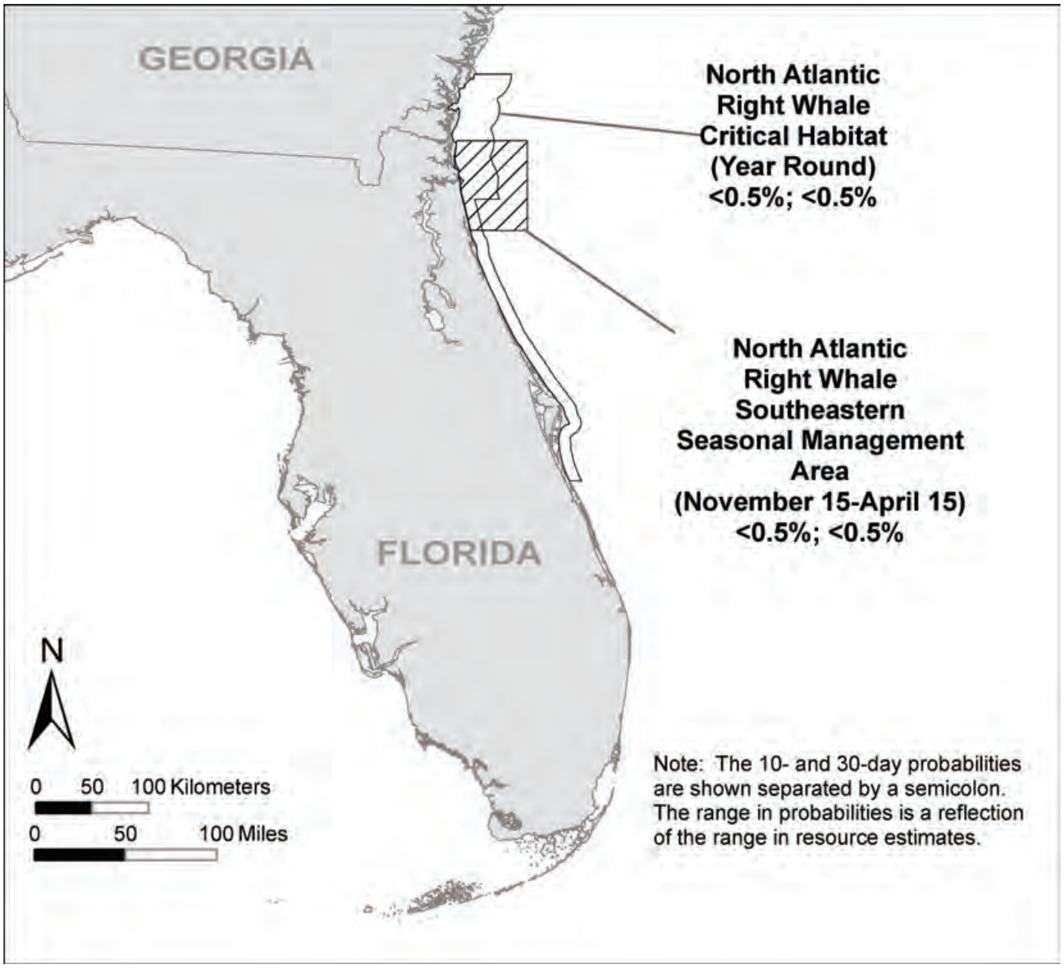


Figure 3-17. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 30 Days the Surface Waters Overlying Seafloor Habitats as a Result of an EPA Proposed Action. (Locations of seafloor polygons correspond to nearshore ["N" − 0-20 m], shelf ["S" − 20-300 m], and deepwater ["D" – 300 m to outer jurisdiction].)



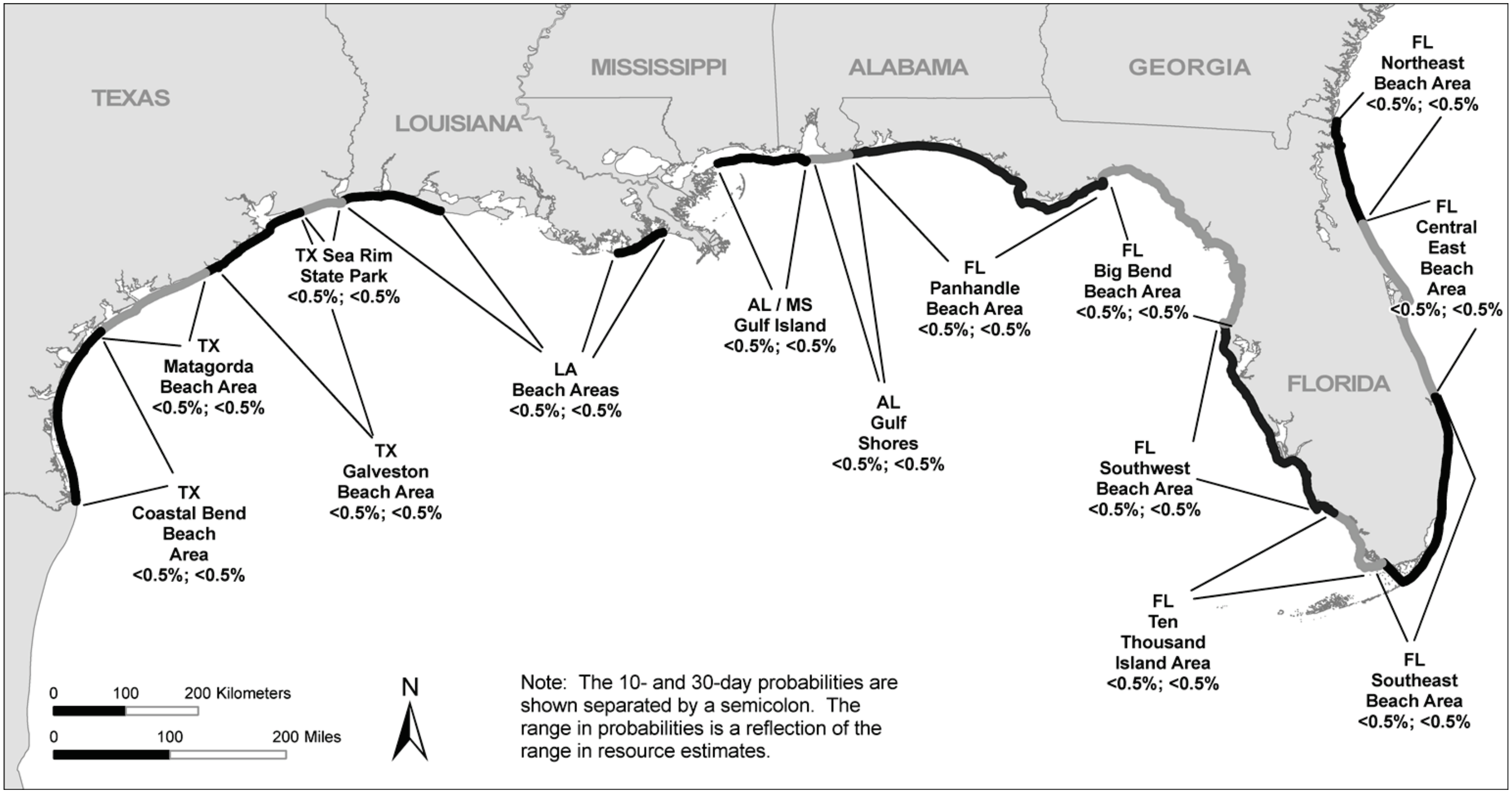
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-18. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Manatee Habitats as a Result of an EPA Proposed Action.



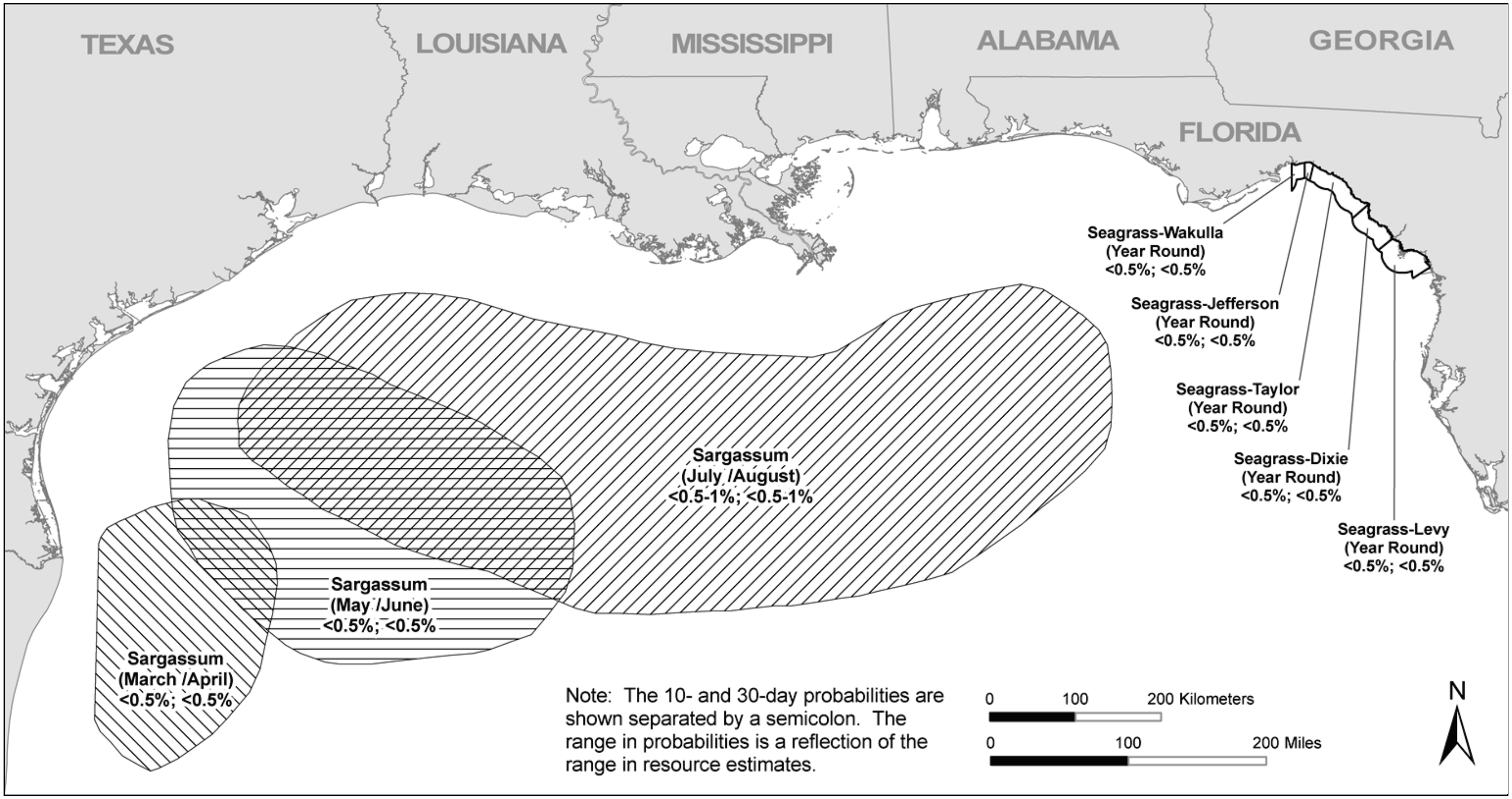
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-19. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days North Atlantic Right Whale Critical Habitat and Southeastern Seasonal Management Area as a Result of an EPA Proposed Action.



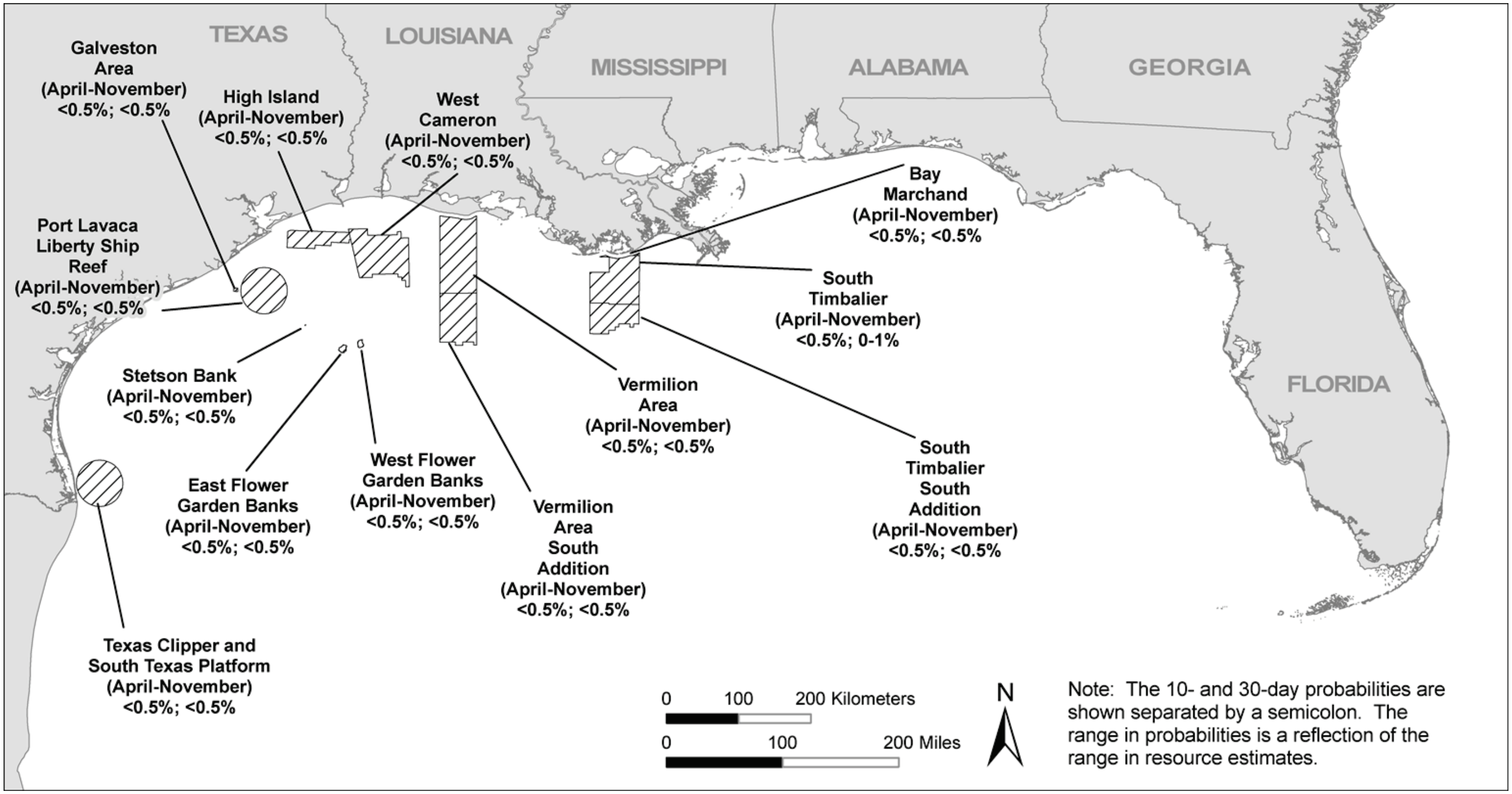
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-20. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Recreational Beaches as a Result of an EPA Proposed Action.



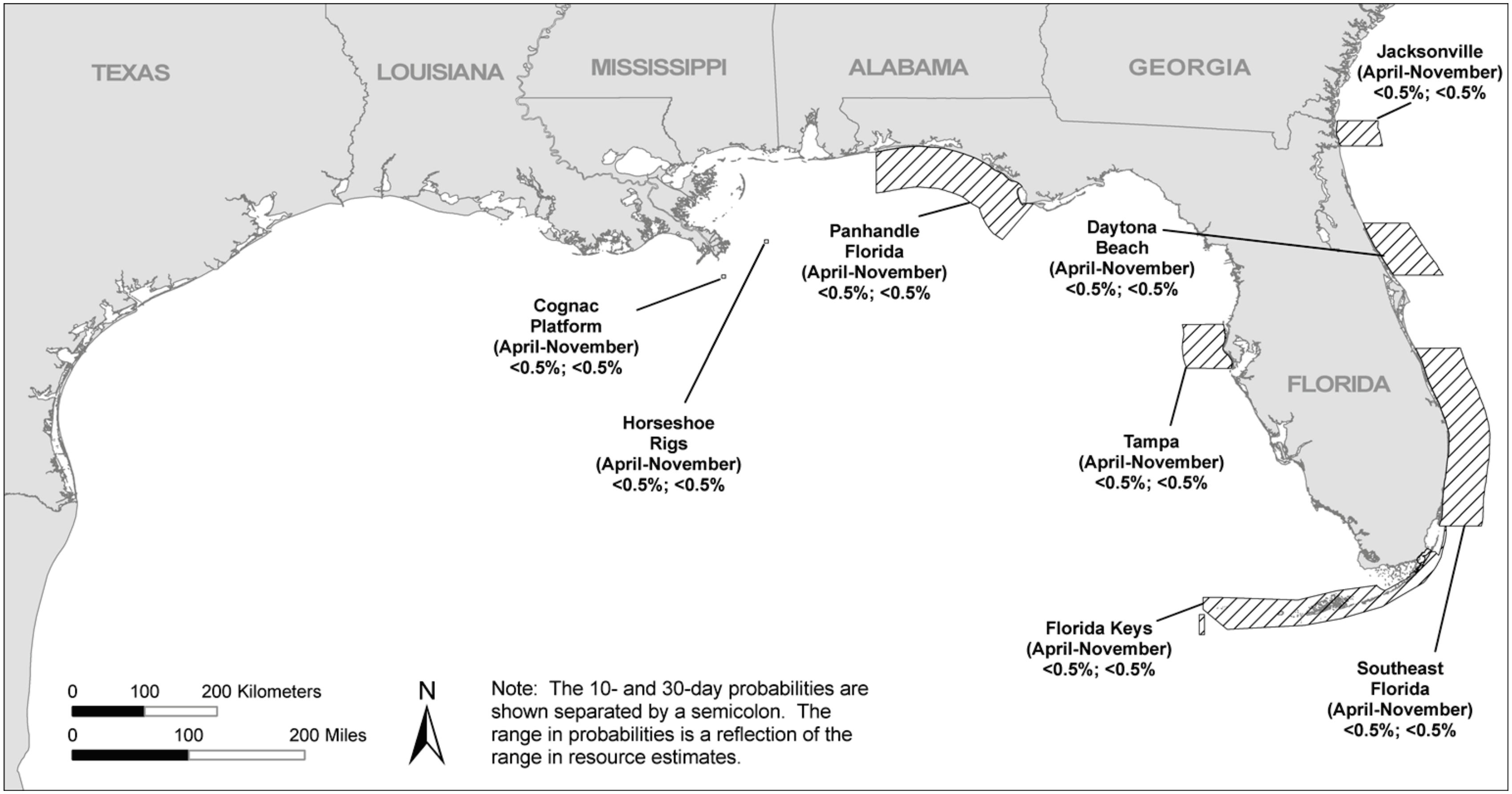
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-21. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Seagrass and *Sargassum* Locations as a Result of an EPA Proposed Action.



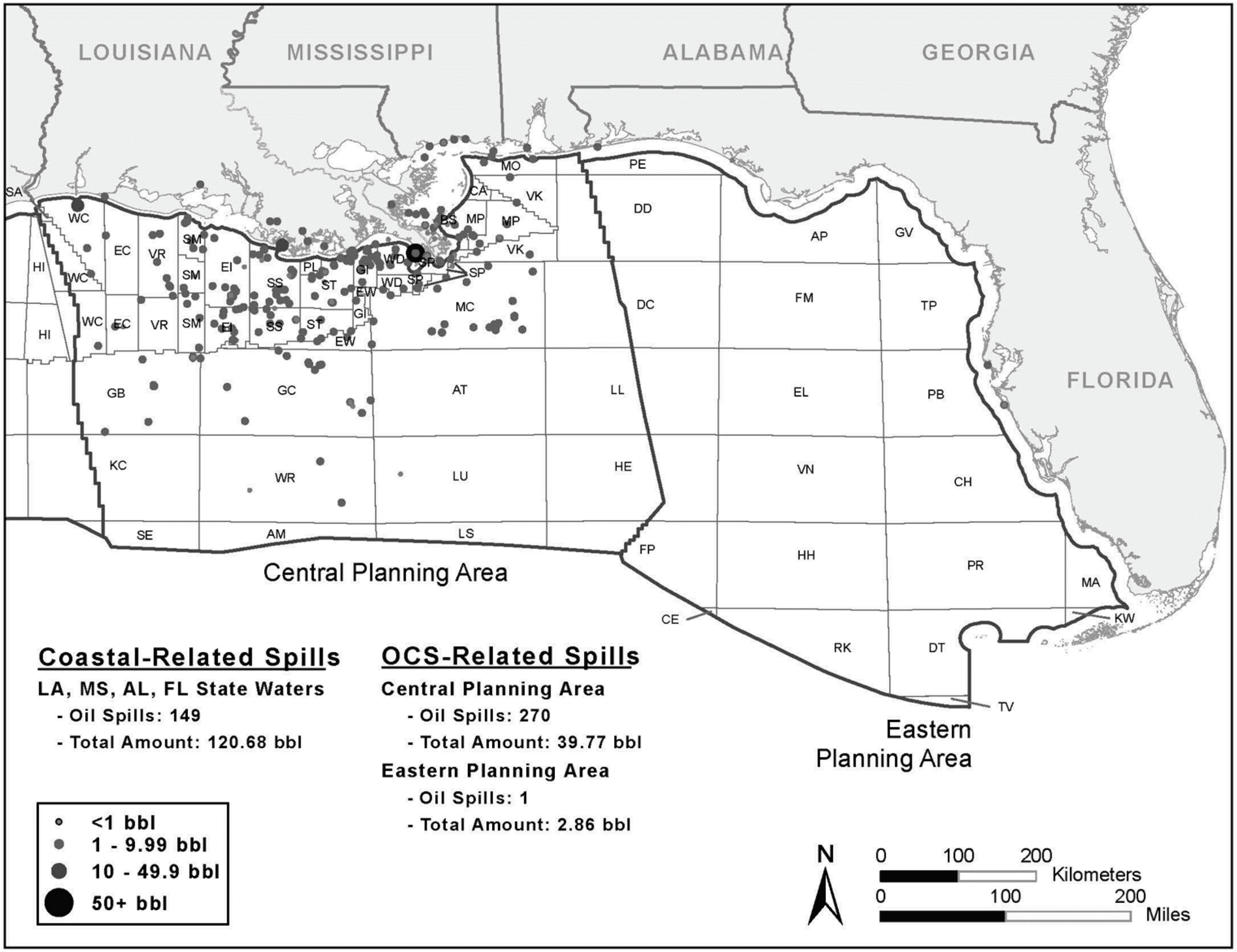
Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-22. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Recreational Dive Sites (in the western Gulf of Mexico) as a Result of an EPA Proposed Action.



Note: The 10- and 30-day probabilities are shown separated by a semicolon. The range in probabilities is a reflection of the range in resource estimates.

Figure 3-23. Probabilities of Oil Spills (≥1,000 bbl) Occurring and Contacting within 10 and 30 Days Recreational Dive Sites (in the eastern Gulf of Mexico and eastern Florida shelf waters) as a Result of an EPA Proposed Action.



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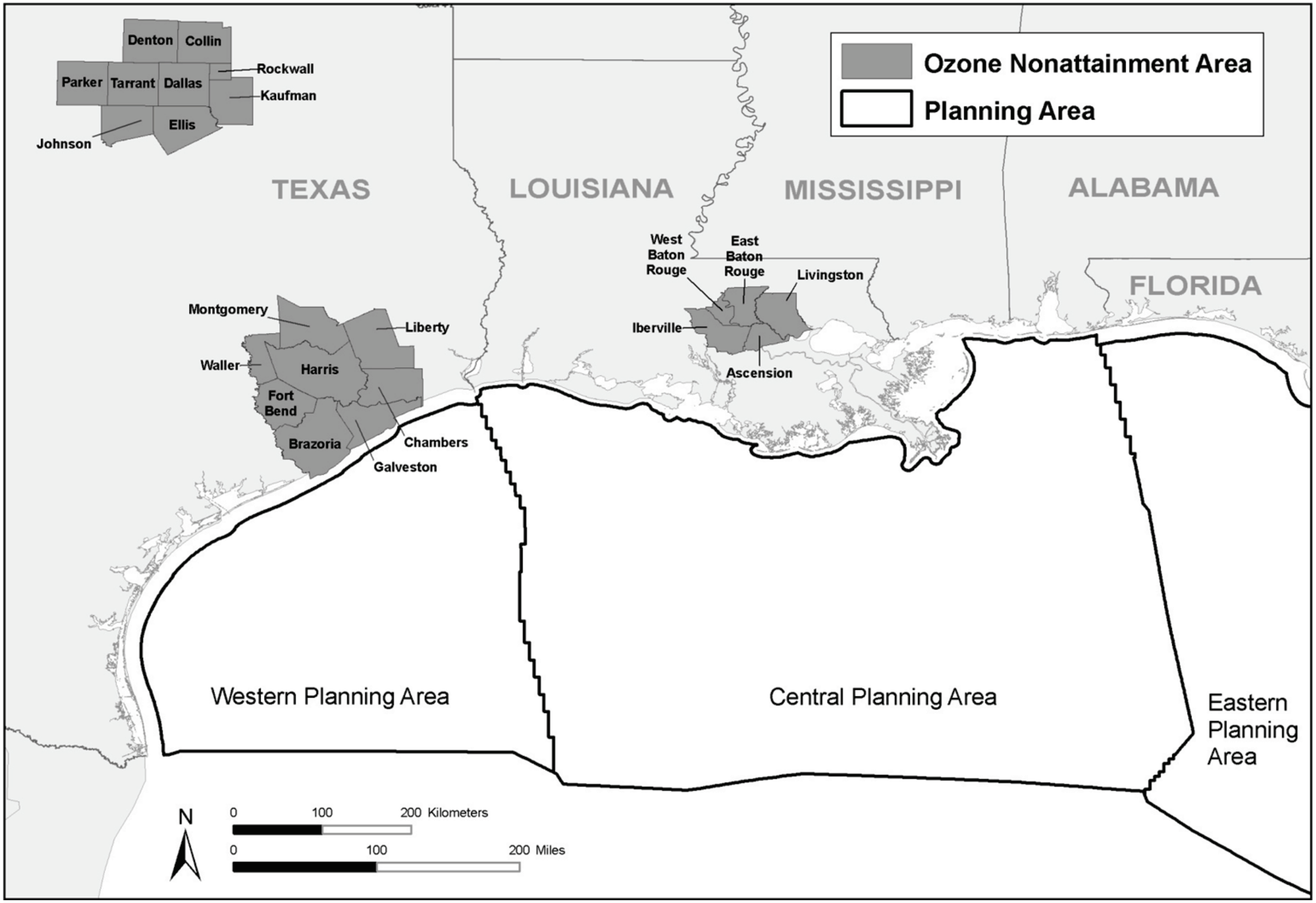

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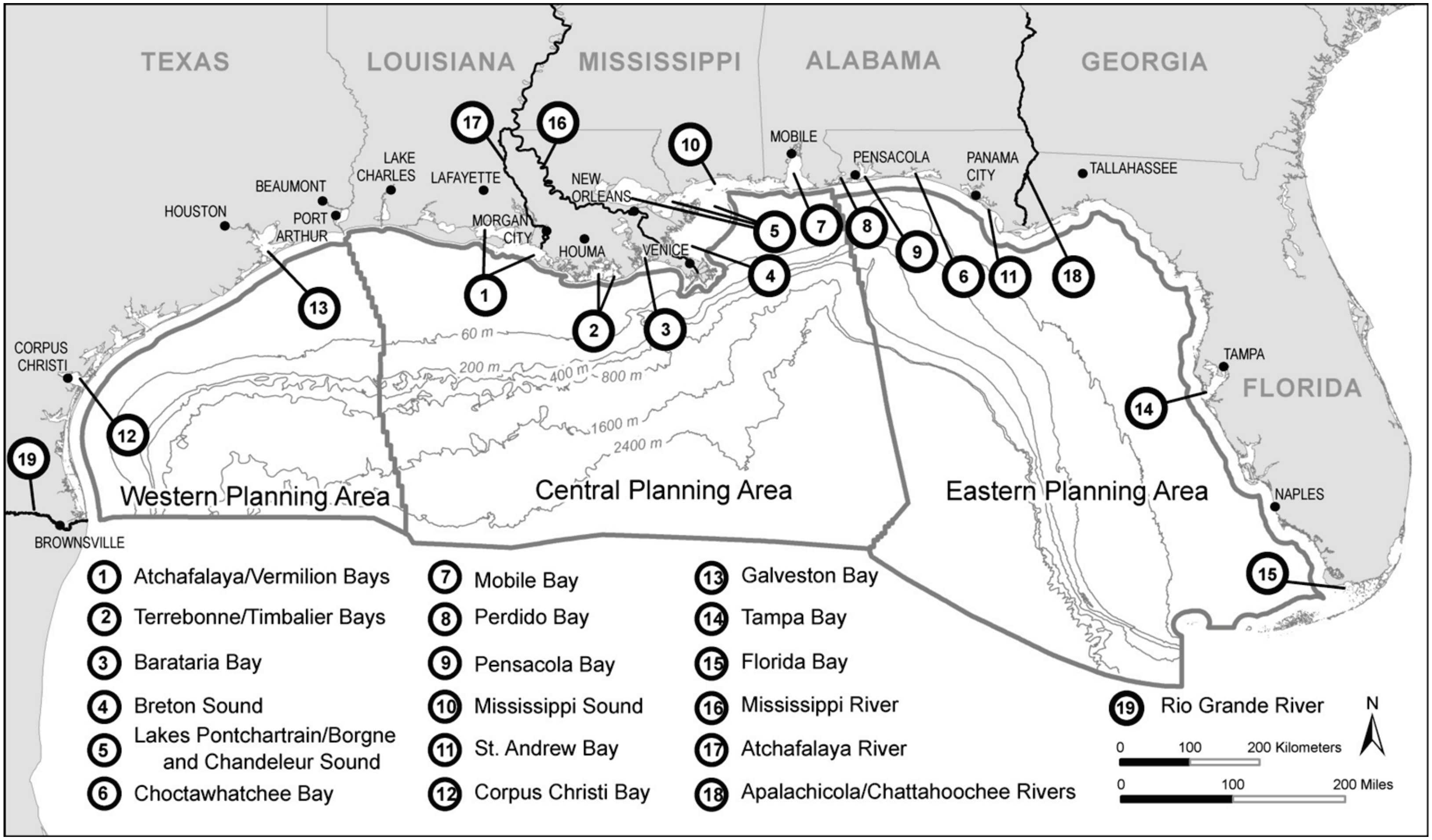

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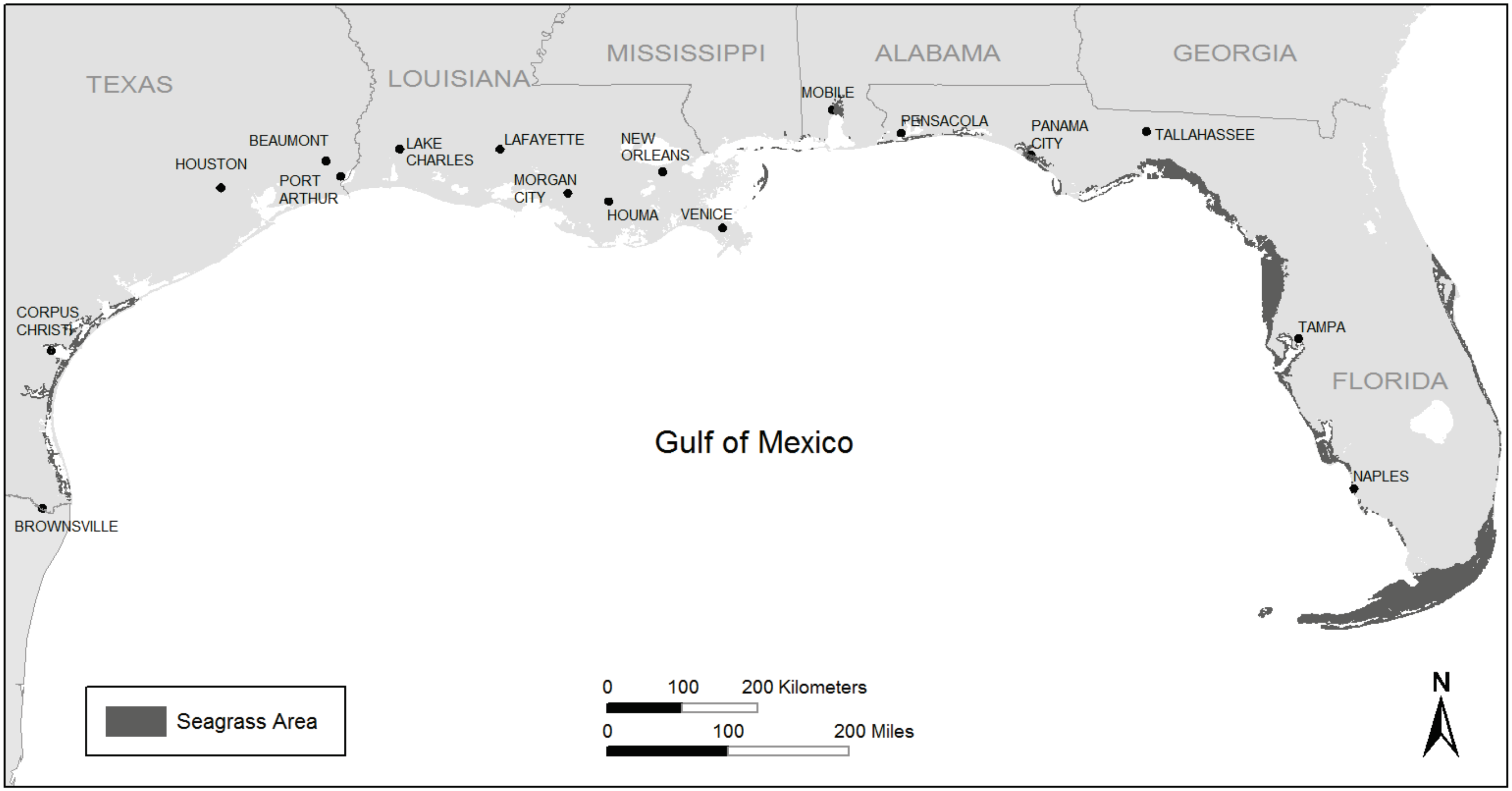

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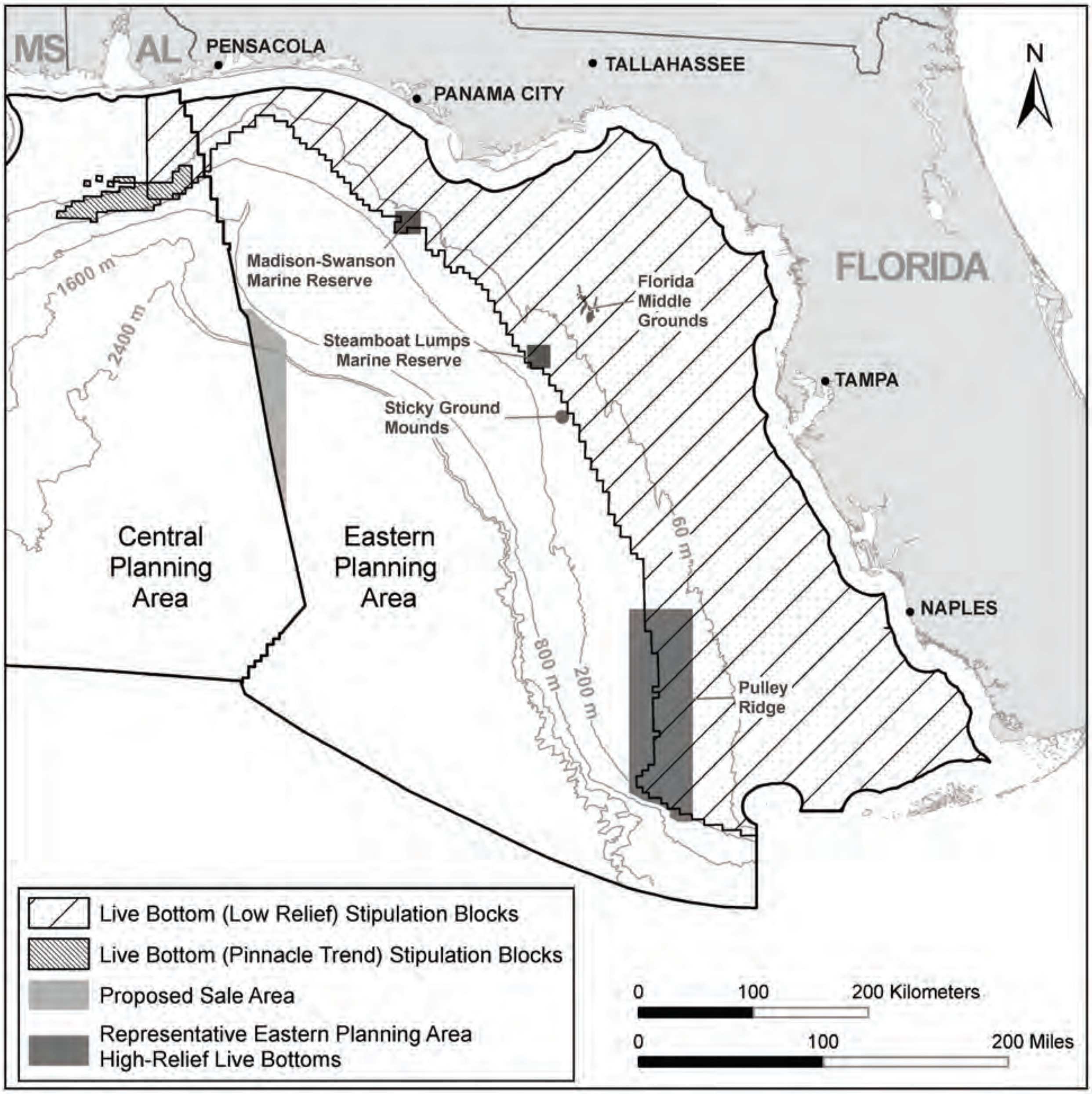

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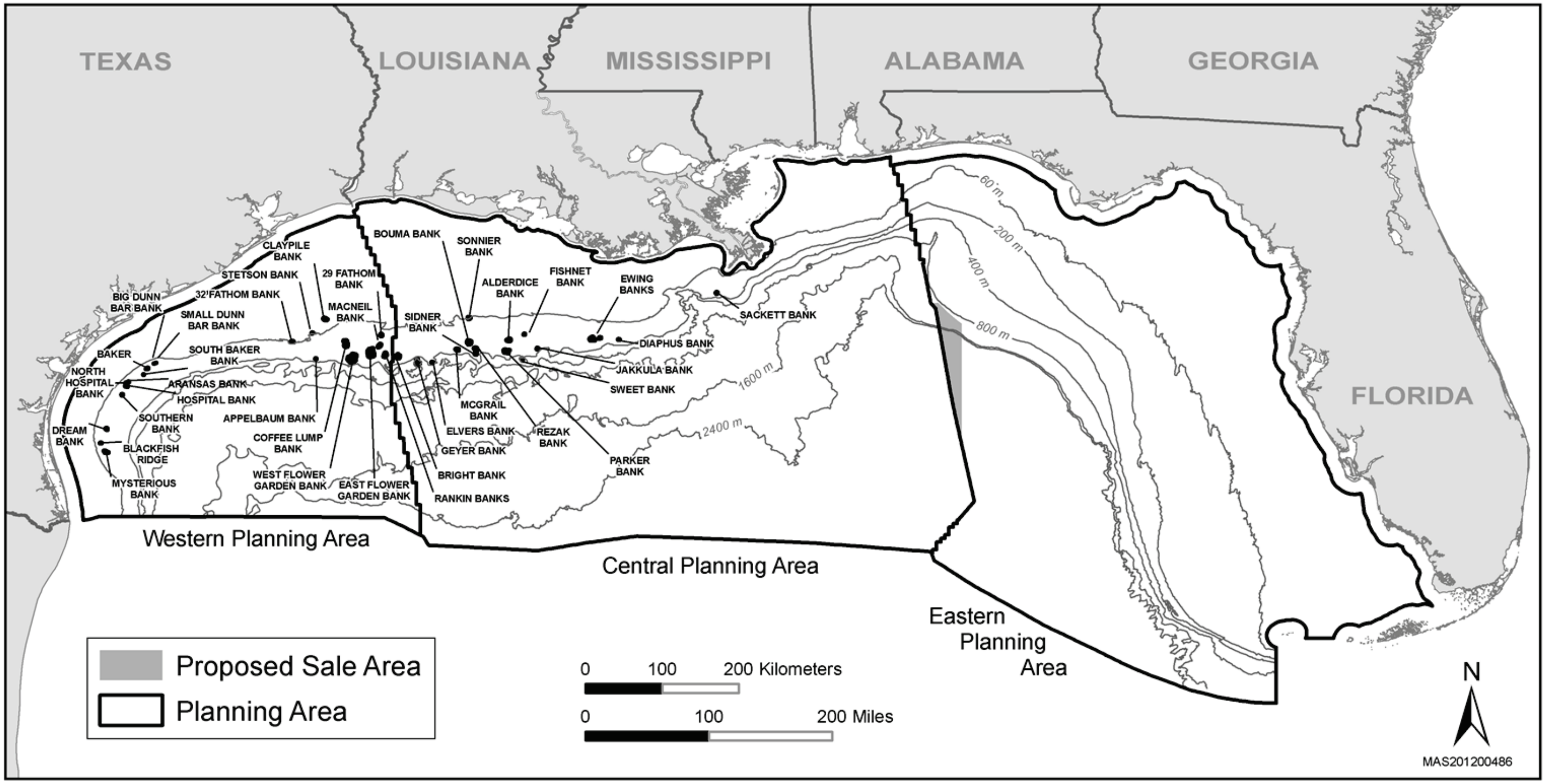

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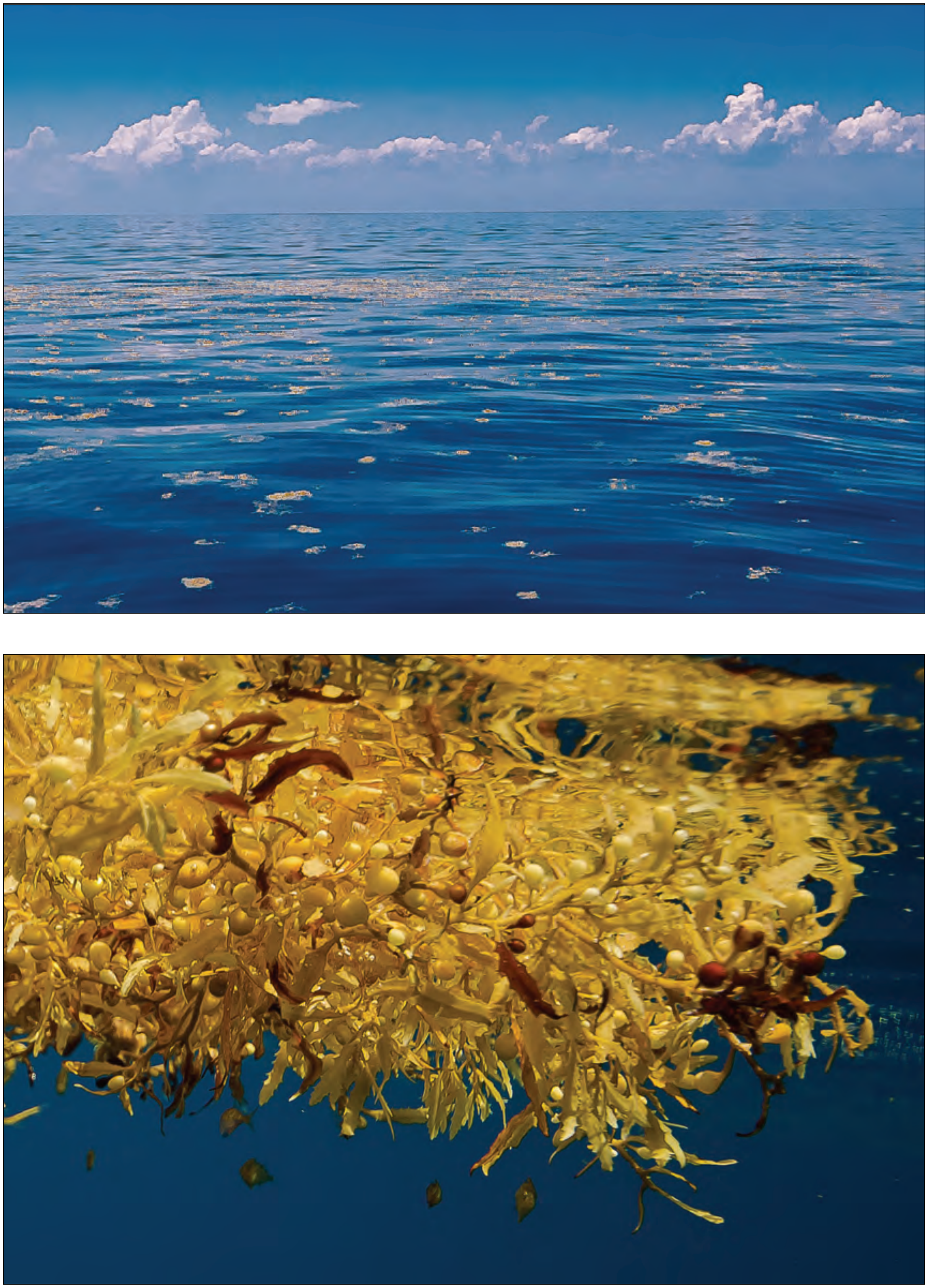
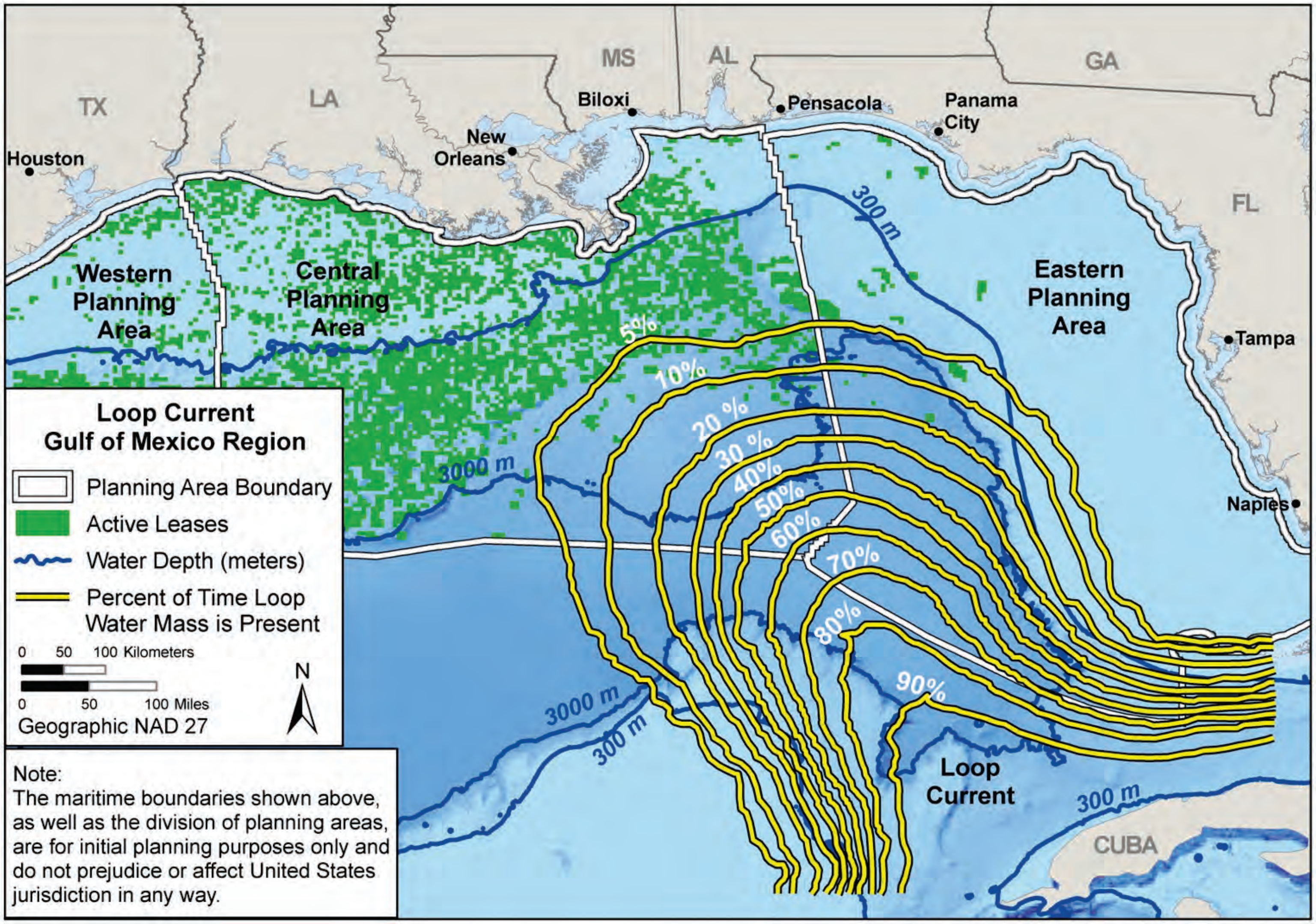


Figure 4-6. *Sargassum* Algae Floating at the Sea Surface (top photo shows view above the surface; bottom photo shows view below the surface) (*Sargassum* floats at the top of the water column and provides habitats for a variety of organisms, and its position at the sea surface makes it particularly vulnerable to floating contaminants like spilled oil.).



Note:
The maritime boundaries shown above, as well as the division of planning areas, are for initial planning purposes only and do not prejudice or affect United States jurisdiction in any way.

Figure 4-7. Climatology of Ocean Features in the Gulf of Mexico Using Satellite Remote-Sensing Data (adapted from Vukovich, 2007).

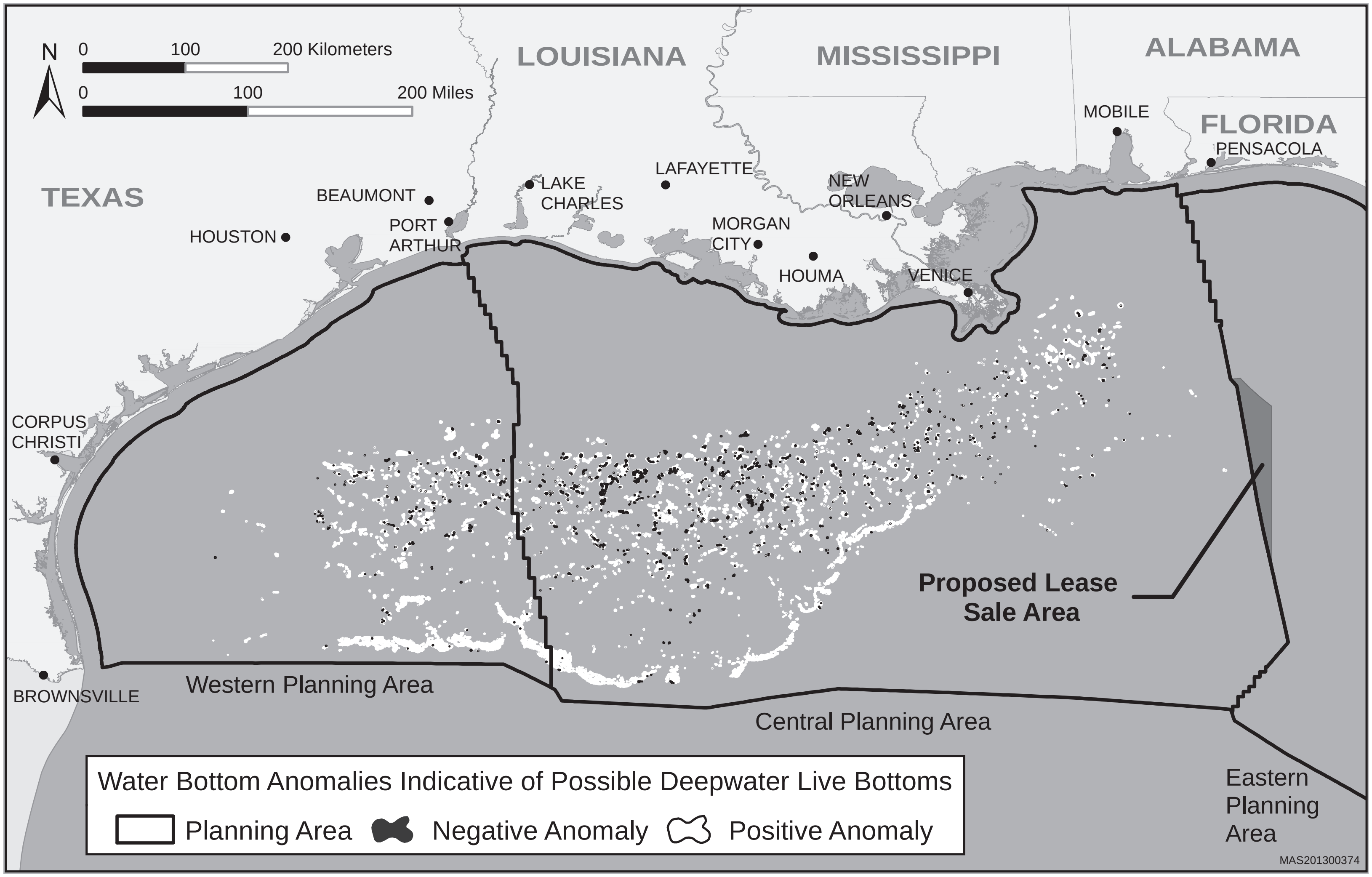


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Figure 4-9. Important Bird Areas along the U.S. Gulf Coast and in the Impact Area of the *Deepwater Horizon* Oil Spill (reprinted with permission from the National Audubon Society, Inc., 2010) (Note: Of the roughly 64 Important Bird Areas depicted on this figure, >50% occur along the Gulf Coast of Florida in the Eastern Planning Area.) (Note from the original figure: "A total of 71 Important Bird Areas across the Gulf—encompassing an area as large as Maryland and Connecticut combined—are central to Audubon plans to safeguard bird populations. Identified for their importance to species of conservation concern, Important Bird Areas on both public and private lands are prime locations for hands-on restoration projects by committed stewardship groups and for long-term conservation. Many are vital to the grueling north-south journeys of migratory birds along the flyways of the western hemisphere.").

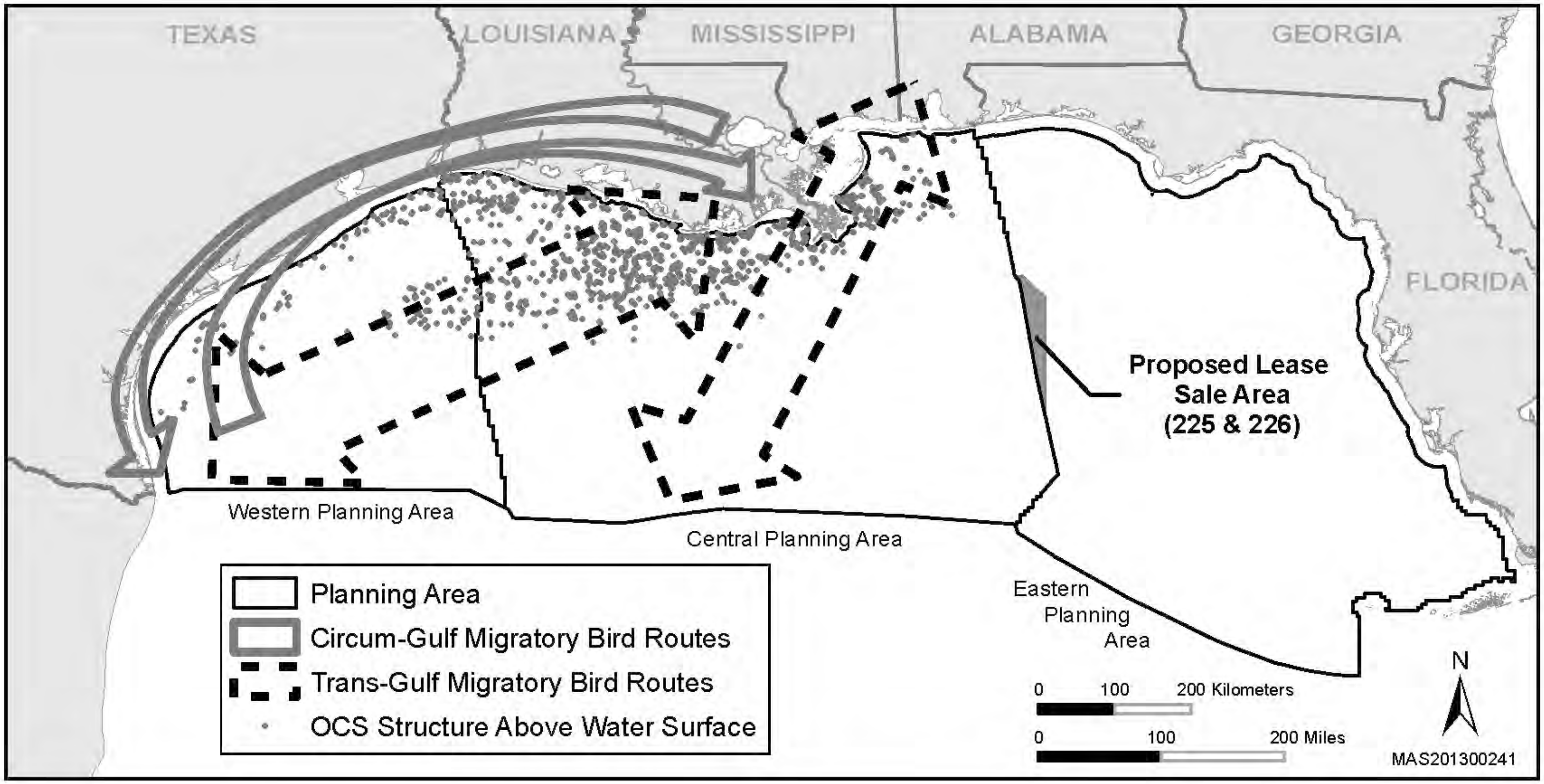

Figure 4-10. Relative Migratory Paths or Corridors for Trans-Gulf Migratory Birds in the Gulf of Mexico (Spring migration is indicated by northerly facing arrows; fall migration is indicated by south-southwest facing arrows. Trans-Gulf migrations are represented by dashed lines; circum-Gulf migrations are represented by gray unbroken arrows.) (adapted from Rappole and Ramos, 1994).

Figure 4-11. Map Indicating the Position of the *Deepwater Horizon* Oil Spill as of June 2010 and Globally Important Bird Areas Most at Risk (reprinted with permission from the American Bird Conservancy, 2010).

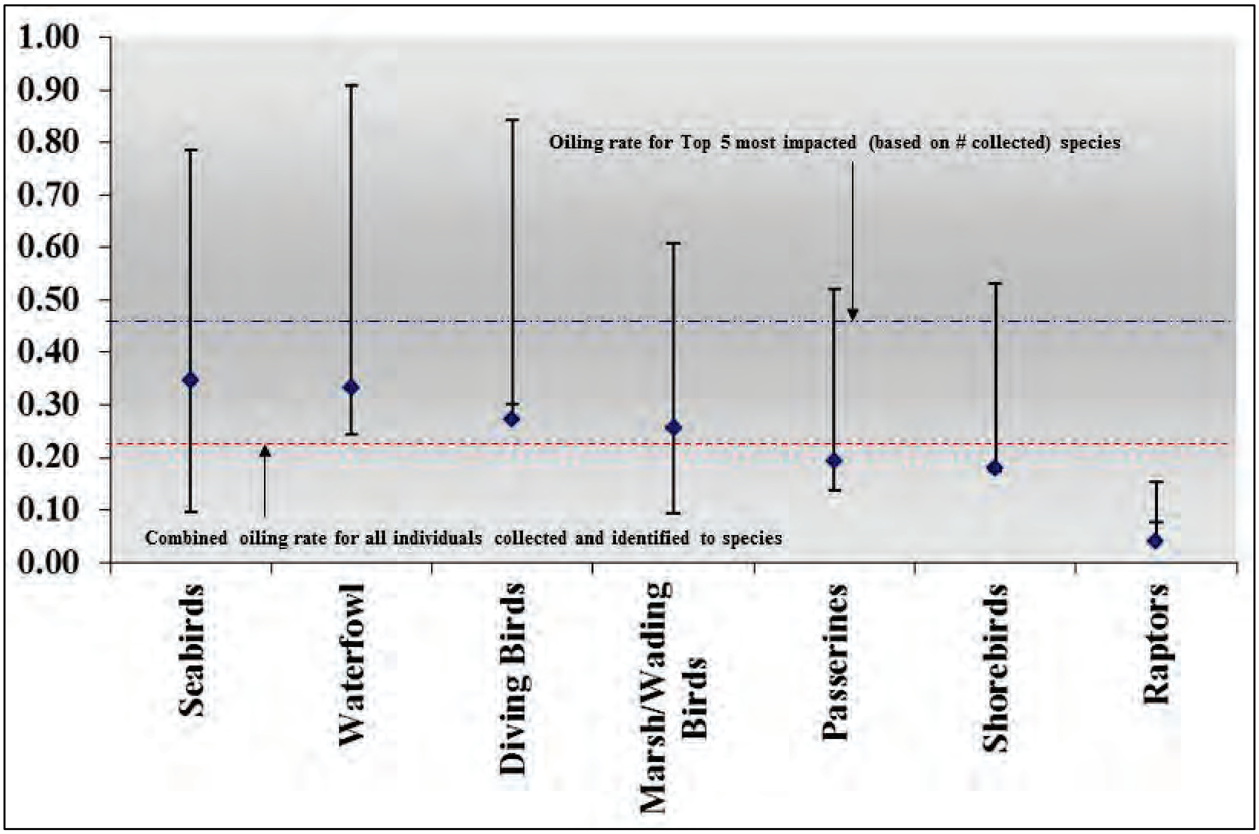

Figure 4-12. Oiling Rates for the Seven Avian Species Considered in This EIS and in the 2012-2017 WPA/CPA Multisale EIS. (The Top 5 most-impacted species collected [#, oiling rate in percent] in order were as follows: laughing gull [2,981, 0.40]; brown pelican [826, 0.41]; northern gannet [475, 0.62]; royal tern [289, 0.52]; and black skimmer [253, 0.22]. Note: The lower leg of confidence intervals overlapped zero for several species groups and is thus not to scale.)

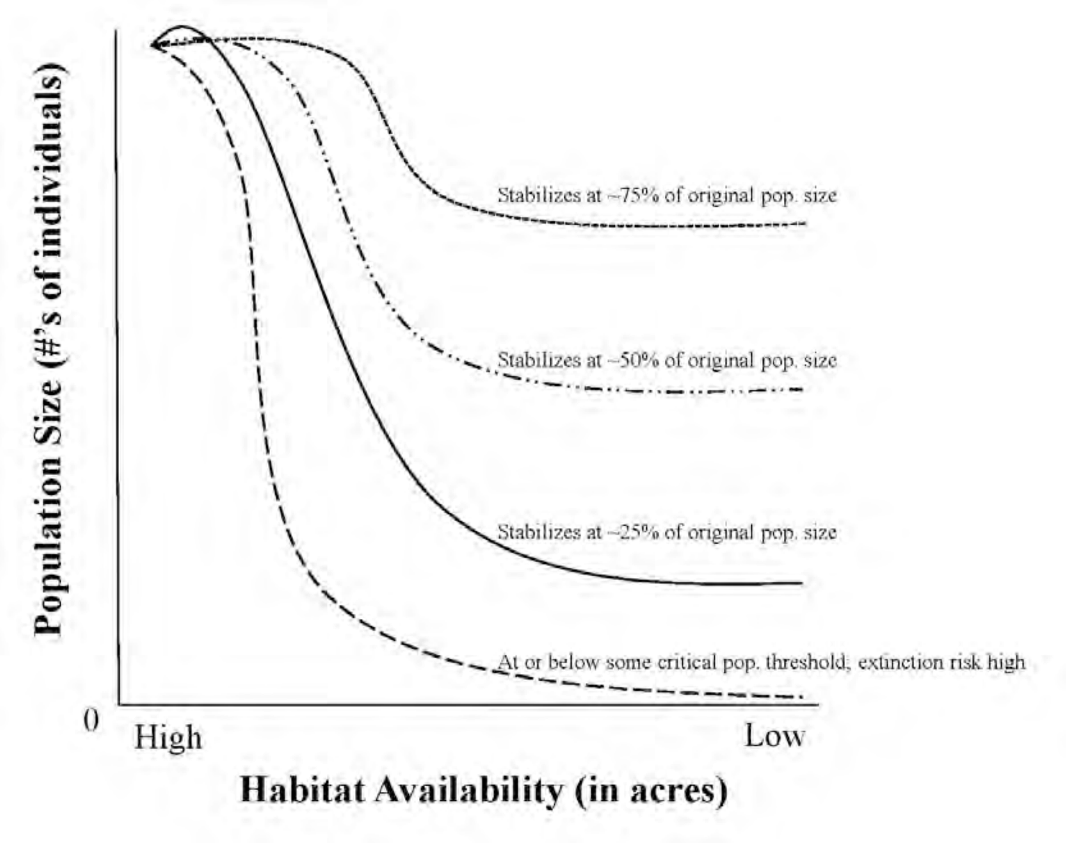

Figure 4-13. Hypothetical Population Trajectories for Breeding and Wintering Coastal Shorebirds and Marsh- and Waterbirds in the Gulf of Mexico (USDOI, FWS, 2010) in Response to Predicted Effects of Climate Change. (The population starting points, trajectories, shape of the curves or functional relationships, and endpoints are relative [Fahrig, 2001 and 2002]. Particularly sensitive species include those with a small initial population size [threatened and endangered species; e.g., dashed line], species with starting population trajectories indicating declines [species of conservation concern], habitat specialists or saltmarsh obligates, and those species whose life-history characteristics make [solid line and dot-dash lines above] it challenging to respond to major population losses or perturbations [North American Bird Conservation Initiative, 2010]. Though there is a fair amount of uncertainty regarding potential impacts of climate change [Conroy et al., 2011; Nichols et al., 2011], sea-level rise is occurring [Intergovernmental Panel on Climate Change, 2007]. Though the ultimate result is unknown, it is highly probable that the increase in water level will result in an inland shift of each of the respective habitat zones [Galbraith et al., 2002; Sutherland, 2004; Harley et al., 2006] with the potential for serious reductions in island, cobble-sand-beach, and tidal- and mudflat habitats. The Intergovernmental Panel on Climate Change [2007] estimated that 30% of global coastal wetlands will be lost. Note: Even in the absence of climate change impacts, the availability of suitable habitat [baseline habitat available] is declining for many or most of the avian species considered due to various other anthropogenic [e.g., coastal development, modifications to or removal of natural sediment delivery systems, disturbance effects, habitat loss and fragmentation associated with oil and gas development both in State and Federal waters] and natural [e.g., subsidence, hurricanes, wind, wave, and tidal action] factors.)

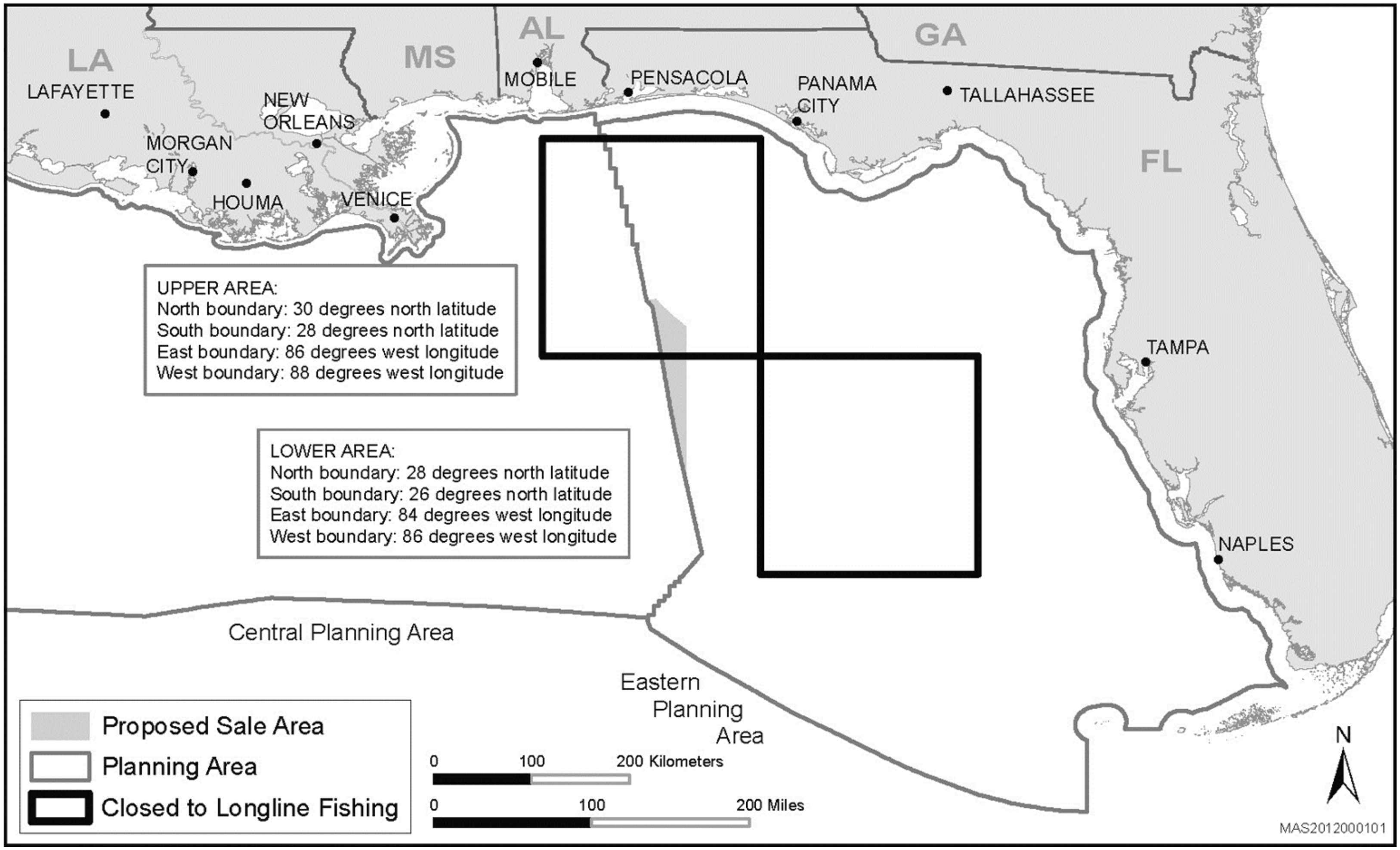

Figure 4-14. Areas Closed to Longline Fishing in the Gulf of Mexico.

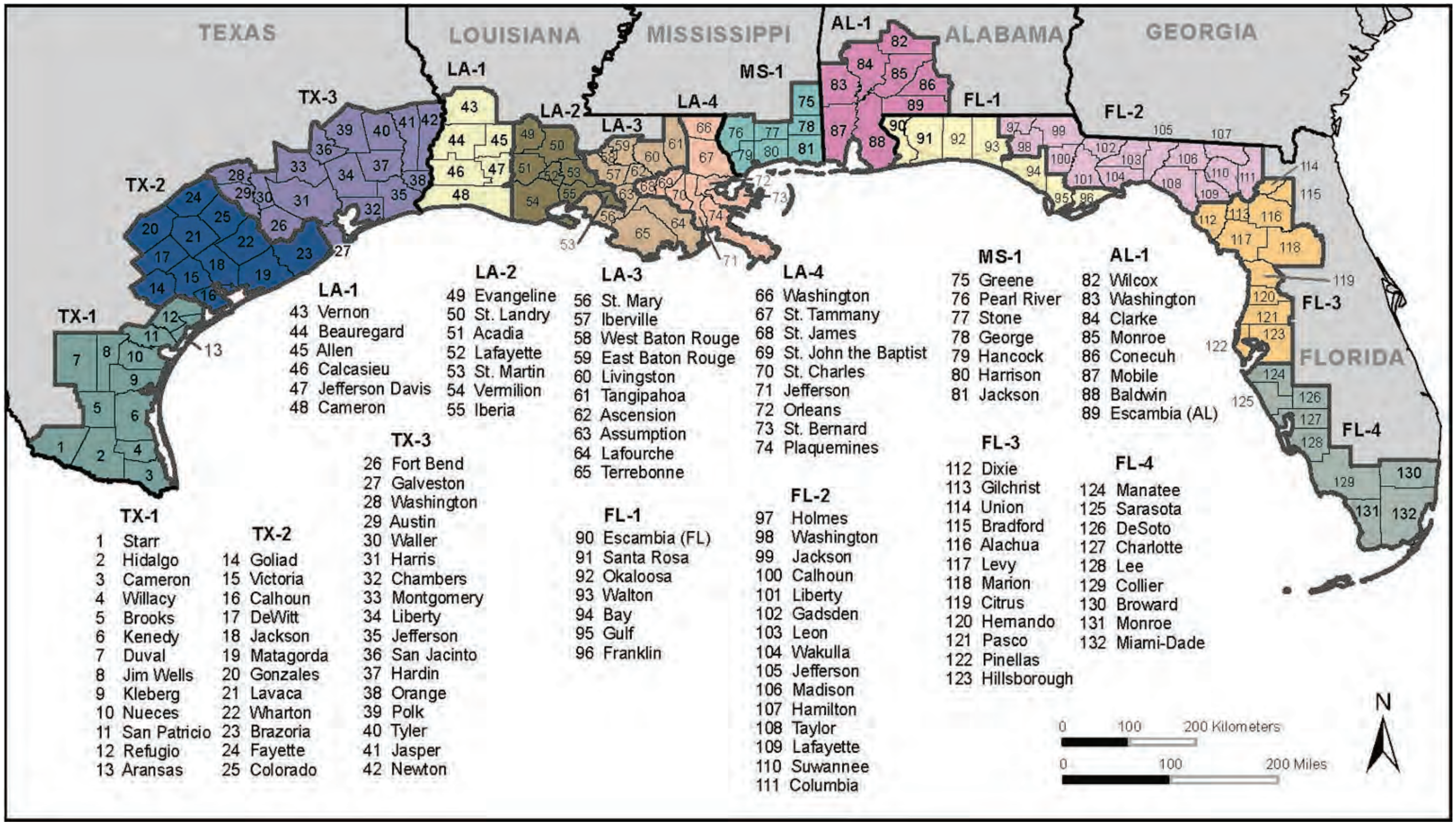

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Figure 4-16. Onshore Infrastructure Located in Louisiana and Mississippi (Dismukes, 2011).

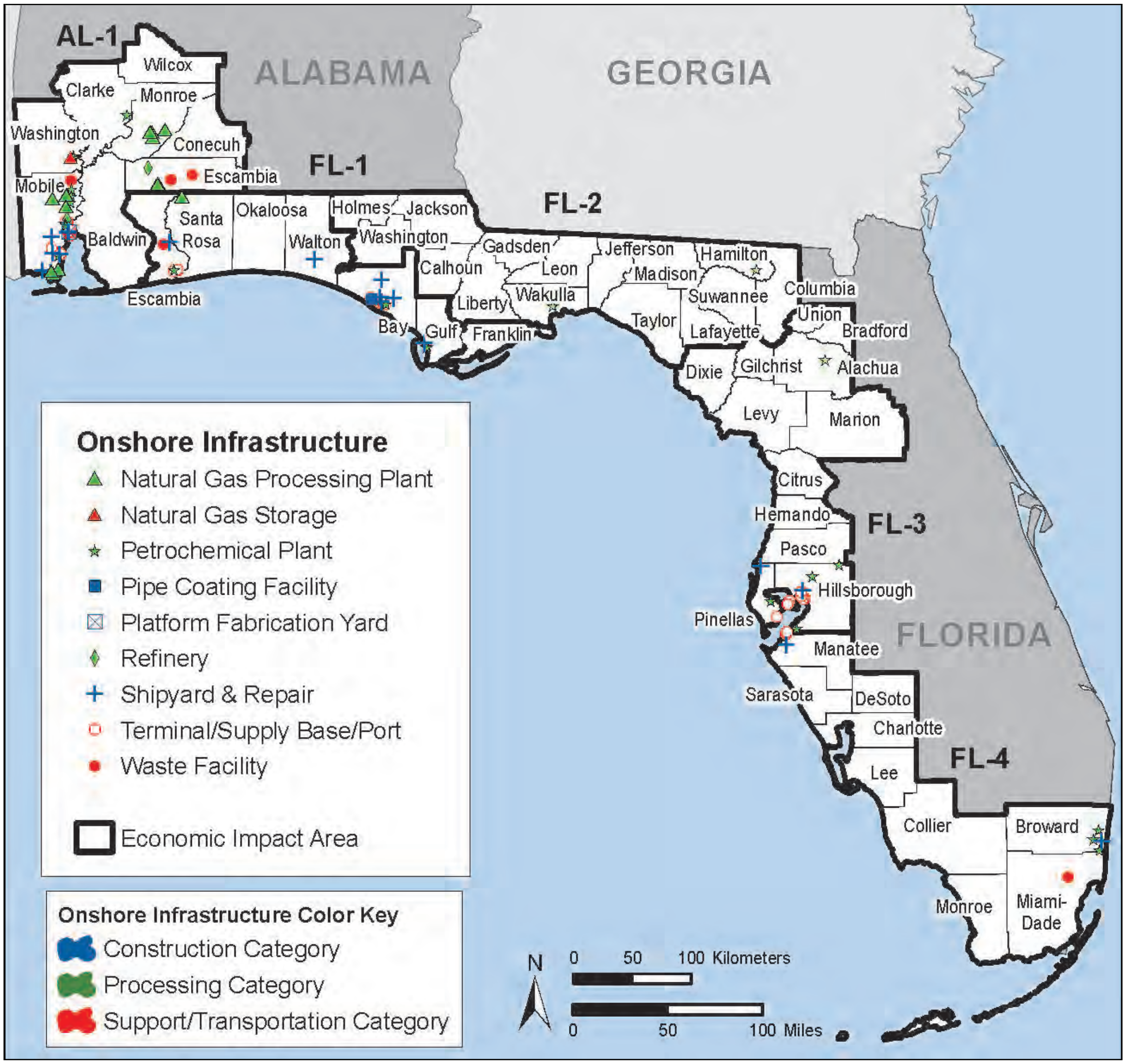


Figure 4-17. Onshore Infrastructure Located in Alabama and Florida (Dismukes, 2011).

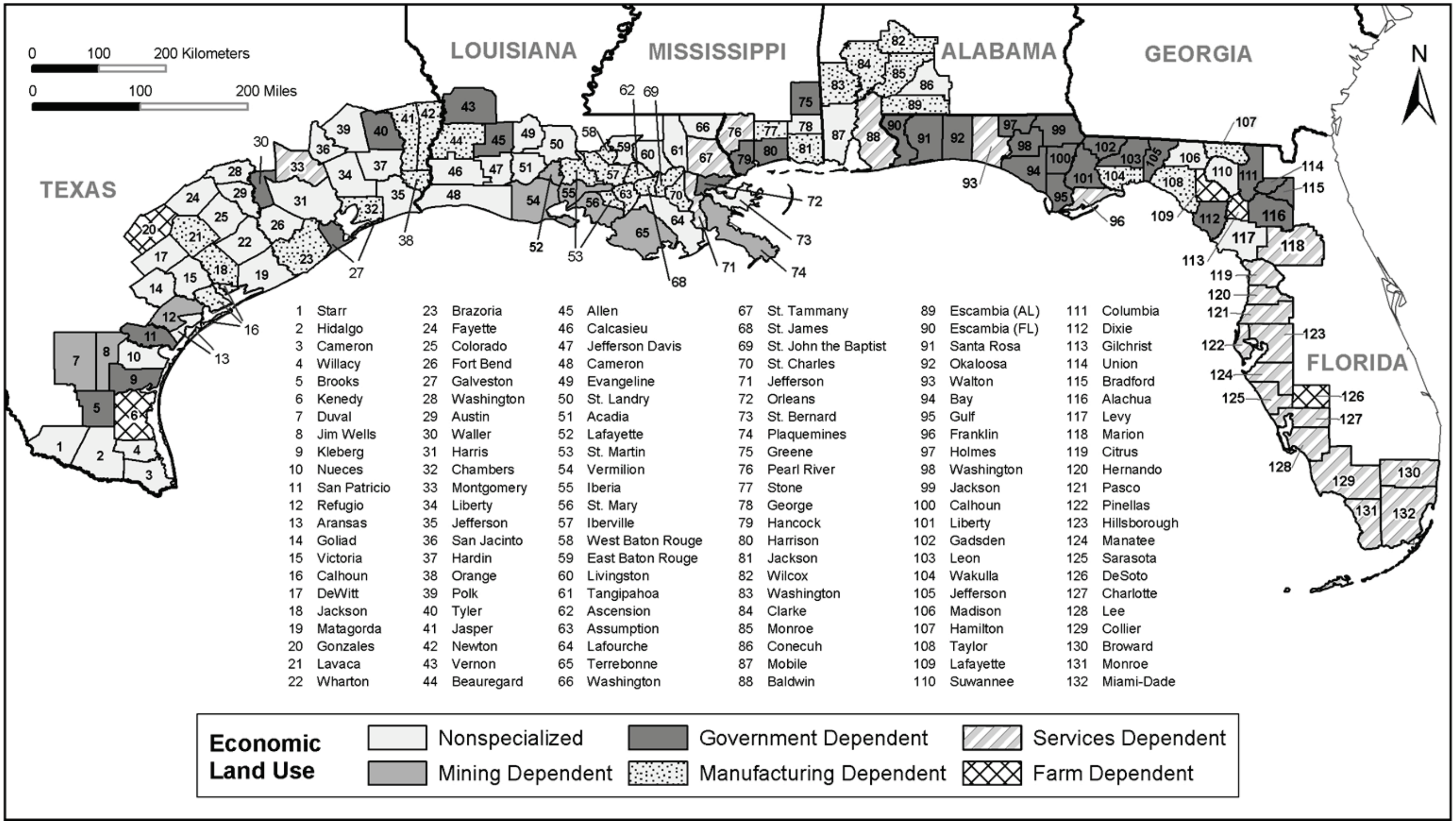
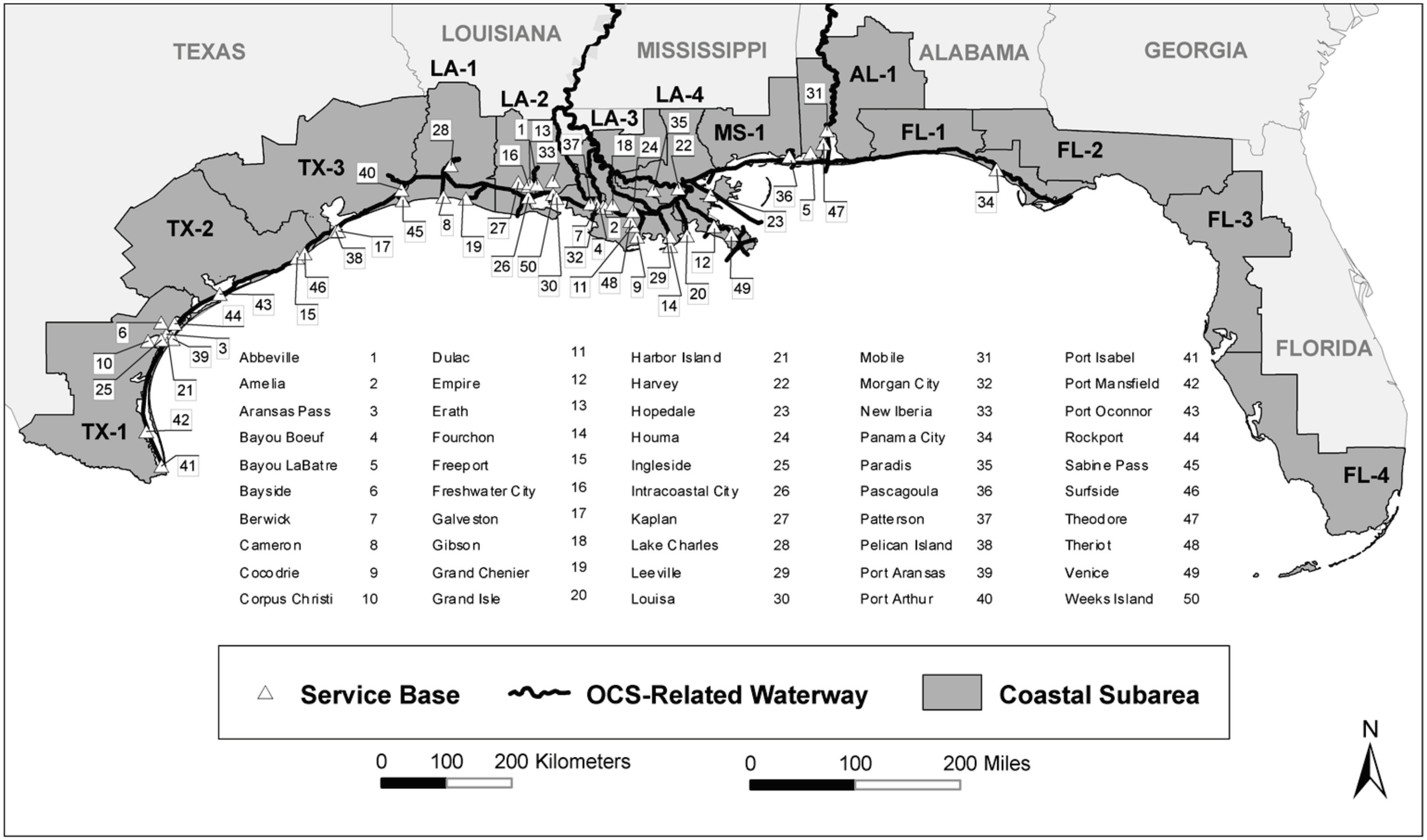


Figure 4-18. Economic Land-Use Patterns (U.S. Dept. of Agriculture, Economic Research Service, 2004).



Abbeville	1	Dulac	11	Harbor Island	21	Mobile	31	Port Isabel	41
Amelia	2	Empire	12	Harvey	22	Morgan City	32	Port Mansfield	42
Aransas Pass	3	Erath	13	Hopedale	23	New Iberia	33	Port Oconnor	43
Bayou Boeuf	4	Fourchon	14	Houma	24	Panama City	34	Rockport	44
Bayou LaBatre	5	Freeport	15	Ingleside	25	Paradis	35	Sabine Pass	45
Bayside	6	Freshwater City	16	Intracoastal City	26	Pascagoula	36	Surfside	46
Berwick	7	Galveston	17	Kaplan	27	Patterson	37	Theodore	47
Cameron	8	Gibson	18	Lake Charles	28	Pelican Island	38	Theriot	48
Cocodrie	9	Grand Chenier	19	Leeville	29	Port Aransas	39	Venice	49
Corpus Christi	10	Grand Isle	20	Louisa	30	Port Arthur	40	Weeks Island	50

Figure 4-19. OCS-Related Service Bases in the Gulf of Mexico (Dismukes, 2011).

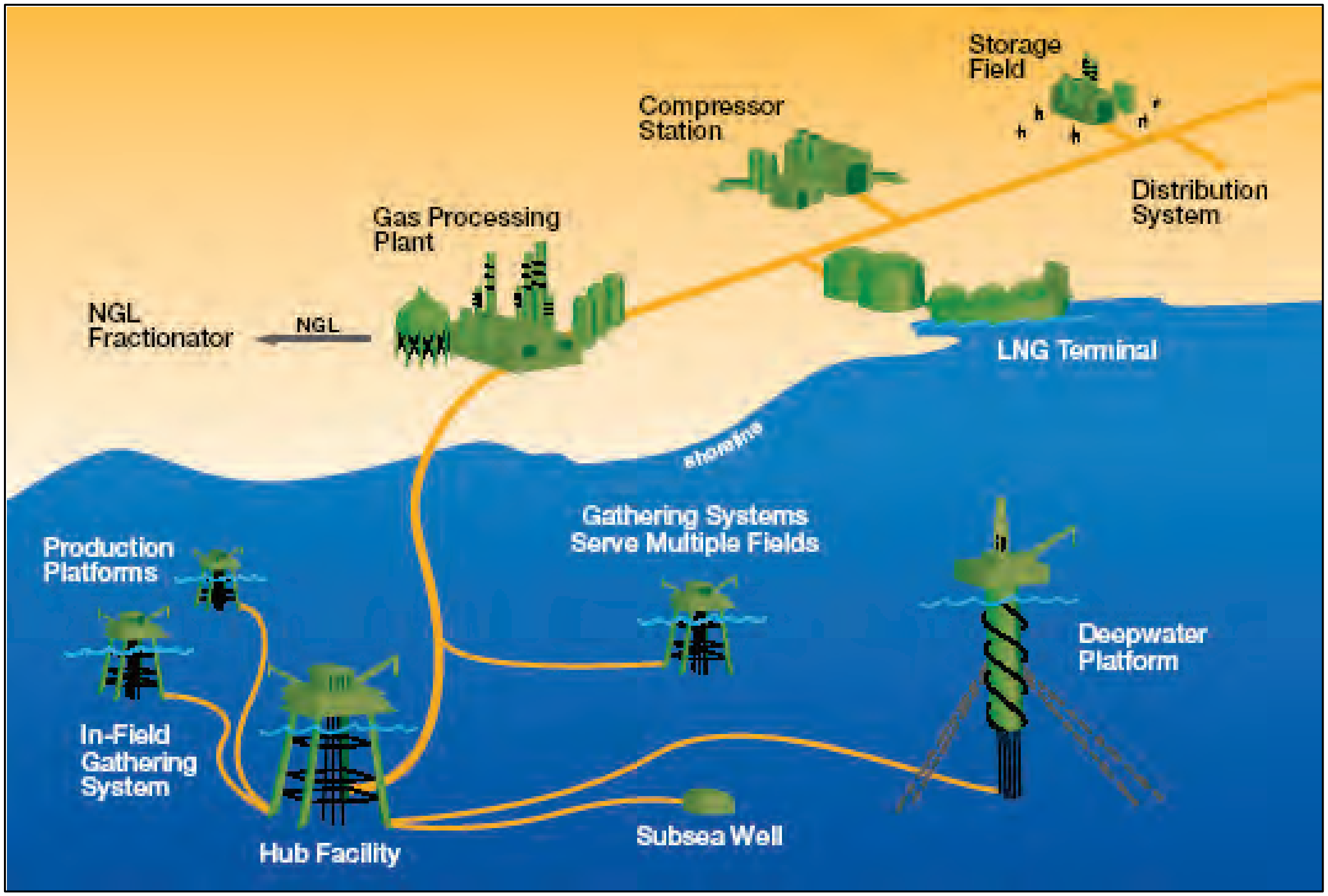


Figure 4-20. Gas Supply Schematic for the Gulf of Mexico (Dismukes, 2011).

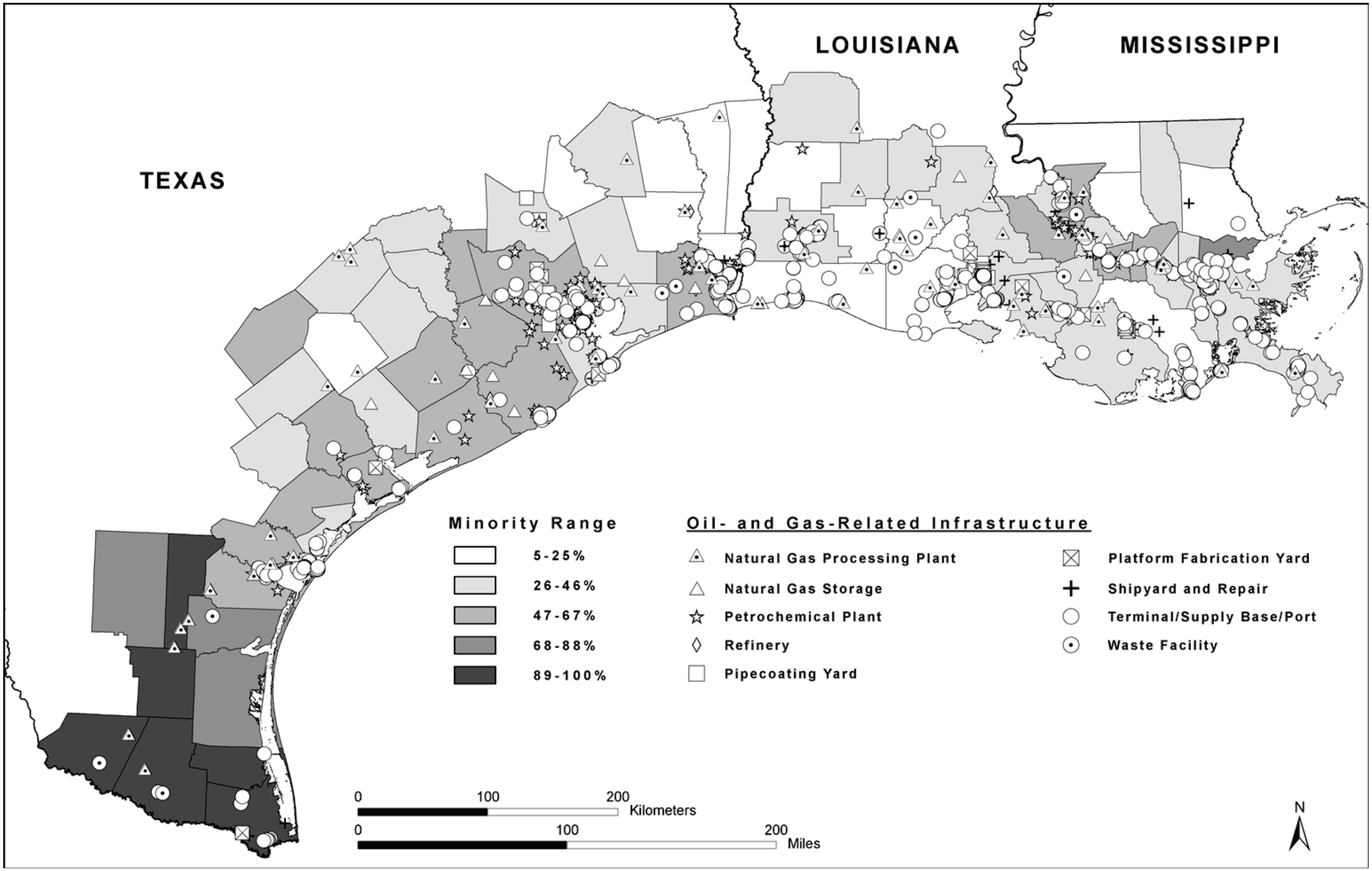


Figure 4-21. Percentage of Minority Population by County in Texas and by Parish in Louisiana with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

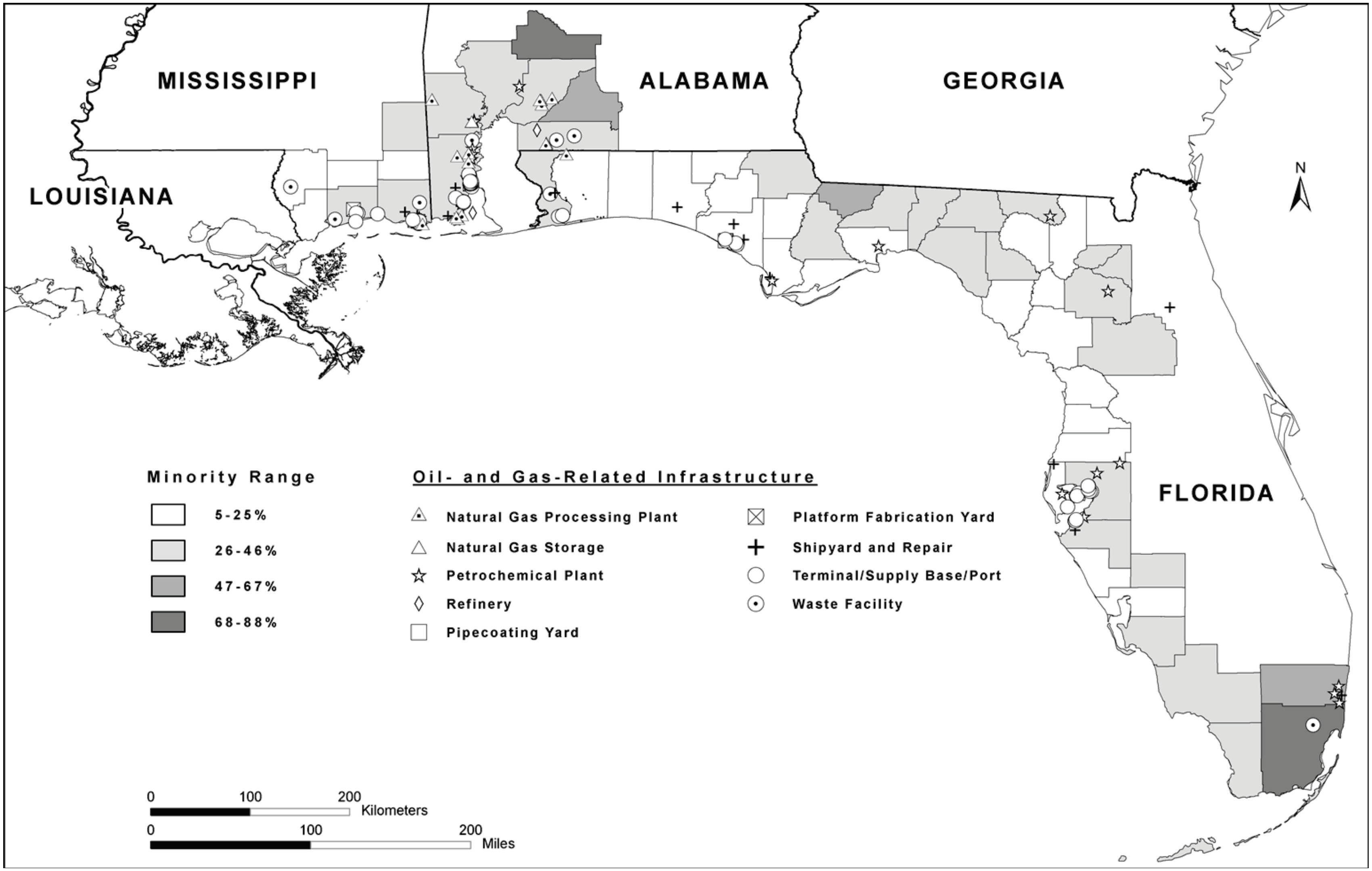


Figure 4-22. Percentage of Minority Population by County in Mississippi, Alabama, and Florida with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

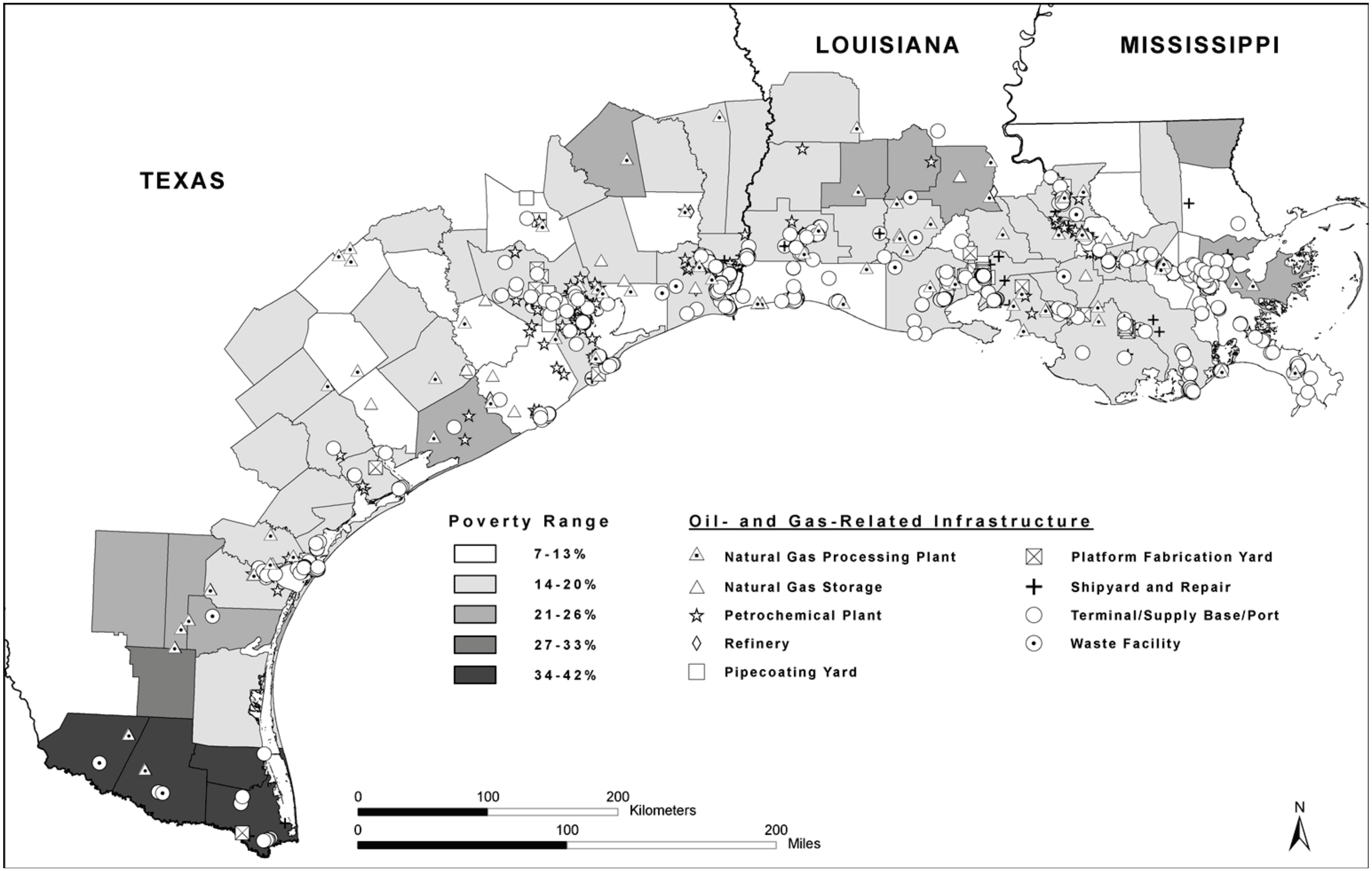


Figure 4-23. Percentage of Poverty by County in Texas and by Parish in Louisiana with Distribution of OCS Infrastructure (Sources: Poverty Range, USDOC, Census Bureau, 2009; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

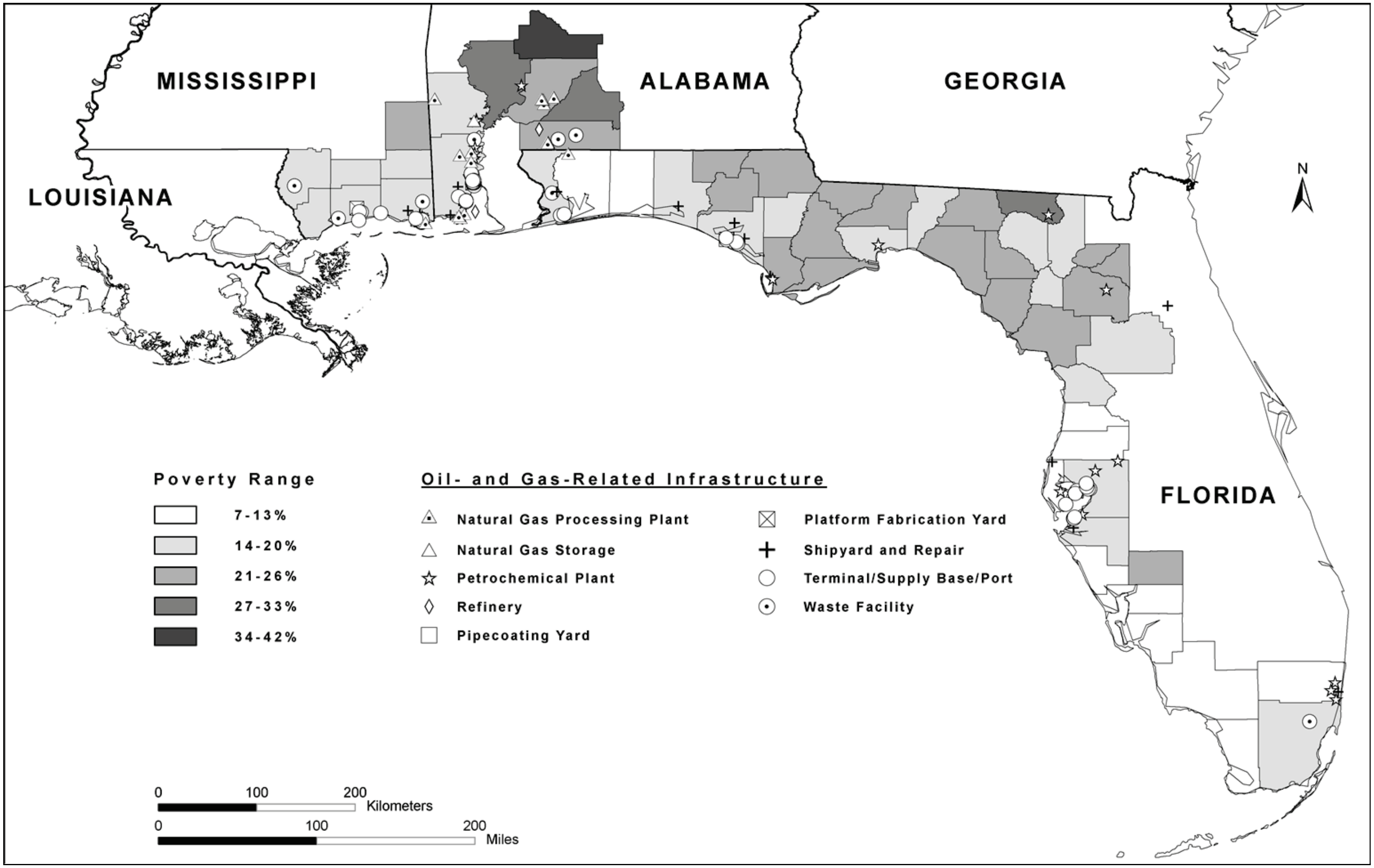


Figure 4-24. Percentage of Poverty by County in Mississippi, Alabama, and Florida with Distribution of OCS Infrastructure (Sources: Poverty Range, USDOC, Census Bureau, 2009; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

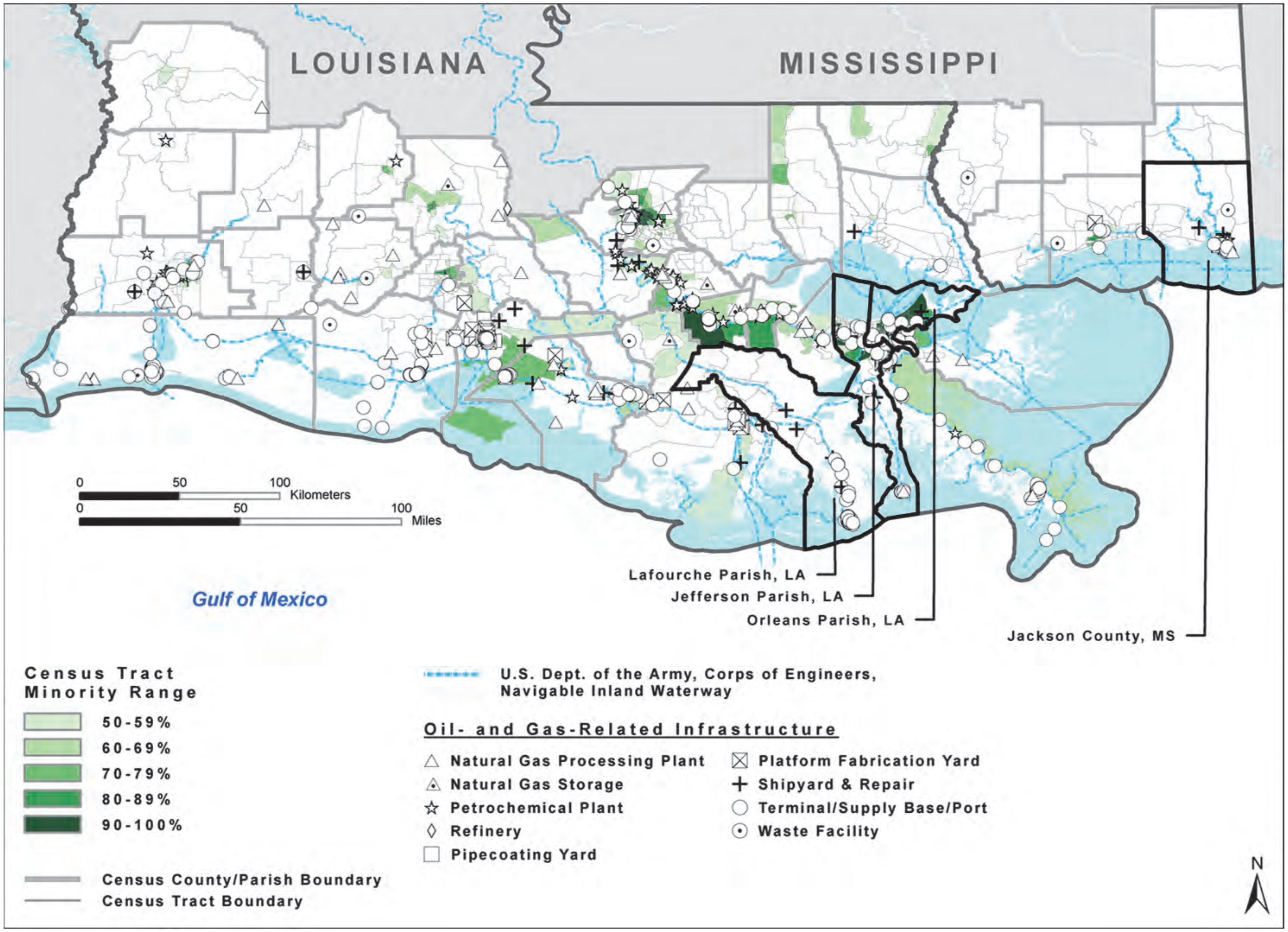


Figure 4-25. Percentage of Minority Population by Census Tract in Louisiana with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

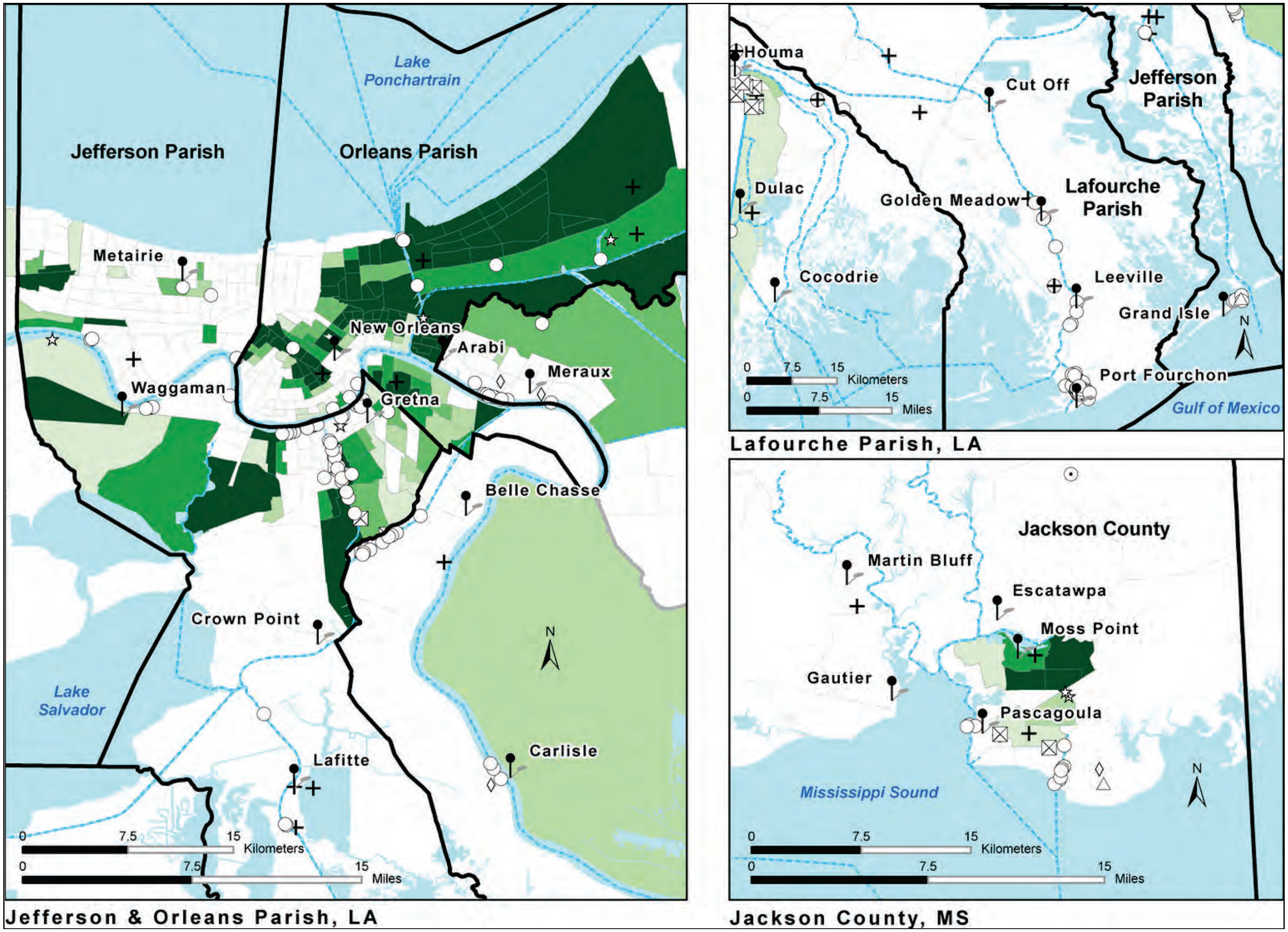


Figure 4-26. Percentage of Minority Population by Census Tract in Jefferson, Orleans, and Lafourche Parishes in Louisiana and in Jackson County in Mississippi with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

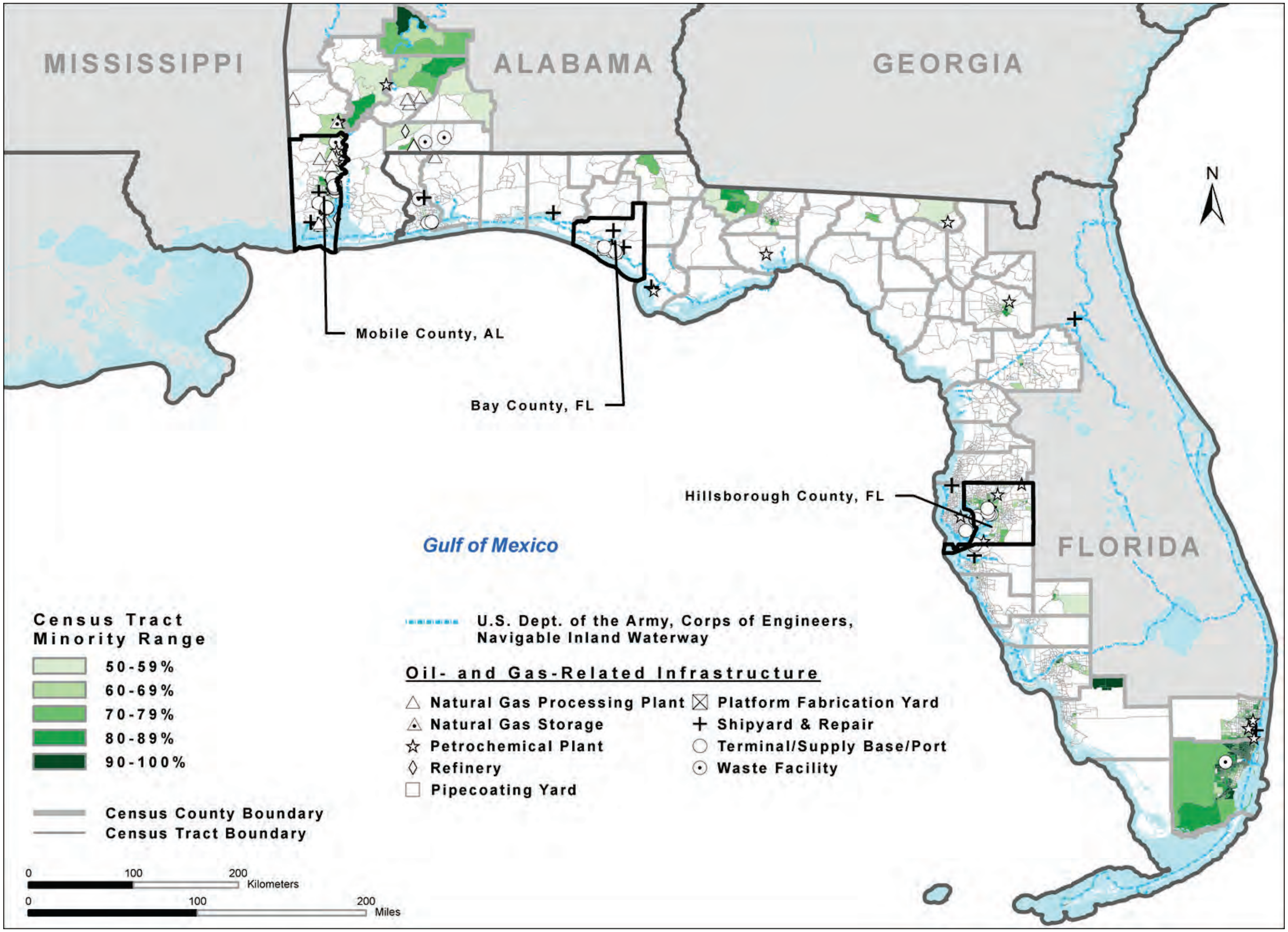


Figure 4-27. Percentage of Minority Population by Census Tract in Alabama and Florida with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

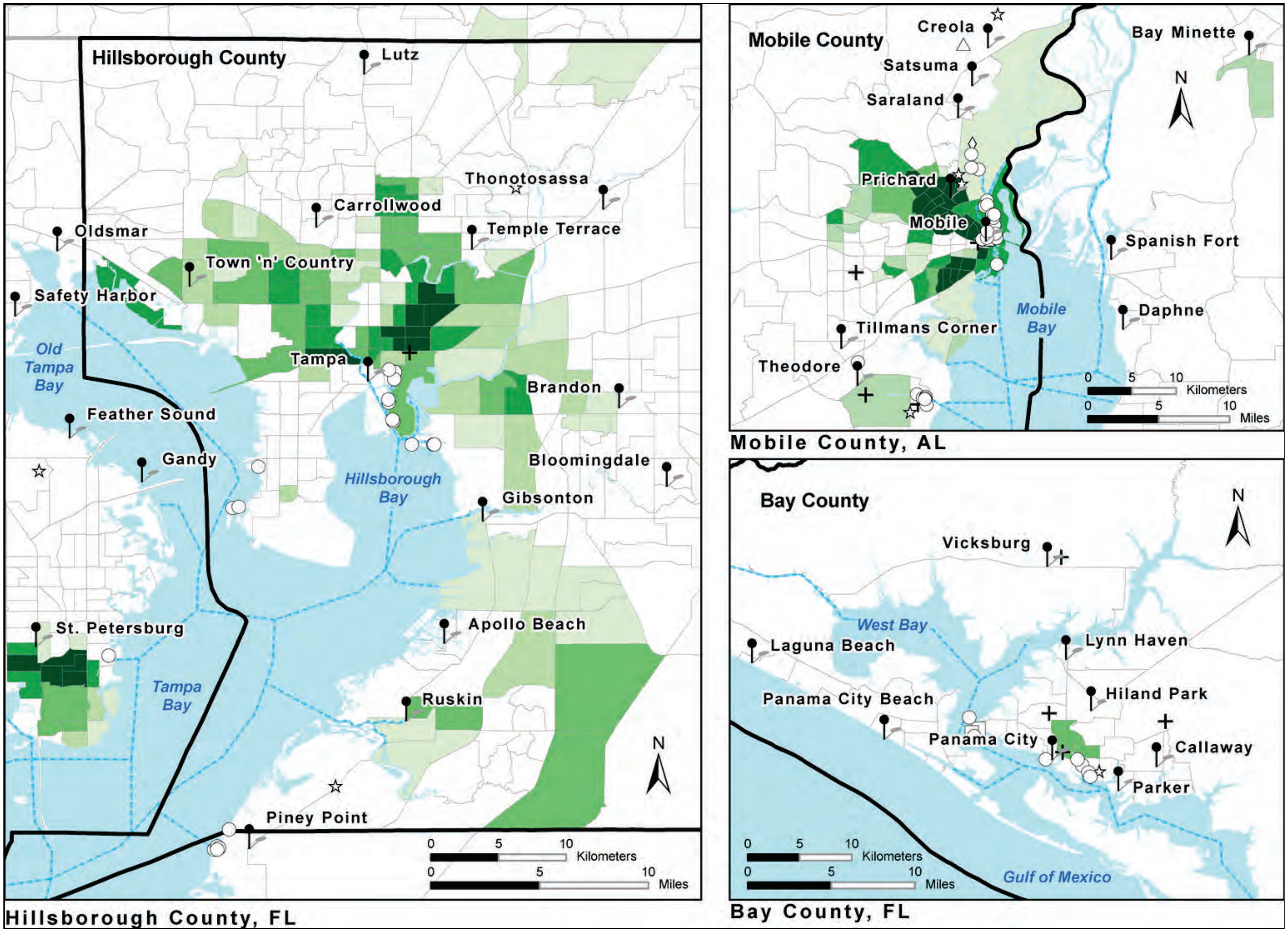


Figure 4-28 Percentage of Minority Population by Census Tract in Hillsborough and Bay Counties in Florida and in Mobile County in Alabama with Distribution of OCS Infrastructure (Sources: Minority Range, USDOC, Census Bureau, 2010; Oil- and Gas-Related Infrastructure, Kaplan et al., 2011).

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TABLES

Table 3-1

Projected Oil and Gas in the Gulf of Mexico OCS

	Typical Lease Sale	OCS Cumulative (2012-2051)
Western Planning Area		
Reserve/Resource Production		
Oil (BBO)	0.116-0.200	2.510-3.696
Gas (Tcf)	0.538-0.938	12.539-18.434
Central Planning Area		
Reserve/Resource Production		
Oil (BBO)	0.460-0.894	15.825-21.733
Gas (Tcf)	1.939-3.903	63.347-92.691
Eastern Planning Area		
Reserve/Resource Production		
Oil (BBO)	0-0.071	0-0.211
Gas (Tcf)	0-0.162	0-0.502

BBO = billion barrels of oil.
Tcf = trillion cubic feet.

Table 3-2

Offshore Scenario Information Related to a Typical Sale in the Eastern Planning Area[1] for the Years 2012-2051

	Water Depth >800 m	Total EPA
Wells Drilled		
Exploration and Delineation Wells	3-12	3-12
Development and Production Wells	0-17	0-17
Producing Oil Wells	0-10	0-10
Producing Gas Wells	0-4	0-4
Production Structures		
Installed	0-1	0-1
Removed Using Explosives	0	0
Total Removed	0-1	0-1
Method of Transportation[2]		
Percent Piped	>99.9%	>99.9%
Percent Barged	<0.01%	<0.01%
Percent Tankered	<0.01%	<0.01%
Length of Installed Pipelines (km)[3]	0-82	0-82
Service-Vessel Trips (1,000's round trips)	0.144-17	0.144-17
Helicopter Operations (1,000's operations)	0-0.027	0-0.027

[1] Refer to **Figure 3-1**.

[2] 100% of gas is assumed to be piped.

[3] Projected length of pipelines does not include length in State waters.

Table 3-3

Offshore Scenario Information Related to OCS Program Activities
in the Eastern Planning Area[1] for the Years 2012-2051

	Water Depth >800 m	Total EPA
Wells Drilled		
Exploration and Delineation Wells	10-27	10-27
Development and Production Wells	0-40	0-40
Producing Oil Wells	0-25	0-25
Producing Gas Wells	0-10	0-10
Production Structures		
Installed	0-2	0-2
Removed Using Explosives	0	0
Total Removed	0-2	0-2
Method of Transportation[2]		
Percent Piped	>99.9%	>99.9%
Percent Barged	<0.01%	<0.01%
Percent Tankered	<0.01%	<0.01%
Length of Installed Pipelines (km)[3]	0-233	0-233
Service-Vessel Trips (1,000's round trips)	0.48- 35	0.48- 35
Helicopter Operations (1,000's operations)	0-0.054	0-0.054

[1] Refer to **Figure 3-1**.

[2] 100% of gas is assumed to be piped.

[3] Projected length of pipelines does not include length in State waters.

Table 3-4

Offshore Scenario Information Related to OCS Program Activities in the Gulf of Mexico (WPA, CPA, and EPA[1]) for the Years 2012-2051

	Offshore Subareas[2]						
	0-60 m	60-200 m	200-800 m	800-1,600 m	1,600-2,400 m	>2,400 m	Total OCS[2]
Wells Drilled							
Exploration and Delineation Wells	2,730-3,900	990-1,390	920-1,350	700-960	770-1,030	790-1,170	6,910-9,827
Development and Production Wells	3,380-4,820	1,240-1,730	1,130-1,670	860-1,190	950-1,280	970-1,450	8,530-12,180
Producing Oil Wells	520-701	215-278	704-1,030	574-783	663-873	620-915	3,296-4,605
Producing Gas Wells	2,510-3,629	885-1,272	306-470	196-287	187-267	250-385	4,334-6,320
Production Structures							
Installed	1,210-1,720	110-160	26-40	25-30	32-33	32-38	1,435-2,026
Removed Using Explosives	796-1,139	69-104	3-4	0	0	0	868-1,247
Total Removed	1,090-1,560	100-150	24-34	20-28	23-30	22-33	1,279-1,837
Method of Transportation[3]							
Percent Piped	>99%	>99%	>99%	>99%	87->99%		92->99%
Percent Barged	<1%	0%	0%	0%	0%		<1%
Percent Tankered[4]	0%	0%	0%	0%	0-13%		0-7%
Length of Installed Pipelines (km)[5]	10,482-21,121	NA	NA	NA	NA	NA	30,428-69,749
Service-Vessel Trips (1,000's round trips)	1,366-1,942	196-280	111-162	466-619	584-626	587-719	3,310-4,382
Helicopter Operations (1,000's operations)	24,221-47,322	2,297-4,444	595-1,174	574-1,111	676-1,287	888-1,738	28,710-55,605

[1] Refer to **Figure 3-1**.

[2] Subareas totals may not add up to the planning area total because of rounding.

[3] 100% of gas is assumed to be piped.

[4] Tankering is forecasted to occur only in water depths >1,600 m.

[5] Projected length of pipelines does not include length in State waters.

NA means information is not available.

Table 3-5

Annual Volume of Produced Water Discharged by Depth
(millions of bbl)

Year	Shelf 0-60 m	Shelf 60-200 m	Slope 200-400 m	Deepwater 400-800 m	Deepwater 800-1,600 m	Ultra-Deepwater 1,601-2,400 m	Ultra-Deepwater >2,400 m	Total
2000	370.6	193.1	35.5	25.6	12.2	0.0	0.0	637.0
2001	364.2	185.2	35.0	32.0	16.6	0.0	0.0	633.0
2002	344.6	180.4	32.5	35.2	21.4	0.0	0.0	614.1
2003	359.4	182.9	31.2	39.0	35.5	0.2	0.0	648.2
2004	346.7	160.5	29.3	36.9	39.2	1.9	0.0	614.5
2005	270.1	113.5	23.1	33.5	43.0	5.8	0.0	489.0
2006	260.3	99.7	20.6	35.1	61.5	12.4	0.0	489.6
2007	307.0	139.4	22.2	40.0	70.3	15.5	0.1	594.5
2008	252.7	118.6	15.9	32.7	60.1	16.5	0.1	496.6
2009	263.9	108.3	19.9	39.2	65.3	25.0	0.1	521.7
2010	275.8	115.7	20.9	40.7	56.7	32.5	0.1	542.4
2011	271.3	116.9	20.5	39.7	67.7	32.2	0.1	548.4
2012	237.2	109.0	20.8	35.0	71.3	31.8	0.1	505.2

Source: Langley, official communication, 2013.

Table 3-6

Average Annual Inputs of Petroleum Hydrocarbons
to Coastal Waters of the Gulf of Mexico, 1990-1999

Inputs	Western Gulf of Mexico		Eastern Gulf of Mexico	
	(tonnes)	(bbl)	(tonnes)	(bbl)
Extraction of Petroleum				
Platforms Spills	90	630	trace[1]	trace
Atmospheric Releases (VOC’s)	trace	trace	trace	trace
Permitted Produced-Water Discharges	590	4,130	trace	trace
Sum of Extraction Inputs	680	4,760	trace	trace
Transportation of Petroleum				
Pipelines Spills	890	6,230	trace	trace
Tank Vessel Spills	770	5,390	140	980
Coastal Facilities Spills[2]	740	5,180	10	70
Atmospheric Releases (VOC’s)[3]	trace	trace	trace	trace
Sum of Transportation Inputs[4]	2,400	16,800	160	1,120
Consumption of Petroleum				
Land-Based Sources[5]	11,000	77,000	1,600	11,200
Recreational Vessels	770	5,390	770	5,390
Vessel >100 GT (spills)	100	700	30	210
Vessel >100 GT (operational discharges)	trace	trace	trace	trace
Vessel <100 GT (operational discharges)	trace	trace	trace	trace
Deposition of Atmospheric Releases (VOC’s)	90	630	60	420
Aircraft Jettison of Fuel	NA	NA	NA	NA
Sum of Consumption[4]	12,000	84,000	2,500	17,500

[1] Trace indicates <70 bbl (10 tonnes).

[2] Coastal facility spills do not include spills in coastal waters related to exploration and production spills or spills from vessels. The category “Coastal Facilities” includes aircraft, airport, refined product in coastal pipeline, industrial facilities, marinas, marine terminals, military facilities, municipal facilities, reception facilities, refineries, shipyards, and storage tanks.

[3] Volatization of light hydrocarbons during tank vessel loading, washing, and voyage.

[4] Sums may not match.

[5] Inputs from land-based sources during consumption of petroleum are the sum of diverse sources. Three categories of wastewater discharge are summed: municipal; industrial (not related to petroleum refining); and petroleum refinery wastewater. Urban runoff is included. It results from oil droplets from vehicles washing into waterways from parking lots and roads, and the improper disposal of oil containing consumer products.

GT = gross tons.
NA = not available.
VOC’s = volatile organic compounds.

Source: NRC, 2003.

Table 3-7

Average Annual Inputs of Petroleum Hydrocarbons
to Offshore Waters of the Gulf of Mexico, 1990-1999

Inputs	Western Gulf of Mexico		Eastern Gulf of Mexico	
	(tonnes)	(bbl)	(tonnes)	(bbl)
Natural Sources				
Seeps	70,000	490,000	70,000	490,000
Extraction of Petroleum				
Platforms Spills	50	350	trace[1]	trace
Atmospheric Releases (VOC's)	60	420	trace	trace
Permitted Produced-Water Discharges	1,700	11,900	trace	trace
Sum of Extraction[4]	1,800	12,600	trace	trace
Transportation of Petroleum				
Pipelines Spills	60	420	trace	trace
Tank Vessels Spills	1,500	10,500	10	70
Atmospheric Releases (VOC's)	trace	trace	trace	trace
Sum of Transportation[4]	1,600	11,200	10	70
Consumption of Petroleum				
Land-Based Consumption[2]	NA	NA	NA	NA
Recreational Vessel Consumption[3]	NA	NA	NA	NA
Vessel >100 GT (spill)	120	840	70	490
Vessel >100 GT (operational discharges)	25	175	trace	trace
Vessel <100 GT (operational discharges)	trace	trace	trace	trace
Deposition of Atmospheric Releases (VOC's)	1,200	8,400	1,600	11,200
Aircraft Jettison of Fuel	80	560	80	560
Sum of Consumption[4]	1,400	9,800	1,800	12,600

[1] Trace indicates <70 bbl (10 tonnes).
[2] Limited to coastal zone.
[3] Limited to within 3 mi (5 km) of the coast.
[4] Sums may not match.
GT = gross tons.
NA = not available.
VOC's = volatile organic compounds.

Source: NRC, 2003.

Table 3-8

Estimated Global Average Annual Inputs of Oil Entering the Marine Environment from Ships and Other Sea-Based Activities Based on 1988-1997 Data

Source	Metric Tonnes per Year	Barrels per Year	Percent of Total
Ships	457,000	3,199,000	37%
Offshore Exploration and Production	20,000	140,000	2%
Coastal Facilities	115,000	805,000	9%
Small Craft Activity	53,000	371,000	4%
Natural Seeps	600,000	4,200,000	48%
Unknown (unidentified) Sources	200	1,400	0%
Total	1,245,200	8,716,400	100%

Source: GESAMP, 2007.

Table 3-9

Annual Summary of Number and Total Volume of Oil Spilled into the Gulf of Mexico, 2001-2011

Year	Number of Spills in the Gulf of Mexico	Volume of Spills in the Gulf of Mexico bbl (gallons)
2001	1,728	3,187 (133,872)
2002	733	2,535 (106,465)
2003	801	1,181 (49,617)
2004	908	760 (31,935)
2005	804	44,141 (1,853,919)
2006	868	2,947 (123,788)
2007	616	1,560 (65,511)
2008	523	355 (14,928)
2009	454	212 (8,898)
2010	455	4,928,389 (206,992,317)
2011	498	483 (20,276)

Note: The volume does not include oil spilled in rivers that enter the Gulf of Mexico. The reported spills include spills of crude and refined hydrocarbon products.

Source: USDHS, CG, 2012.

Table 3-10

Number and Sizes of Spills Estimated to Occur in
OCS Offshore Waters from an Accident Related to Rig/Platform and Pipeline Activities
Supporting an EPA Typical Sale Over a 40-Year Time Period

Spill Size Group	Spill Rate (spills/BBO)[1]	Number of Spills Estimated for an EPA Proposed Action	Estimated Median Spill Size (bbl)[1]
0-1.0 bbl	2,020	<1-143	<0.024
1.1-9.9 bbl	57.4	<1-4	3.0
10.0-49.9 bbl	17.4	<1-1	
50.0-499.9 bbl	11.3	<1-1	130
500.0-999.9 bbl	1.63	<1	
≥1,000 bbl	1.13	<1	2,200[2]
≥10,000 bbl	0.31	<1	---[3]
Catastrophic Spill Event	---[4]	<1[4]	---[5]

Notes: The number of spills estimated is derived by application of the historical rate of spills per volume crude oil handled (1996-2010) (Anderson et al., 2012) to the projected production from a typical sale (**Table 3-1**). The actual number of spills that may occur in the future could vary from the estimated number.

[1] Source: Anderson et al. (2012) and calculations based on data therein. The spill rates presented are a sum of rates for U.S. OCS platforms/rigs and pipelines, and include the *Deepwater Horizon* oil spill.

[2] 2,000-bbl estimated median spill size without the *Deepwater Horizon* oil spill.

[3] During the last 15 years, the only rig/platform spill ≥10,000 bbl was the *Deepwater Horizon* oil spill, which was 4,900,000 bbl. A median spill size calculation requires at least 3 data points. As such, a median spill size could not be calculated. However, the *Deepwater Horizon* spill is considered to be a low-probability, catastrophic event, which is not reasonably expected (refer to **Appendix B**); therefore, BOEM believes it is more appropriately included in the "Catastrophic Spill Event" category in this table.

[4] The catastrophic spill event is considered to have a low probability of occurrence and is not reasonably expected (refer to **Appendix B**).

[5] During the last 15 years, the only rig/platform catastrophic spill event was the *Deepwater Horizon* oil spill at 4,900,000 bbl in volume. Since there are no other data points, BOEM could not calculate a median.

Table 3-11

Existing Coastal Infrastructure Related to OCS Activities in the Gulf of Mexico

Infrastructure	Texas	Louisiana	Mississippi	Alabama	Florida	Total
Pipeline Landfalls[1]	13	109	3	4	0	129
Platform Fabrication Yards[2]	12	37	4	1	0	54
Shipyards[2]	32	64	9	18	14	137
Pipecoating Facilities[2]	9	6	0	2	2	19
Supply Bases[2]	32	55	2	7	0	96
Ports[2]	11	14	3	1	5	34
Waste Disposal Facilities[2]	16	29	3	3	2	53
Natural Gas Storage Facilities[2]	13	8	0	1	0	22
Helicopter Hubs[2]	118	115	4	4	0	241
Pipeline Shore Facilities[2]	13	40	0	0	0	53
Barge Terminals[2]	110	122	6	6	8	252
Tanker Ports[2]	4	6	0	0	0	10
Gas Processing Plants[2]	39	44	1	13	1	98
Refineries[2]	18	15	1	3	0	37
Petrochemical Plants[2]	126	66	2	9	13	216

[1] USDOI, BOEMRE, 2011.

[2] Dismukes, 2011.

Table 3-12

Waterway Length, Depth, Traffic, and Number of Trips for 2011

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Gulf Intracoastal Waterway					
Apalachee Bay to Panama City, FL	230	12	661	0	375
Panama City to Pensacola Bay, FL	187	12	1,812	0	1,306
Pensacola Bay, FL to Mobile Bay, AL	78	12	4,733	0	4,559
Mobile Bay, AL to New Orleans, LA	228	12, 14	17,295	0	21,952
Mississippi River, LA to Sabine River, TX	452	12, 10	63,384	0	52,470
Sabine River to Galveston, TX	143	12	59,132	0	33,756
Galveston to Corpus Christi, TX	322	11, 11, 10.2	25,561	0	19,333
Corpus Christi, TX to Mexican Border	226	10, 12, 7	2,212	0	1,641
Morgan City - Port Allen Route, LA	109	10	16,985	0	8,958
Florida Harbors, Channels, and Waterways					
Escambia and Conecuh Rivers, FL and AL; Escambia Bay, FL	12	10	2,273	0	2,789
La Grange Bayou, FL	3	9	249	0	81
Panama City Harbor, FL	9	34, 32, 10	2,142	313	879
Pensacola Harbor, FL	21	35, 33, 15, 14	752	33	336
St. Marks River, FL	61	9	62	0	28
Tampa Harbor, FL	140.5	45, 43, 34, 12, 9	31,408	1,190	822
Port Manatee, FL	5.1	40	3,724	17	231
Alabama Harbors, Channels, and Waterways					
Mobile Harbor, AL	71	47, 45, 40, 13-39	55,552	1,480	27,110
Theodore Ship Channel, AL	14	4	5,567	1,003	233
Mississippi Harbors, Channels, and Waterways					
Biloxi Harbor, MS	39	12, 10, 12	1,612	2	1,828
Gulfport Harbor, MS	34	30, 32, 8	2,151	2,119	1,899
Pascagoula Harbor, MS	18	40, 38, 38, 22, 12	36,863	637	3,216
Bayou Casotte, MS	2	38	36,557	558	3,019
Louisiana Harbors, Channels, and Waterways					
Atchafalaya River (Lower), LA	62	20	1,225	471	8,618
Barataria Bay Waterway, LA	71	16	156	0	3,056
Bayou Lafourche and Bayou Lafourche-Jump Waterway	85	28, 27, 27, 9	4,754	2,083	15,037
Bayou Little Caillou, LA	56	12	134	0	473
Bayou Teche, LA	181	3,3,4,7	733	0	576
Bayou Teche and Vermilion River, LA	88	8,11,9,8,5	613	23	2,627
Bayou Terrebonne, LA	61	10	174	0	681
Calcasieu River and Pass, LA	186	42, 42, 41-42, 36, 12, 7	54,247	1,558	61,847

Table 3-12. Waterway Length, Depth, Traffic, and Number of Trips for 2011 (continued).

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Louisiana Harbors, Channels, and Waterways (continued)					
Freshwater Bayou, LA	39	12	442	112	6,121
Houma Navigation Canal, LA	62	16, 15, 16	465	35	1,668
Mermentau River, LA	131	4, 7, 12, 10, 10, 9, 11, 6, 8, 4, 4, 7	321	0	1,298
Mermentau River, Bayou Nezpique, and Des Cannes, LA	122	9, 14, 10	394	0	499
Mississippi River, Baton Rouge LA to the Mouth of Passes	461	-	446,346	233,019	5,611
Port of New Orleans, LA	88	45, 30, 32, 36, 37, 12	77,175	25,881	1,789
Port of Baton Rouge, LA	152	45, 40, 9, 12	57,872	51,140	51,797
Port of South Louisiana	91	45	246,509	78,410	2,528
Port of Plaquemines, LA	138	45	54,093	71,245	604
Passes of the Mississippi River, LA	60.18	13, 45	227,981	3,264	5596
Mississippi River Gulf Outlet via Venice Vicinity Consolidation	22	16, 14, 14	1,881	38	7,408
Petit Anse, Tigre, and Carlin Bayous	28	6, 9, 5, 7	2,724	0	2,943
Port of Iberia	14	13	2,200	NA	NA
Port of Morgan City, LA	-	12	1,558	212	10,363
Waterway from Empire, LA to the Gulf of Mexico	17	6, 9, 14	865	0	7,374
Waterway from Intracoastal Waterway to Bayou Dulac, LA	61	14	75	0	893
Texas Harbors, Channels, and Waterways					
Brazos Island Harbor, TX	50	36.5, 31, 38, 12, 14, 7	5,907	236	1,273
Cedar Bayou, TX	23	11	1,177	0	1,075
Channel to Aransas Pass, TX	12	14	945	3	1,075
Channel to Port Bolivar, TX	17	12		0	18,111
Corpus Christi Ship Channel, TX	58	47, 45, 46, 47, 14, 9	70,538	1,415	99,280
Dickenson Bayou, TX	34	9	150	0	92
Freeport Harbor, TX	15	44, 37, 18, 40	23,312	866	2,966
Galveston Channel, TX	7	41	13,744	2,703	22,419
Houston Ship Channel, TX	119	45, 40, 32-39, 9, 7, 35-37, 7, 40, 12	237,799	6,029	79,118
Matagorda Ship Channel, TX	91	35, 9.8, 10, 12.8, 2	9,333	329	1,847
Sabine-Neches Waterway, TX	160	40, 37, 39, 32, 27, 20, 9, 8	137,218	1,908	31,828
Texas City Channel, TX	14	43, 41, 42, 42	57,758	776	6,625

Source: U.S. Dept. of the Army, COE, 2011a.

Table 3-13

OCS-Related Service Bases

Texas

TX1-1	TX-2	TX-3
Aransas Pass (Nueces) Bayside (Aransas) Corpus Christi (Nueces) Harbor Island (Nueces) Ingleside (San Patricio) Port Aransas (Nueces) Port Isabel (Cameron) Port Mansfield (Willacy) Rockport (Aransas)	Freeport (Brazoria) Port O'Connor (Calhoun)	Galveston (Galveston) Pelican Island (Galveston) Port Arthur (Jefferson) Sabine Pass (Jefferson) Surfside (Harris)

Louisiana

LA-1	LA-2	LA-3	LA-4
Cameron (Cameron) Grand Chenier (Cameron) Lake Charles (Calcasieu)	Abbeville (Vermilion) Erath (Vermilion) Freshwater City (Vermilion) Intracoastal City (Vermilion) Kaplan (Vermilion) New Iberia (Iberia) Weeks Island (Iberia)	Amelia (St. Mary) Bayou Boeuf (St Mary) Berwick (St. Mary) Cocodrie (Terrebonne) Dulac (Terrebonne) Fourchon (Lafourche) Gibson (Terrebonne) Houma (Terrebonne) Leeville (Lafourche) Louisa (St. Mary) Morgan City (St. Mary) Patterson (St. Mary) Theriot (Terrebonne)	Empire (Plaquemines) Grand Isle (Jefferson) Harvey (Jefferson) Hopedale (St. Bernard) Paradis (St. Charles) Venice (Plaquemines)

Mississippi and Alabama

MS-1	AL-1
Pascagoula (Jackson)	Bayou LaBatre (Mobile) Mobile (Mobile) Theodore (Mobile)

Florida

FL-1	FL-2	FL-3	FL-4
Panama City (Bay)	NA	NA	NA

Note: The county or parish in which the service base is located is noted in parentheses.
NA = not available.

Source: USDOI, BOEMRE, 2011.

Table 3-14

OCS Pipeline Landfalls Installed Since 1996

Segment Number	Year of Installation*	Product Type	Size	Company	State
10631	1996	Oil	24"	Equilon Pipeline Company LLC	LA
12470	1996	Oil	24"	Manta Ray Gathering Company LLC	LA
11217	1997	Gas	30"	Enbridge Offshore	LA
11496	1997	Oil	12"	ExxonMobil Pipeline Company	LA
11952	2000	Oil	18-20"	ExxonMobil Pipeline Company	TX
14470	2004	Oil	10"	Chevron USA Inc.	LA
13972	2004	Oil	24"	Manta Ray Gathering Company LLC	TX
13987	2004	Oil	24"	Manta Ray Gathering Company LLC	TX
13534	2005	Oil	30"	BP Pipelines (North America)	LA
13534	2005	Oil	30"	Mardi Gras Endymion Oil Pipeline Co.	LA
17108	2007	Gas/Condensate	16"	Stone Energy Corporation	LA
17691	2009	Gas/Oil	08"	Stone Energy Corporation	LA

*Year when the initial hydrostatic test occurred.

Source: USDOI, BOEMRE, 2011.

Table 3-15

Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Platforms, 1964-2012

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Facility or Structure and Cause of Spill Cause/Consequences of Spill
4/08/1964	EI 208	94	48	2,559	Continental Oil	Freighter struck Platform A: fire, platform and freighter damaged
10/03/1964	Hurricane Hilda			11,869[4]	Event Total	5 platforms destroyed during Hurricane Hilda
	EI 208	94	48	5,180	Continental Oil	Platforms A, C, and D destroyed: blowouts (several days)
	SS 149	55	33	5,100	Signal O & G	Platform B destroyed: blowout (17 days)
	SS 199	102	44	1,589	Tenneco Oil	Platform A destroyed: lost storage tank
7/19/1965	SS 29	15	7	1,688[5]	PanAmerican	Well #7 drilling: blowout (8 days), minimal damage
1/28/1969	6B 5165 Santa Barbara Channel, California	190	6	80,000	Union Oil	Well A-21 drilling: blowout (10 days), 50,000 bbl during blowout phase, subsequent seepage of 30,000 bbl (over decades), 4,000 birds killed, considerable oil on beaches, platform destroyed
3/16/1969	SS 72	30	6	2,500	Mobil Oil	Submersible rig *Rimtide* drilling in heavy seas bumped by supply vessel
2/10/1970	MP 41	39	14	65,000[6]	Chevron Oil	Platform C: rig shifted and sheared wellhead, blowout (3-4 days), fire of unknown origin, blowout 12 wells (49 days), lost platform, minor amounts of oil on beaches
12/01/1970	ST 26	60	8	53,000	Shell Oil	Platform B: wireline work, gas explosion, fire, blowout (138 days), lost platform and 2 drilling rigs, 4 fatalities, 36 injuries, minor amounts of oil on beaches
1/09/1973	WD 79	110	17	9,935	Signal O & G	Platform A: oil storage tank structural failure
1/26/1973	PL 23	61	15	7,000	Chevron Oil	Platform CA: storage barge sank in heavy seas
11/23/1979	MP 151	280	10	1,500[7]	Texoma Production	MODU Pacesetter III: diesel tank holed, workboat contact in heavy seas
11/14/1980	HI 206	60	27	1,456	Texaco Oil	Platform A: storage tank overflow during Hurricane Jeanne evacuation
9/24/2005	Hurricane Rita			5,066[8]	Event Total	1 platform and 2 rigs destroyed by Hurricane Rita
	EI 314	230	78	2,000[5]	Forest Oil	Platform J: destroyed, lost oil on board and in riser
	SM 146	238	78	1,494[9]	Hunt Petroleum	Jack-up Rig Rowan Fort Worth: swept away, never found
	SS 250	182	69	1,572[9]	Remington O & G	Jack-up Rig Rowan Odessa: legs collapsed
04/20/2010	MC 252	4,992	53	4.9 million[10]	BP E & P	*Deepwater Horizon* Rig: gas explosion, blowout (86 days to cap well), fire, drilling rig sank, 11 fatalities, multiple injuries, considerable oil on beaches, wildlife affected, temporary closure of area fisheries.

Table 3-15. Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Platforms, 1964-2012 (continued).

Notes: 1 barrel (bbl) = 42 gallons, billion = 10^9, MODU = mobile offshore drilling unit

Between 1964 and 2009, over 17.5 billion bbl of oil and 176.1 million cubic feet of natural gas were produced on the OCS.

[1] Crude oil release unless otherwise noted; no spill contacts to land unless otherwise noted.

[2] Outer Continental Shelf (OCS) – submerged lands, subsoil, and seabed administered by the U.S. Federal Government (http://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Outer-Continental-Shelf/Index.aspx).

[3] Gulf of Mexico leasing area unless otherwise noted (official protraction diagrams, http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Official-Protraction-Diagrams.aspx): EI = Eugene Island, HI = High Island, MC = Mississippi Canyon, MP = Main Pass, PL = South Pelto, SS = Ship Shoal, SM = South Marsh Island, ST = South Timbalier, and WD = West Delta.

[4] Hurricane Hilda, 10/3/1964: platform spills ≥1,000 bbl at 3 facilities totaled 11,869 bbl; treated as 1 spill event.

[5] Condensate – a liquid product of natural gas production.

[6] Spill volume estimate between 30,000 and 65,000 bbl, previously reported as 30,000 bbl.

[7] Diesel fuel.

[8] Hurricane Rita, 9/24/2010: platform and 2 rig losses ≥1,000 bbl at 3 locations totaled to 5,066 bbl; treated as 1 spill event. The 5,066-bbl spill was a "passive" spill based on unrecovered pre-storm inventories from the platform and 2 rigs; no spill observed; no response required.

[9] Diesel fuel and other refined petroleum products stored on rig.

[10] The Federal Interagency Solutions Group, 2010.

Source: USDOI, BOEMRE, 2011.

Table 3-16

Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Pipelines, 1964-2012

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Pipeline Segment (pipeline authority[4]) Cause/Consequences of Spill
10/15/1967	WD 73	168	22	160,638	Humble Pipe Line	12" oil pipeline, Segment #7791 (DOT): anchor kinked, corrosion, leak
3/12/1968	ST 131	160	28	6,000	Gulf Oil	18" oil pipeline, Segment #3573 (DOT): barge anchor damage
2/11/1969	MP 299	210	17	7,532	Chevron Oil	4" gas pipeline, Segment #3469 (DOT): , anchor damage
5/12/1973	WD 73	168	22	5,000	Exxon Pipeline	16" gas & oil pipeline, Segment #807 (DOT): internal corrosion, leak
4/17/1974	EI 317	240	75	19,833	Pennzoil	14" oil Bonita pipeline, Segment #1128 (DOI): anchor damage
9/11/1974	MP 73	141	9	3,500	Shell Oil	8" oil pipeline, Segment #36 (DOI): Hurricane Carmen broke tie-in to 12" pipeline, minor contacts to shoreline, brief cleanup response in Chandeleur Area
12/18/1976	EI 297	210	17	4,000	Placid Oil	10" oil pipeline, Segment #1184 (DOI): trawl damage to tie-in to 14" pipeline
12/11/1981	SP 60	190	4	5,100	Atlantic Richfield	8" oil pipeline, Segment #4715 (DOT): workboat anchor damage
2/07/1988	GA A002	75	34	15,576	Amoco Pipeline	14" oil pipeline, Segment #4879 (DOT): damage from illegally anchored vessel
1/24/1990	SS 281	197	60	14,423[5]	Shell Offshore	4" condensate pipeline, Segment #8324 (DOI): anchor damage to subsea tie-in
5/06/1990	EI 314	230	78	4,569	Exxon	8" oil pipeline, Segment #4030 (DOI): trawl damage
8/31/1992	PL 8	30	6	2,000	Texaco	20" oil pipeline, Segment #4006 (DOT): Hurricane Andrew, loose rig Treasure 75, anchor damage, minor contacts to shoreline, brief cleanup response
11/16/1994	SS 281	197	60	4,5335	Shell Offshore	4" condensate pipeline, Segment #8324 (DOI): trawl damage to subsea tie-in
1/26/1998	EC 334	264	105	1,211[5]	Pennzoil E & P	16" gas & condensate pipeline, Segment #11007 (DOT): anchor damage to tie-in to 30" pipeline, anchor dragged by vessel in man-overboard response
9/29/1998	SP 38	108	6	8,212	Chevron Pipe Line	10" gas & oil pipeline, Segment #5625 (DOT): Hurricane Georges, mudslide damage, small amount of oil contacted shoreline
7/23/1999	SS 241	133	50	3,200	Seashell Pipeline	12" oil pipeline, Segment #6462 & Segment #6463 (DOT): "Loop Davis" jack-up rig, barge crushed pipeline when sat down on it
1/21/2000	SS 332	435	75	2,240	Equilon Pipeline	24" oil pipeline, Segment #10903 (DOT): anchor damage from MODU under tow
9/15/2004	MC 20	479	19	1,720[6]	Taylor Energy	6" oil pipeline, Segment #7296 (DOI): Hurricane Ivan, mudslide damage
9/13/2008	HI A264	150	73	1,316[7]	HI Offshore System	42" gas pipeline, Segment #7364 (DOT): Hurricane Ike, anchor damage parted line
7/25/2009	SS 142	60	30	1,500	Shell Pipe Line	20" oil pipeline, Segment #4006 (DOT): micro-fractures from chronic contacts at pipeline crossing caused failure (separators between pipelines missing)

Notes: 1 barrel (bbl) = 42 gallons, billion = 10^9, DOI = U.S. Department of the Interior, DOT = U.S. Department of Transportation, MODU = mobile offshore drilling unit.
Between 1964 and 2009, over 17.5 billion bbl of oil and 176.1 million cubic feet of natural gas were produced on the OCS.

[1] Crude oil release unless otherwise noted; no spill contacts to land unless otherwise noted.

[2] Outer Continental Shelf (OCS) – submerged lands, subsoil, and seabed administered by the U.S. Federal Government (http://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Outer-Continental-Shelf/Index.aspx).

[3] Gulf of Mexico leasing area unless otherwise noted (official protraction diagrams, http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Official-Protraction-Diagrams.aspx): EC = East Cameron, EI = Eugene Island, GA = Galveston, HI = High Island, MC = Mississippi Canyon, MP = Main Pass, PL = South Pelto, SS = Ship Shoal, SP = South Pass, ST = South Timbalier, WD = West Delta.

[4] Pipeline authority: DOI = Department of the Interior, BOEMRE; DOT = Department of Transportation, Pipeline and Hazardous Materials Safety Administration.

[5] Condensate – a liquid product of natural gas production.

[6] The 1,720-bbl spill was a "passive" spill based on unrecovered pre-storm inventory trapped in the segment by a mudslide; no spill observed, no response required.

[7] The 1,316-bbl spill was a "passive" spill based on unrecovered pre-storm inventory in the segment parted by storm; no spill observed, no response required.

Source: USDOI, BOEMRE, 2011.

Table 3-17

Probability (percent chance) of a Particular Number of Offshore Spills ≥1,000 bbl Occurring
as a Result of Either Facility or Pipeline Operations Related to an EPA Proposed Action

Number of Spills	Facility Spills (%)		Pipeline Spills (%)		Total Spills (%)	
	Low*	High	Low	High	Low	High
0	100	98	100	94	100	92
1	0	2	0	6	0	7
2	0	<0.5	0	<0.5	0	<0.5
3	0	<0.5	0	<0.5	0	<0.5

* The columns under each spill category refer to the low and high resource estimates.

Table 3-18

Mass Balance of a Hypothetical Winter Spill of 2,200 bbl Spilled
over a 12-Hour Period from a Pipeline Break

Time Elapsed from Start of Spill Event (days)	% of Spill on the Surface	% of Spill in the Water Column	% of Spill Evaporated	% of Spill Decayed	% of Spill Ashore
1	70	2	27	1	0
2	62	2	35	1	0
5	59	1	37	3	0
10	54	1	39	6	0
15	49	1	41	9	0
20	45	1	43	11	0
25	0	1	44	13	42
30	0	1	45	15	39

Table 3-19

Mass Balance of a Hypothetical Summer Spill of 2,200 bbl Spilled
over a 12-Hour Period from a Pipeline Break

Time Elapsed from Start of Spill Event (days)	% of Spill on the Surface	% of Spill in the Water Column	% of Spill Evaporated	% of Spill Decayed	% of Spill Ashore
1	72	0	27	1	0
2	64	0	35	1	0
5	58	0	39	3	0
10	46	0	41	6	7
15	0	0	43	9	48
20	0	0	44	11	45
25	0	0	45	13	42
30	0	0	46	15	39

Table 3-20

Spill Numbers, Source, Location, and Characteristics of Maximum Spill for Offshore Waters (a) and Coastal Waters (b) (data extracted from USCG records, 1996-2009)

	Total Number of Spill Events	Number of Spills (≥1,000 bbl)	Number of Spills (<1,000 bbl)	Average Spill Size (<1,000 bbl)	Number of Spills (<1 bbl)	Maximum Spill Amount (bbl)	Maximum Spill Amount: Source/Product/Year	Total Spill Amount (bbl)
Offshore Spills (1996-2009)								
Central Planning Area (CPA)	12,956	3	12,953	13.5362	12,508	1,631.5700	Unknown/Unknown, Oil Like/2002	13,429.04
Eastern Planning Area (EPA)	60	NA	60	3.6456	45	96.4286	Fishing Boat/Oil, Fuel: No. 2-D/2003	386.56
Central Planning Area (CPA)								
Fixed Platform	5,116	NA	5,116	0.5126	5,003	889.1900	Fixed Platform/Oil:Crude/1998	2,622.26
Pipeline	26	NA	26	0.6122	23	5.9524	Offshore Pipeline/Other Oil/1998	15.92
MODU	288	NA	288	1.9148	276	175.0000	MODU/Oil:Crude/2000	551.46
OSV	362	NA	362	2.1723	326	145.5950	OSV/Oil, Misc:Lubricating/1998	786.38
Tank or Barge	44	NA	44	25.5210	42	940.0000	Tank Ship/Other Oil/2001	1,122.92
Known (c)	3,039	NA	3,039	0.5934	2,965	240.2380	Passenger/Oil:Diesel/1998	1,803.35
Unknown (d)	4,081	3	4,078	0.6049	3,873	1,631.5700	Unknown/Unknown Material, Oil Like/2002	6,526.75
Totals	12,956	3	12,953	31.9311	12,508	4,027.5454		13,429.04
Eastern Planning Area (EPA)								
Fixed Platform	6	NA	6	1.8372	5	5.0000	Fixed Platform/Oil:Crude/2007	5.41
Pipeline	NA	NA	NA	NA	NA	NA	NA	NA
MODU	2	NA	2	1.1310	1	2.3810	MODU/Oil:Diesel/1997	2.50
OSV	NA	NA	NA	NA	NA	NA	NA	NA
Tank or Barge	3	NA	3	12.7494	1	30.9762	Tank Barge/ Jet Fuel: Jp-5/2000	42.90
Known (c)	39	NA	14	20.4201	5	142.9405	Fishing Boat/Oil, Fuel: No. 2-D/2003	285.88
Unknown (d)	10	NA	10	2.0062	9	47.6190	Jet Fuel: Automotive J-8/1999	49.86
Totals	60	NA	35	38.1438	21	228.9167	Unknown/Gasoline: Automotive/2007	386.56

Table 3-20. Spill Numbers, Source, Location, and Characteristics of Maximum Spill for Offshore Waters (a) and Coastal Waters (b) (data extracted from USCG records, 1996-2009) (continued).

	Total Number of Spill Events	Number of Spills (≥1,000 bbl)	Number of Spills (<1,000 bbl)	Average Spill Size (<1,000 bbl)	Number of Spills (<1 bbl)	Maximum Spill Amount (bbl)	Maximum Spill Amount: Source/Product/Year	Total Spill Amount (bbl)
Coastal Spills (1996-2009)								
Coastal States: Louisiana								
Fixed Platform	738	2	736	1.0899	681	1,200.0000	Fixed Platform/Oil:Crude/2007	3,002.20
Pipeline	40	NA	40	26.8672	27	745.3810	Onshore Pipeline/Oil:Crude/1998	1,074.69
MODU	22	NA	22	3.0630	20	61.9048	MODU/Oil:Diesel/2003	67.39
OSV	63	NA	63	1.3769	54	28.5714	OSV/Oil:Diesel/1996	86.74
Tank or Barge	13	NA	13	0.1932	12	1.4286	Tank Barge/Oil:Crude/2000	2.51
Known (c)	718	1	717	1.4673	661	25,420.0000	Desg. Waterfront Facility/Oil:Crude/2005	26,472.07
Unknown (d)	1,432	NA	1,432	0.2156	1,401	65.0000	Unknown/Gasoline:Casinghead/2004	308.78
Totals	3,026	3	3,023	34.2732	2,856	27,522.2857		56,434.38
Coastal States: Mississippi								
Fixed Platform	6	NA	6	0.0167	6	0.0238	Fixed Platform/Oil, Misc:Motor/2000	0.10
Pipeline	NA	NA	NA	NA	NA	NA	NA	NA
MODU	4	NA	4	0.0476	4	0.1190	MODU/Oil:Diesel/1999	0.19
OSV	2	NA	2	0.0476	2	0.0714	OSV/Oil:Diesel/1998	0.10
Tank or Barge	5	NA	5	0.2429	4	1.0000	Tank Barge/Oil, Fuel:No. 2-D	1.21
Known (c)	375	NA	375	0.6927	342	23.8095	Fishing Boat/Oil, Fuel: No. 2-D/2004	259.77
Unknown (d)	40	NA	40	0.2012	38	2.3810	Unknown/Gasoline: Automotive (Unleaded)/2002	8.05
Totals	432	NA	432	1.2487	396	27.4048		293.23
Coastal States: Alabama								
Fixed Platform	19	NA	19	0.0271	19	0.0952	Fixed Platform/Other Oil/1999	0.51
Pipeline	NA	NA	NA	NA	NA	NA	NA	NA
MODU	NA	NA	NA	NA	NA	NA	NA	NA
OSV	3	NA	3	0.0198	3	0.0238	OSV/Oil, Misc:Lubricating/2008	0.06
Tank or Barge	1	NA	1	0.0238	1	0.0238	Tank Barge/Oil, Misc:Motor/1996	0.02
Known (c)	95	NA	95	0.8059	81	23.8095	Fishing Boat/Oil:Diesel/2001	76.56
Unknown (d)	7	NA	7	0.2211	6	1.0714	Unknown/Oil, Misc:Lubricating/2004	1.55

Table 3-20. Spill Numbers, Source, Location, and Characteristics of Maximum Spill for Offshore Waters (a) and Coastal Waters (b) (data extracted from USCG records, 1996-2009) (continued).

	Total Number of Spill Events	Number of Spills (≥1,000 bbl)	Number of Spills (<1,000 bbl)	Average Spill Size (<1,000 bbl)	Number of Spills (<1 bbl)	Maximum Spill Amount (bbl)	Maximum Spill Amount: Source/Product/Year	Total Spill Amount (bbl)
Totals	125	NA	125	1.0977	110	25.0238		78.71
Coastal States: Florida								
Fixed Platform	1	NA	1	0.0024	1	0.0024	Fixed Platform/Other Oil/2004	0.0024
Pipeline	NA	NA	NA	NA	NA	NA	NA	NA
MODU	NA	NA	NA	NA	NA	NA	NA	NA
OSV	1	NA	1	0.0238	1	0.0238	OSV/Oil, Misc:Lubricating/2008	0.0238
Tank or Barge	1	NA	1	0.4762	1	0.4762	Freight Barge/Hydraulic Fluid or Oil/ 2005	0.4762
Known (c)	346	NA	346	2.0472	326	16.6667	Aircraft/Jet Fuel: Jp-8/2000	131.18
Unknown (d)	40	NA	40	0.8332	37	4.7619	Unknown/Oil, Fuel: No. 2-D/2000	13.37
Totals	389	NA	389	3.3828	366	21.93		145.05

bbl = barrel

MODU = mobile offshore drilling unit.

NA = not applicable.

OSV = offshore support vessel.

Note: Reader should note that the spills are reported to the USCG by responsible parties, other private patties, and government personnel. The USCG does not verify the source or volume of every report.

(a) Central and Eastern Planning Areas – Spills that occurred in water depths 3 nmi (3.5 mi; 5.6 km) from the coastline to the OCS planning area boundary.

(b) Coastal waters – 0-3 nmi (0-3.5 mi; 0-5.6 km) from the coastline and spills in rivers, lakes, bays, and estuaries.

(c) Includes sources assumed to not be related to Federal or State oil and gas exploration and production, such as aircraft, deepwater port, commercial vessel, designated waterfront facility, facility particular hazard, factory, fishing boat, freight barge, freight ship, industrial facility, industrial vessel, land facility (nonmarine), land vehicle, unknown, marine, MARPOL reception, unclassified tow/tug, tank truck, oil recovery, municipal facility, onshore pipeline, other onshore marine facility, passenger, public vessel unclassified, recreational, research vessel, railroad equipment, shipyard/repair facility, and shoreline.

(d) Spill sources reported as unknown.

Table 3-21

Oil-Spill Occurrence Probability Estimates for Offshore Spills Greater Than or Equal to 1,000 Barrels Resulting from the EPA Proposed Actions (2012-2017) and the OCS Program (2012-2051)

	Volume (Bbbl)	Mean Number of Spills from			Mean Number of Spills	Probability (% chance) of One or More Spills from			Probability (% chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Proposed Actions									
EPA (low estimate)	0	0	0	0	0	0	0	0	0
EPA (high estimate)	0.071	0.02	0.06	0	0.08	2	6	0	8
OCS Program									
EPA (low estimate)	0	0	0	0	0	0	0	0	0
EPA (high estimate)	0.211	0.05	0.19	0	0.24	5	17	0	21

Note: Bbbl = billion barrels; n = less than 0.5%; ** = greater than 99.5%.
“Platforms” refers to facilities used in exploration, development, or production.

Table 3-22

Oil-Spill Occurrence Probability Estimates for Offshore Spills Greater Than or Equal to 10,000 Barrels Resulting from the EPA Proposed Actions (2012-2017) and the OCS Program (2012-2051)

	Volume (Bbbl)	Mean Number of Spills from			Mean Number of Spills	Probability (% chance) of One or More Spills from			Probability (% chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Proposed Actions									
EPA (low estimate)	0	0	0	0	0	0	0	0	0
EPA (high estimate)	0.071	0.01	0.01	0	0.02	1	1	0	2
OCS Program									
EPA (low estimate)	0	0	0	0	0	0	0	0	0
EPA (high estimate)	0.211	0.03	0.04	0	0.07	3	4	0	6

Note: Bbbl = billion barrels; n = less than 0.5%; ** = greater than 99.5%.
“Platforms” refers to facilities used in exploration, development, or production.

Table 3-23

Primary Cleanup Options Used during the *Deepwater Horizon* Response

	Fresh Oil	Sheens	Mousse	Tarballs	Burn Residue
On-Water Response	Disperse, skim, burn	Light sheens very difficult to recover, heavier sheens picked up with sorbent boom or sorbent pads	Skim	Snare boom	Manual removal
On-Land Response	Sorbent pads, manual recovery, flushing with water, possible use of chemical shoreline cleaning agents	Light sheens very difficult to recover, heavier sheens picked up with sorbent boom or sorbent pads	Sorbent pads, manual recovery	Snare boom, manual removal, beach cleaning machinery	Manual removal

Source: USDOC, NOAA, 2010.

Table 3-24

Pipelines* Damaged after the 2004-2008 Hurricanes Passed through the WPA and CPA

Hurricane	Total Damage Reports	Pipe and Movement	Platform Connection	Riser	Mudflow	Outside Impact	Unknown
Ivan	168	38	20	67	16	9	18
Katrina	299	61	139	66	1	9	14
Rita	243	31	94	89	0	8	21
Gustav/Ike	314	14	2	273	2	7	16

* Not discriminated by diameter.

Sources: Energo Engineering, 2010; Atkins et al., 2007.

Table 3-25

Causes of Hurricane-Related Pipeline Spills Greater Than 50 Barrels

Hurricane	Amount Spilled (bbl)	Cause
Ivan	1,720	Mudflow
Ivan	671	Movement
Ivan	126	Platform
Ivan	200	Platform
Ivan	250	Platform
Ivan	260	Platform
Ivan	95	Movement
Ivan	123	Movement
Katrina	960	Movement
Katrina	50	Platform
Katrina	55	Riser
Katrina	132	Mudslide
Katrina	50	Movement
Rita	75	Riser
Rita	100	Outside Force
Rita	862	Outside Force/Platform
Rita	67	Platform
Rita	108	Riser
Ike	69	Movement
Ike	108	Riser
Ike	56	Platform
Ike	1,316	Outside Force
Ike	209	Riser
Ike	268	Riser

Source: USDOI, BOEMRE, 2011.

Table 3-26

Number and Volume of Chemical and Synthetic-Based Fluid Spills
in the Gulf of Mexico during 2005-2012

Spill Size (bbl)	2005		2006		2007		2008	
	Chemical	SBF	Chemical	SBF	Chemical	SBF	Chemical	SBF
50-<100	0	0	1	1	0	0	5	0
100-<500	2	5	1	4	0	1	4	1
500-<1,000	1	0	0	0	1	0	3	0
≥1,000	0	0	0	0	0	1	0	1
Spill Size (bbl)	2009		2010		2011		2012	
	Chemical	SBF	Chemical	SBF	Chemical	SBF	Chemical	SBF
50-<100	0	1	0	2	0	1	1	2
100-<500	2	3	1	0	0	1	2	1
500-<1,000	0	0	0	0	0	0	1	0
≥1,000	0	0	0	0	0	0	0	0

SBF = synthetic-based fluid.
Note: The SBF fraction of the whole drilling fluid was recorded, not the total volume of drilling fluid.

Source: USDOI, BSEE, 2013.

Table 3-27

Quantities of Dredged Materials Disposed of in ODMDS, 2005-2010

New Orleans District		
Year	Amount Disposed of in ODMDS	
	yd^3	m^3
2005	21,403,200	16,364,887
2006	13,493,400	10,317,054
2007	17,550,700	13,419,265
2008	16,800,900	12,845,968
2009	7,619,332	5,825,400
2010	15,386,100	11,764,212
Average	15,375,605	11,756,131
Mobile District		
Year	Amount Disposed of in ODMDS	
	yd^3	m^3
2005	3,796,900	2,903,110
2006	3,219,100	2,461,324
2007	1,952,800	1,493,111
2008	3,725,093	2,848,206
2009	10,351,223	7,914,545
2010	4,361,670	3,334,933
Average	4,567,798	3,492,538

ODMDS = ocean dredged material disposal site.

Source: U.S. Dept. of the Army, COE, 2011b.

Table 3-28

Number of Vessel Calls at U.S. Gulf Ports Between 2002 and 2011[1]

Vessel Type	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Tanker – Product[2,3]	5,100	5,143	5,764	6171	6,594	6784	6597	6,451	7,000	8,413
Tanker – Crude[2,4]	3,698	4,227	4,361	4303	4,343	4614	4574	4,502	5,150	5,626
Container [5]	1,262	1,263	1,284	1378	1,354	1306	1372	1,641	1,934	2,338
Dry Bulk[6]	4,983	4,837	4,959	4575	5,289	4988	4563	4,021	3,475	3,917
RO-RO (Roll-on Roll-off)[7]	431	398	370	337	423	386	374	491	549	566
Gas[8]	514	624	548	558	622	628	462	441	500	604
Combo[9]	418	375	258	201	155	135	116	102	94	66
General[10]	1,267	1,167	1,141	1,160	1,246	1,362	1,363	1,300	1,387	1,459
All Types	17,673	18,034	18,685	18,683	20,026	20,203	19,421	18,949	20,089	22,989

[1] The data in this report are only for oceangoing self-propelled vessels of 10,000 deadweight ton (DWT) capacity or greater. In 2005, these vessels accounted for 98% of the capacity calling at U.S. ports.

[2] Petroleum tankers and chemical tankers.

[3] 10,000-69,999 DWT.

[4] >70,000 DWT.

[5] Container carriers and refrigerated container carriers.

[6] Bulk vessels, bulk containerships, cement carriers, ore carriers, and wood-chip carriers.

[7] RO/RO vessels, RO/RO containerships, and vehicle carriers.

[8] Liquefied natural gas carriers, liquefied natural gas/liquefied petroleum gas carriers, and liquefied petroleum carriers.

[9] Ore/bulk/oil carriers and bulk/oil carriers.

[10] General cargo carriers, partial containerships, refrigerated ships, barge carriers, and livestock carriers.

Source: USDOT, MARAD, 2013.

Table 3-29

Hurricane Landfalls in the Northern Gulf of Mexico from 1995 through 2012

Event	Year	Affected State	Storm Name	Intensity at Landfall
1	1995	AL, FL	Opal	Hurricane Category 3
2	1995	FL	Erin	Hurricane Category 2
3	1997	LA, AL	Danny	Hurricane Category 1
4	1998	FL	Earl	Hurricane Category 1
5	1998	MS, AL	Georges	Hurricane Category 2
6	1999	TX	Bret	Hurricane Category 3
7	2002	LA	Lili	Hurricane Category 1
8	2003	TX	Claudette	Hurricane Category 1
9	2004	MS, AL	Ivan	Hurricane Category 4
10	2005	LA, MS	Cindy	Hurricane Category 1
11	2005	FL, AL	Dennis	Hurricane Category 3
12	2005	LA, MS	Katrina	Hurricane Category 5
13	2005	TX, LA	Rita	Hurricane Category 3
14	2007	TX, LA	Humberto	Hurricane Category 1
15	2008	LA	Gustav	Hurricane Category 2
16	2008	TX, LA	Ike	Hurricane Category 4
17	2008	TX	Dolly	Hurricane Category 1
18	2012	LA	Isaac	Hurricane Category 1

Note: There were no hurricane landfalls in the northern Gulf of Mexico in 2009 or 2010.

Source: USDOC, NOAA, 2012.

Table 3-30

Oil Spilled from Pipelines on the Federal OCS, 2002-2009

Regulator	Area	Total Oil Spilled (bbl)	Oil Spilled due to Hurricanes (bbl)	Proportion of Total Oil Spilled due to Hurricanes (%)
BOEM	Federal OCS	5,522	5,179	94
DOT	Federal OCS	5,667	3,272	58
DOT	State Waters	9,903	9,622	97

Source: USDOI, BOEMRE, 2011.

Table 4-1

National Ambient Air Quality Standards

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour (1)	None	
	35 ppm (40 mg/m^3)	1-hour (1)		
Lead	0.15 µg/m^3 (2)	Rolling 3-Month Average	Same as Primary	
	1.5 µg/m^3	Quarterly Average	Same as Primary	
Nitrogen Dioxide	53 ppb (3)	Annual (Arithmetic Average)	Same as Primary	
	100 ppb	1-hour (4)	None	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour (5)	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual (6) (Arithmetic Average)	Same as Primary	
	35 µg/m^3	24-hour (7)	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour (8)	Same as Primary	
	0.08 ppm (1997 std)	8-hour (9)	Same as Primary	
	0.12 ppm	1-hour (10)	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Average)	0.5 ppm	3-hour (1)
	0.14 ppm	24-hour (1)		
	75 ppb (11)	1-hour	None	

(1) Not to be exceeded more than once per year.

(2) Final rule signed October 15, 2008.

(3) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(4) To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

(5) Not to be exceeded more than once per year on average over 3 years.

(6) To attain this standard, the 3-year average of the weighted annual mean $PM^{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.

(7) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).

(8) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm (effective May 27, 2008).

(9) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as USEPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(c) The USEPA is in the process of reconsidering these standards (set in March 2008).

(10) (a) The USEPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard (“anti-backsliding”).
(b) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤1.

(11) Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb.

Table 4-2

Eastern Planning Area: Estimates of High-Case Emissions for a Single Sale, Highest Year of Emissions during the 40-Year Period of Activity (tons/year)

	NO_x	SO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	368.63	0.29	12.87	12.49	6.51	95.77	31,239.58	0.22	1.33
Development/Production Well Drilling	1,179.93	0.92	41.19	39.96	20.85	306.41	100,044.06	0.71	4.25
Platform Installation and Removal	195.69	0.14	6.71	6.50	2.86	52.12	15,594.87	0.09	0.71
Pipeline Installation	1.68	0.00	0.05	0.05	0.05	0.35	181.05	0.00	0.01
Production Platforms	49.92	0.69	0.52	0.52	40.73	55.21	5,656.70	283.64	0.08
Tankers Loading	0.05	0.00	0.0011	0.0010	10.50	0.0045	1.99	2.05E-05	0.0001
Tankers in Transit	2.31	0.00	0.06	0.05	0.22	0.23	100.83	0.0005	0.00
Tankers Unloading	0.05	0.00	0.0011	0.0010	3.23	0.0045	1.99	2.05E-05	0.0001
Helicopters	0.0005	0.0001	0.0001	0.0001	0.0012	0.01	0.62	0.00E+00	0.00E+00
Support Vessels	281.56	0.34	9.65	9.36	4.12	74.99	22,438.08	0.14	1.02
Total	2,079.83	2.38	71.05	68.93	89.07	585.08	175,259.77	284.80	7.41

Table 4-3

Eastern Planning Area: Estimates of High-Case Emissions for Cumulative Sales, Total Emissions during the 40-Year Period of Activity (tons)

	NO_x	SO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	6,058.67	4.86	207.38	201.15	114.29	1,540.28	528,021.44	4.04	24.10
Development/Production Well Drilling	8,975.81	7.20	307.22	298.01	169.32	2,281.89	782,253.99	5.99	35.71
Platform Installation and Removal	587.07	0.43	20.12	19.51	8.59	156.36	46,784.60	0.28	2.14
Pipeline Installation	243.96	0.24	6.92	6.71	7.13	50.52	26,252.58	0.31	1.20
Production Platforms	1,382.88	19.01	14.52	14.32	1,128.31	1,529.20	156,690.50	7,856.92	2.33
Tankers Loading	0.41	0.01	1.01E-02	9.23E-03	94.52	0.04	17.94	0.0002	0.0007
Tankers in Transit	21.17	0.56	5.20E-01	4.76E-01	2.01	2.10	924.12	0.0048	0.04
Tankers Unloading	0.41	0.01	1.01E-02	9.23E-03	29.03	0.04	17.94	0.0002	0.0007
Helicopters	0.03	0.0068	5.45E-03	5.45E-03	0.07	0.34	34.08	0.00E+00	0.00E+00
Support Vessels	16,542.56	14.21	567.20	550.18	242.08	4,402.80	1,317,179.31	8.01	60.12
Total	33,812.97	46.53	1,123.89	1,090.38	1,795.33	9,963.57	2,858,176.51	7,875.55	125.64

Table 4-4

Comparison of the Allowable SO_2 or NO_2 Increment to the Breton National Wilderness Area with the National Ambient Air Quality Standards

Increment	Class I Area (BNWA) (μg/m^3)	Allowable Increment (μg/m^3)
3-hour SO_2	1.7	25
24-hour SO_2	1.18	5
Maximum Annual SO_2	1.07	2
Maximum Annual NO_2	0.1	2.5

BNWA = Breton National Wilderness Area.

Table 4-5

Federally Listed Avian Species Considered by State and Associated Planning Area in the Gulf of Mexico[1]

Species	Status	Critical Habitat	IUCN Red List Status[2]	States	Planning Area
Red-cockaded Woodpecker	Endangered	No rules published	Vulnerable	AL, FL, LA, MS, TX	WPA, CPA, EPA
Least Tern[3]	Endangered	No rules published	Least Concern	AL, LA, TX (FL, MS)	WPA, CPA, EPA
Piping Plover	Threatened	Designated	Near Threatened	AL, FL, LA, MS, TX	WPA, CPA, EPA
Roseate Tern	Endangered	No rules published	Least Concern	FL only	EPA
Wood Stork	Endangered	No rules published	Least Concern	AL, FL, MS	CPA, EPA
Whooping Crane	Endangered	Designated	Endangered	TX, LA[4], FL[4]	WPA, CPA, EPA
Mississippi Sandhill Crane	Endangered	Designated	Not Yet Assessed	MS only	CPA
Attwater’s Prairie Chicken	Endangered	No rules published	Not Yet Assessed	TX only	WPA
N. Aplomado Falcon	Endangered	No rules published	Not Yet Assessed	TX only	WPA
Mountain Plover	Threatened	NA; proposed threatened	Near Threatened	TX only	WPA
Everglades Snail Kite	Endangered	Designated	Not Yet Assessed	FL only	EPA
Cape Sable Seaside Sparrow	Endangered	Designated	Not Yet Assessed	FL only	EPA
Audubon’s Crested Caracara	Threatened	No rules published	Not Yet Assessed	FL only	EPA
Sprague’s Pipit	Candidate	NA - Priority 2	Vulnerable	LA, TX	WPA, CPA
Bald Eagle	Delisted	No rules published	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Peregrine Falcon	Delisted	Designated	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Eastern Brown Pelican	Delisted	No rules published	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Red Knot	Candidate	NA - Priority 3	Least Concern	FL, LA, TX	WPA, CPA, EPA

[1] Information contained in this table obtained via an email attachment from FWS sent on April 6, 2012 (USDOI, FWS, 2012a) and from FWS’s endangered species website and associated queries for “species” available at USDOI, FWS (2012b). Additional information for each species can be found at NatureServe Explorer (2012). Note: All species listed in the table are considered, but only the piping plover, roseate tern, whooping crane, wood stork, Mississippi sandhill crane, bald eagle, eastern brown pelican, and red knot will be analyzed.

[2] International Union for Conservation of Nature (IUCN) – The Red List classifies species as imperiled (critically endangered, endangered, or vulnerable); not imperiled (near threatened or least concern); extinct (extinct, extinct in the wild); or data deficient (Butchart et al., 2004 and 2005; Harris et al., 2012). If species meet quantitative thresholds of any of these criteria, they will be added to the Red List: (1) decline in population size; (2) small geographic range; (3) small population size plus decline; (4) very small population size; or (5) quantitative analysis.

[3] The Interior population of least tern was listed as endangered on May 28, 1985 (*Federal Register*, 1985) throughout much of its breeding range in the Midwest. This designation does not provide or extend Endangered Species Act protection to the breeding population of the Gulf Coast “population” of least terns. Similarly, Endangered Species Act protection for breeding least terns only applies to certain segments or areas (inland rivers and lakes ~50 mi [80 km] inland) of Louisiana, Mississippi, and Texas.

[4] The whooping crane is considered endangered throughout its range in the U.S. except where nonessential experimental flocks have been established. More recently, a release site (White Lake Wetlands Conservation Area, Vermilion Parish) was added in Louisiana (Table 4-14 of the 2012-2017 WPA/CPA Multisale EIS) with a release of 10 birds on February 22, 2011. To date, only 3 of the original 10 released cranes remain; an additional release of 16 cranes occurred on December 1, 2011. The Gulf Coast States that have these nonessential experimental flocks include Alabama, Louisiana, Mississippi, and Florida; as well, wild whooping cranes may rarely occur as transients in Mississippi and Alabama, but they are not known to breed in either state.

Table 4-6

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 4-6. 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

Table 4-6. 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	
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
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

Table 4-6. 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	
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
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

Table 4-6. 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	
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
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

Table 4-6. 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. 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
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. For more information, refer to the Weekly Bird Impact Data and Consolidated Wildlife Reports (USDOI, FWS, 2011). 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* 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., 1990, 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. Overall oiling rate across species including "others" and "unknowns" was 0.24 versus 0.25 for individuals identified to species. Oiling rate for the Top 5 (refer to **bold** rows in the table) most-impacted avian species was 0.43 and included representatives only from the seabird group. 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, the 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, 2010) 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, report (USDOI, FWS, 2010).

Table 4-6. 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).

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[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.

[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, 2005; Ford, 2006; Castege 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 Weise 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 will 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 will 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. 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).

* Corrected values are based on revisiting the original calculations after publication of the 2012-2017 WPA/CPA Multisale EIS. An additional estimate for total mortality based on Piatt and Ford (1996) is also provided.

Table 4-7

Economic Significance of Commercial Fishing in the Gulf of Mexico

State	Landings Revenue	Sales Impacts	Job Impacts	CFQ
Alabama	40,530	391,300	8,759	0.44
Florida	116,091	12,988,379	64,744	0.97
Louisiana	284,425	1,691,033	29,185	2.19
Mississippi	37,998	289,241	6,392	1.96
Texas	150,232	1,682,135	18,874	0.27
Total	629,276	17,042,088	127,954	--

CFQ = commercial fishing quotient.

Source: USDOC, NMFS, 2011.

Table 4-8

Recreational Fishing Effort Data
(angler trips in the Gulf of Mexico by location and mode in 2009, 2010, and 2011)

State	Area	2009	2010	2011	% State Total in 2011
Alabama	Shore Ocean (<3 nmi)	322,126	447,041	603,546	24.3
	Shore Inland	449,470	365,234	598,700	24.1
	Charter Ocean (<3 nmi)	9,166	8,860	19,874	0.8
	Charter Ocean (>3 nmi)	36,259	17,424	48,616	2.0
	Charter Inland	10,656	7,221	6,351	0.3
	Private/Rental Ocean (<3 nmi)	131,997	114,816	191,563	7.7
	Private/Rental Ocean (>3 nmi)	134,411	69,335	188,994	7.6
	Private/Rental Inland	618,502	656,226	825,821	33.3
	Total	1,712,587	1,686,157	2,483,465	100.0
West Florida	Shore Ocean (<9 nmi)	2,688,011	1,610,807	1,982,194	14.3
	Shore Inland	3,793,756	4,034,208	3,862,665	27.8
	Charter Ocean (<9 nmi)	196,753	159,317	179,880	1.3
	Charter Ocean (>9 nmi)	262,005	203,201	236,088	1.7
	Charter Inland	113,842	98,440	119,826	0.9
	Private/Rental Ocean (<9 nmi)	2,605,196	2,257,349	1,901,217	13.7
	Private/Rental Ocean (>9 nmi)	751,869	681,551	500,067	3.6
	Private/Rental Inland	5,265,888	5,221,323	5,118,740	36.8
	Total	15,677,320	14,266,196	13,900,677	100.0
Louisiana	Shore Ocean (<3 nmi)	38,930	11,664	48,893	1.1
	Shore Inland	730,053	717,006	1,073,035	23.4
	Charter Ocean (<3 nmi)	3,931	2,762	6,937	0.2
	Charter Ocean (>3 nmi)	21,173	8,106	15,742	0.3
	Charter Inland	157,692	68,018	90,057	2.0
	Private/Rental Ocean (<3 nmi)	81,008	59,347	77,986	1.7
	Private/Rental Ocean (>3 nmi)	99,352	11,568	80,952	1.8
	Private/Rental Inland	2,995,875	2,984,016	3,182,645	69.5
	Total	4,128,014	3,862,487	4,576,247	100.0
Mississippi	Shore Ocean (<3 nmi)	143	0	0	0.0
	Shore Inland	309,612	596,544	760,788	47.1
	Charter Ocean (<3 nmi)	2,803	904	3,123	0.2
	Charter Ocean (>3 nmi)	330	949	221	0.0
	Charter Inland	7,656	4,989	7,891	0.5
	Private/Rental Ocean (<3 nmi)	16,962	12,419	18,682	1.2
	Private/Rental Ocean (>3 nmi)	26,316	4,626	12,974	0.8
	Private/Rental Inland	715,505	612,162	811,711	50.2
	Total	1,079,327	1,232,593	1,615,390	100.0
Gulf Total	Shore Ocean (<3 nmi)	3,049,210	2,069,512	2,634,633	11.7
	Shore Inland	5,282,891	5,712,992	6,295,188	27.9
	Charter Ocean (<3 nmi)	212,653	171,843	209,814	0.9
	Charter Ocean (>3 nmi)	319,767	229,680	300,667	1.3
	Charter Inland	289,846	178,668	224,125	1.0
	Private/Rental Ocean (<3 nmi)	2,835,163	2,443,931	2,189,448	9.7
	Private/Rental Ocean (>3 nmi)	1,011,948	767,080	782,987	3.5
	Private/Rental Inland	9,595,770	9,473,727	9,938,917	44.0
	Total	22,597,248	21,047,433	22,575,779	100.0

Notes: This table presents the sum of fishing data from Louisiana, Mississippi, Alabama, and West Florida.
State waters in Florida extend 9 nmi (10.4 mi; 16.67 km) from the coast rather than the typical 3 nmi (3.5 mi; 5.6 km).

Source: USDOC, NMFS, 2012.

Table 4-9

Recreational Fishing Catch Data
Fish Species Caught by Recreational Anglers from 2008 through 2011

Species/Year	2007	2008	2009	2010	2011
Panel A: Number of Fish					
Atlantic Croaker	3,928,295	5,020,732	5,029,701	5,337,312	7,950,146
Black Drum	1,310,832	1,975,432	1,770,479	1,763,633	1,884,447
Blackfin Tuna	85,579	137,887	84,978	32,147	53,829
Cobia	118,789	160,155	86,106	62,400	109,388
Dolphins	518,324	640,488	401,891	270,119	456,829
Gag	3,003,086	4,556,734	2,969,559	2,260,741	1,269,038
Gray Snapper	5,632,849	7,316,720	4,446,255	2,451,867	2,800,767
Great Amberjack	243,007	248,910	212,229	382,672	250,954
King mackerel	456,714	374,338	673,530	291,065	244,812
Little Tuny	376,257	203,560	168,356	140,474	201,761
Pinfishes	10,929,444	16,112,529	9,876,807	10,415,589	8,851,759
Red Drum	9,068,231	10,310,311	8,132,874	9,718,538	9,992,160
Red Grouper	1,054,261	3,105,159	3,172,238	2,242,746	2,009,532
Red Snapper	4,481,634	2,789,675	2,941,448	1,769,536	2,041,512
Sand Seatrout	4,770,124	5,335,003	6,632,448	6,329,040	8,268,113
Sheepshead	2,420,502	3,055,781	2,911,901	2,884,114	3,849,215
Southern Flounder	891,087	594,926	837,108	991,760	987,796
Southern Kingfish	1,604,741	1,590,202	1,417,523	1,450,408	1,163,302
Spanish Mackerel	3,435,418	3,938,013	3,138,754	4,040,757	3,475,966
Spotted Seatrout	30,037,637	35,141,138	30,700,217	24,703,470	32,700,839
Striped Mullet	1,307,575	1,405,717	967,398	1,791,862	2,214,375
White Grunt	2,183,714	3,721,050	2,285,007	2,494,075	2,852,807
Panel B: Pounds					
Atlantic Croaker	627,525	746,737	417,298	529,427	816,562
Black drum	2,650,910	3,329,225	2,720,006	2,433,846	2,487,203
Blackfin Tuna	371,117	854,254	1,225,530	276,947	415,204
Cobia	1,019,190	797,585	510,151	483,465	1,132,455
Dolphins	2,005,505	1,758,506	2,114,876	685,194	1,295,453
Gag	2,521,392	3,250,623	1,485,256	1,630,999	665,580
Gray Snapper	1,639,212	2,016,456	1,525,684	882,715	1,250,520
Great Amberjack	1,029,530	1,407,076	1,523,734	1,483,609	946,467
King mackerel	2,552,044	1,804,192	3,677,465	1,808,493	1,679,476
Little Tuny	582,894	439,608	517,938	418,973	455,612
Pinfishes	1,394,218	2,029,509	801,445	2,028,069	1,574,080
Red Drum	13,202,268	14,496,283	11,773,528	13,509,248	15,340,878
Red Grouper	1,111,020	879,028	981,966	762,208	640,002
Red Snapper	4,077,886	2,806,925	3,648,516	1,655,857	3,486,486
Sand Seatrout	1,624,380	1,880,159	2,308,490	2,579,227	3,412,201
Sheepshead	3,522,023	4,415,722	3,904,616	3,296,696	6,990,784
Southern Flounder	966,768	687,368	910,196	1,104,725	1,120,655
Southern Kingfish	542,043	553,205	638,419	568,799	390,627
Spanish Mackerel	2,021,013	2,943,974	2,072,995	2,546,029	2,132,604
Spotted Seatrout	13,332,324	16,156,781	15,393,934	12,259,023	17,924,543
Striped Mullet	1,566,017	1,614,209	899,038	2,674,277	2,055,630
White Grunt	568,247	1,131,685	1,030,272	930,723	1,266,126

Source: USDOC, NMFS, 2012.

Table 4-10

Economic Impact of Recreational Fishing in the Gulf of Mexico in 2009

State	Expenditures	Sales	Value Added	Employment
Alabama	501,594	474,746	245,437	4,924
West Florida	4,837,871	4,369,022	2,385,738	42,314
Mississippi	446,760	417,080	162,099	3,188
Louisiana	2,080,443	1,774,692	894,123	19,688
Texas	2,244,579	2,846,858	1,434,733	22,127
Total	10,111,247	9,882,398	5,122,130	92,241

Note: Expenditures, sales, and value-added are presented in thousands of dollars.

Source: USDOC, NMFS, 2011.

Table 4-11

Employment in the Leisure/Hospitality Industry in Selected Geographic Regions

EIA/Region	2001	2002	2003	2004	2005	2006	2007	2008	2009
Panel A — Economic Impact Area									
TX-1	45,553	46,979	48,490	49,165	50,446	53,281	54,654	54,551	53,691
TX-2	14,055	14,113	14,241	14,728	14,670	16,153	16,564	16,883	16,702
TX-3	195,214	203,090	207,245	214,025	219,203	231,840	241,110	240,231	240,366
LA-1	13,682	14,065	14,300	14,725	15,339	14,747	14,563	14,295	14,246
LA-2	17,653	17,451	18,560	19,817	20,787	21,072	21,517	21,364	20,588
LA-3	37,902	38,048	40,752	42,229	43,483	44,533	44,810	46,037	44,157
LA-4	80,990	80,677	81,243	85,093	47,641	64,812	68,531	68,605	67,438
MS-1	31,485	32,752	33,714	33,297	18,024	29,191	29,680	27,702	26,938
AL-1	23,785	23,937	24,488	24,464	25,481	26,463	26,850	26,516	26,034
FL-1	34,829	36,139	36,520	39,956	41,133	41,887	41,688	40,001	41,003
FL-2	17,934	19,733	18,860	21,588	21,861	22,478	22,913	22,502	21,699
FL-3	123,248	130,250	132,256	137,302	145,005	145,894	149,448	146,368	142,393
FL-4	238,090	251,658	256,472	268,487	274,635	280,874	283,748	283,359	280,380
TX EIA Total	254,822	264,182	269,976	277,918	284,319	301,274	312,328	311,665	310,759
LA EIA Total	150,227	150,241	154,855	161,864	127,250	145,164	149,421	150,301	146,429
MS EIA Total	31,485	32,752	33,714	33,297	18,024	29,191	29,680	27,702	26,938
AL EIA Total	23,785	23,937	24,488	24,464	25,481	26,463	26,850	26,516	26,034
FL EIA Total	414,101	437,780	444,108	467,333	482,634	491,133	497,797	492,230	485,475
EIA Total	874,420	908,892	927,141	964,876	937,708	993,225	1,016,076	1,008,414	995,635
Panel B — Coastal									
TX	57,637	59,250	60,873	61,983	63,069	67,625	68,195	67,388	68,025
LA	88,235	87,640	88,431	92,703	56,242	73,405	77,567	77,580	75,958
MS	30,052	31,295	32,172	31,625	16,152	26,926	27,444	25,575	25,080
AL	21,231	21,690	22,249	22,250	23,099	24,186	24,437	24,319	23,990
FL	377,323	399,122	404,048	423,855	437,761	445,948	450,414	445,164	441,068
Coastal Total	574,478	598,997	607,773	632,416	596,323	638,090	648,057	640,026	634,121
Panel C — Statewide									
TX	818,164	840,506	854,733	877,284	900,646	943,581	982,437	995,445	982,122
LA	191,394	192,342	198,195	206,298	171,674	189,822	194,614	194,905	189,527
MS	116,714	120,243	121,528	122,557	110,430	123,402	125,192	121,033	115,924
AL	148,989	149,172	154,287	158,390	163,390	168,558	171,697	168,413	166,237
FL	772,721	808,429	817,571	866,269	893,043	912,409	932,012	922,534	896,923
State Total	2,047,982	2,110,692	2,146,314	2,230,798	2,239,183	2,337,772	2,405,952	2,402,330	2,350,733

Notes:

(1) The economic impact areas (EIA's) are shown in **Figure 4-16**.
(2) The "Coastal" category refers to the counties within the EIA's that are directly along the coast of the U.S.
(3) The "Statewide" category refers to the number of employees within the borders of the entire state.
(4) The leisure/hospitality industry is defined according to the North American Industrial Classification System.
(5) The employment figure for any given year corresponds to the total number of employees in December of that year.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2010.

Table 4-12

Total Wages Earned by Employees in the Leisure/Hospitality Industry in Selected Geographic Regions

EIA/Region	2001	2002	2003	2004	2005	2006	2007	2008	2009
Panel A — Economic Impact Area									
TX-1	516,185	544,244	566,896	586,252	627,083	685,028	739,142	746,670	766,750
TX-2	148,743	155,321	158,437	168,256	175,260	190,740	209,082	221,889	237,274
TX-3	3,018,006	3,184,819	3,269,332	3,482,253	3,711,467	4,067,402	4,341,536	4,559,854	4,635,997
LA-1	179,049	190,839	196,760	207,015	252,162	250,432	251,148	257,990	263,543
LA-2	176,741	186,845	195,892	219,352	243,347	280,120	295,347	308,107	314,147
LA-3	446,102	452,046	487,564	498,022	543,970	597,138	633,241	654,806	667,398
LA-4	1,318,417	1,378,771	1,429,488	1,493,019	1,409,983	1,246,477	1,505,206	1,633,224	1,595,567
MS-1	591,065	591,974	608,043	618,987	617,535	453,168	621,439	616,442	560,510
AL-1	281,331	287,381	300,006	305,922	321,934	347,512	371,712	388,644	390,968
FL-1	470,616	508,316	528,008	599,949	655,141	721,483	761,247	738,910	743,731
FL-2	182,944	209,213	210,758	232,143	249,152	270,339	294,144	293,528	291,417
FL-3	1,849,168	1,956,066	2,046,441	2,224,235	2,418,168	2,576,029	2,752,991	2,906,630	2,795,652
FL-4	4,219,638	4,391,881	4,669,982	5,131,115	5,650,225	5,981,862	6,304,312	6,493,402	6,344,752
TX EIA Total	3,682,934	3,884,384	3,994,665	4,236,761	4,513,810	4,943,170	5,289,760	5,528,413	5,640,021
LA EIA Total	2,120,309	2,208,501	2,309,704	2,417,408	2,449,462	2,374,167	2,684,942	2,854,127	2,840,655
MS EIA Total	591,065	591,974	608,043	618,987	617,535	453,168	621,439	616,442	560,510
AL EIA Total	281,331	287,381	300,006	305,922	321,934	347,512	371,712	388,644	390,968
FL EIA Total	6,722,366	7,065,476	7,455,189	8,187,442	8,972,686	9,549,713	10,112,694	10,432,470	10,175,552
EIA Total	13,398,005	14,037,716	14,667,607	15,766,520	16,875,427	17,667,730	19,080,547	19,820,096	19,607,706
Panel B — Coastal									
TX	706,679	737,035	761,880	790,346	834,820	927,109	986,605	994,817	1,027,931
LA	1,401,025	1,459,632	1,512,219	1,578,886	1,503,750	1,359,770	1,631,966	1,764,631	1,734,276
MS	579,122	579,914	595,776	605,542	602,391	433,995	600,226	594,626	539,240
AL	259,024	265,870	279,872	284,844	299,662	324,127	347,209	363,802	367,039
FL	6,309,393	6,624,756	6,991,895	7,687,112	8,410,661	8,955,648	9,456,949	9,762,721	9,522,041
Coastal Total	9,255,243	9,667,207	10,141,642	10,946,730	11,651,284	12,000,649	13,022,955	13,480,597	13,190,527
Panel C — Statewide									
TS	12,226,217	12,630,640	12,936,441	13,601,748	14,407,978	15,653,469	16,677,752	17,490,862	17,674,963
LA	2,674,740	2,762,055	2,886,189	3,028,338	3,069,485	3,013,979	3,336,193	3,530,708	3,511,171
MS	1,714,340	1,746,899	1,778,922	1,840,583	1,872,402	1,789,900	1,990,974	2,024,034	1,915,700
AL	1,682,365	1,730,048	1,800,093	1,882,015	1,998,089	2,124,157	2,244,583	2,344,058	2,345,332
FL	13,388,764	13,677,833	14,336,358	15,686,585	17,089,645	18,132,360	19,354,496	19,990,305	19,103,860
State Total	31,686,426	32,547,475	33,738,003	36,039,269	38,437,599	40,713,865	43,603,998	45,379,967	44,551,026

Notes:

(1) The economic impact areas (EIA's) are shown in **Figure 4-16**.
(2) The "Coastal" category refers to the counties within the EIA's that are directly along the coast of the U.S.
(3) The "Statewide" category refers to the number of employees within the borders of the entire state.
(4) The leisure/hospitality industry is defined according to the North American Industrial Classification System.
(5) Wages are presented in thousands of dollars.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2010.

Table 4-13

Total Tourism Spending in Gulf Coast States

State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Texas	36,753	35,106	34,238	34,589	37,065	40,790	44,707	44,428	50,874	47,220
Louisiana	9,227	9,266	9,262	9,418	9,964	8,248	6,718	9,021	9,642	8,942
Mississippi	5,282	5,227	5,345	5,489	5,755	5,939	5,633	6,060	6,329	5,897
Alabama	5,487	5,423	5,368	5,627	6,051	6,639	6,998	7,405	7,723	7,205
Florida	60,296	56,166	54,544	56,265	61,118	64,544	66,165	68,870	70,521	64,027

Note: Data are presented in millions of dollars.

Source: U.S. Travel Association, 2011.

Table 4-14

Number of Beaches and Annual Beach Participation in the Gulf Coast States

State	Number of Beaches	Beach Visitation
Texas	168	4,929,000
Louisiana	28	578,000
Mississippi	20	956,000
Alabama	25	1,527,000
Florida	634	21,989,000

Notes:

(1) The number of beaches is from USEPA (2008).

(2) Beach visitation data comes from National Survey on Recreation and the Environment (Betz, official communication, 2010).

(3) Beach visitation only refers to visitors originating from within the U.S.

Table 4-15

Monthly Employment in the Leisure/Hospitality Industry During 2010

EIA/Region	January	February	March	April	May	June	July	August	September
Economic Impact Area									
TX-1	53,780	54,864	56,434	56,712	57,682	57,817	56,989	56,821	56,106
TX-2	16,372	16,535	16,879	17,357	17,488	17,953	17,744	17,668	17,234
TX-3	233,323	236,395	242,381	245,096	248,306	250,958	248,351	248,857	246,488
LA-1	14,195	14,203	14,435	14,500	14,698	14,774	14,632	14,402	14,487
LA-2	20,441	20,790	21,107	21,666	21,934	21,640	21,319	21,259	21,210
LA-3	42,988	43,485	44,710	44,925	45,606	45,695	45,320	45,556	45,492
LA-4	68,343	68,806	70,051	70,708	70,570	71,257	70,173	70,590	70,982
MS-1	26,404	26,645	27,211	27,583	27,879	28,290	28,052	27,981	27,570
AL-1	25,435	25,925	27,140	28,316	28,962	29,503	28,836	28,571	27,961
FL-1	40,374	42,431	46,703	48,351	49,119	50,806	49,889	48,372	46,160
FL-2	21,621	22,074	22,478	22,868	22,011	21,550	21,238	21,504	22,090
FL-3	142,690	145,777	149,670	150,654	149,325	148,017	145,285	145,267	145,346
FL-4	280,126	285,916	291,067	290,144	284,324	279,782	272,745	272,263	270,061
TX EIA Total	303,475	307,794	315,694	319,165	323,476	326,728	323,084	323,346	319,828
LA EIA Total	145,967	147,284	150,303	151,799	152,808	153,366	151,444	151,807	152,171
MS EIA Total	26,404	26,645	27,211	27,583	27,879	28,290	28,052	27,981	27,570
AL EIA Total	25,435	25,925	27,140	28,316	28,962	29,503	28,836	28,571	27,961
FL EIA Total	484,811	496,198	509,918	512,017	504,779	500,155	489,157	487,406	483,657
EIA Total	986,092	1,003,846	1,030,266	1,038,880	1,037,904	1,038,042	1,020,573	1,019,111	1,011,187
Coastal									
TX	66,575	67,809	70,159	71,833	72,737	73,916	72,832	72,110	70,337
LA	76,571	77,167	78,666	79,306	79,329	79,933	78,923	79,373	79,764
MS	24,585	24,803	25,313	25,675	25,972	26,376	26,249	26,153	25,750
AL	23,425	23,908	25,020	26,192	26,734	27,202	26,551	26,324	25,732
FL	440,714	451,034	464,086	465,718	460,000	456,131	445,905	443,901	438,708
Coastal Total	631,870	644,721	663,244	668,724	664,772	663,558	650,460	647,861	640,291
Statewide									
TX	955,907	971,203	993,927	1,007,287	1,025,007	1,035,662	1,024,465	1,026,375	1,017,550
LA	187,935	189,633	193,519	195,715	196,978	197,360	194,930	195,358	195,476
MS	113,199	114,644	117,222	119,567	120,425	121,213	119,571	120,795	119,569
AL	160,117	160,637	165,671	169,475	171,307	172,834	170,998	171,144	168,839
FL	893,174	915,016	937,711	942,916	934,556	926,893	910,396	907,547	901,179
State Total	2,310,332	2,351,133	2,408,050	2,434,960	2,448,273	2,453,962	2,420,360	2,421,219	2,402,613

(1) The economic impact areas (EIA’s) are shown in **Figure 4-16**.
(2) The “Coastal” category refers to the counties within the EIA’s that are directly along the coast of the U.S.
(3) The “Statewide” category refers to the number of employees within the borders of the entire state.
(4) The leisure/hospitality industry is defined according to the North American Industrial Classification System.
(5) The employment figure for any given year corresponds to the total number of employees in December of that year.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2011a.

Table 4-16

Quarterly Wages in the Leisure/Hospitality Industry in 2009 and 2010

	2009				2010		
EIA/Region	Q1	Q2	Q3		Q1	Q2	Q3
Economic Impact Area							
TX-1	186,485	190,705	196,907		189,011	200,118	202,891
TX-2	55,947	59,888	60,406		56,807	62,136	62,005
TX-3	1,101,383	1,156,040	1,172,061		1,101,259	1,182,646	1,205,761
LA-1	66,498	62,427	68,772		67,858	63,177	69,412
LA-2	76,903	79,958	78,659		74,803	82,036	82,804
LA-3	146,758	147,760	151,476		146,165	155,619	157,535
LA-4	399,037	375,763	372,045		422,006	393,554	389,661
MS-1	139,067	139,486	144,690		137,586	138,553	144,858
AL-1	90,350	101,085	102,964		90,985	105,881	107,282
FL-1	165,362	199,059	208,098		161,938	201,780	203,336
FL-2	72,448	73,443	71,806		68,942	72,564	72,652
FL-3	704,036	685,052	661,734		683,879	706,460	704,891
FL-4	1,644,155	1,582,097	1,455,292		1,614,884	1,639,368	1,543,834
TX EIA Total	1,343,815	1,406,633	1,429,374		1,347,077	1,444,900	1,470,657
LA EIA Total	689,196	665,908	670,952		710,832	694,386	699,412
MS EIA Total	139,067	139,486	144,690		137,586	138,553	144,858
AL EIA Total	90,350	101,085	102,964		90,985	105,881	107,282
FL EIA Total	2,586,001	2,539,651	2,396,930		2,529,643	2,620,172	2,524,713
EIA Total	4,848,429	4,852,763	4,744,910		4,816,123	5,003,892	4,946,922
Coastal							
TX	242,514	258,365	266,840		245,102	271,683	274,253
LA	413,709	389,122	386,512		439,668	412,408	408,835
MS	133,736	134,172	139,231		132,549	133,384	139,556
AL	84,665	95,019	96,792		85,260	99,780	100,742
FL	2,423,701	2,377,078	2,234,861		2,371,990	2,454,904	2,360,412
Coastal Total	3,298,325	3,253,756	3,124,236		3,274,569	3,372,159	3,283,798
Statewide							
TX	4,309,905	4,381,324	4,412,854		4,261,565	4,470,937	4,596,176
LA	864,759	851,017	856,394		884,745	883,392	890,067
MS	466,911	482,749	482,404		456,300	486,254	495,765
AL	548,550	592,439	600,567		549,179	608,297	608,426
FL	4,816,481	4,795,973	4,515,640		4,769,647	4,895,534	4,791,884
State Total	11,006,606	11,103,502	10,867,859		10,921,436	11,344,414	11,382,318

Notes:
(1) The economic impact areas (EIA's) are shown in **Figure 4-16**.
(2) The "Coastal" category refers to the counties within the EIA's that are directly along the coast of the U.S.
(3) The "Statewide" category refers to the number of employees within the borders of the entire state.
(4) The leisure/hospitality industry is defined according to the North American Industrial Classification System.
(5) Wages are presented in thousands of dollars.

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2011a.

Table 4-17

Shipwrecks Reported within 20 Miles of the Proposed Lease Sale Area
for Proposed EPA Lease Sales 225 and 226

Name of Ship	Type of Ship	Date of Loss	Protraction Area	Location Status
Isaac T. Campbell	Schooner	1909	Lloyd Ridge	Not Located
Providencia	Gas screw	1936	Lloyd Ridge	Not Located
Springfield	Schooner	1918	De Soto Canyon	Not Located
Thomas Dennison	4-masted schooner	1913	De Soto Canyon	Not Located

Table 4-18

Classification of the Gulf Economic Impact Areas

State	Economic Area	Labor Market	County/Parish	State	Economic Area	Labor Market	County	State	Economic Area	Labor Market	County
Alabama	AL-1	Mobile	Baldwin	Texas	TX-1	Brownsville	Cameron	Florida	FL-1	Panama City	Bay
			Clarke				Hidalgo				Franklin
			Conecuh				Starr				Gulf
			Escambia				Willacy			Pensacola	Escambia
			Mobile			Corpus Christi	Aransas				Okaloosa
			Monroe				Brooks				Santa Rosa
			Washington				Duval				Walton
			Wilcox				Jim Wells		FL-2	Tallahassee	Calhoun
							Kenedy				Gadsden
Mississippi	MS-1	Biloxi-Gulfport	George				Kleberg				Holmes
			Greene				Nueces				Jackson
			Hancock				Refugio				Jefferson
			Harrison				San Patricio				Leon
			Jackson		TX-2	Brazoria	Brazoria				Liberty
			Pearl River				Matagorda				Wakulla
			Stone				Wharton				Washington
						Victoria	Calhoun			Lake City	Columbia
Louisiana	LA-1	Lake Charles	Allen				Colorado				Hamilton
			Beauregard				Dewitt				Lafayette
			Calcasieu				Fayette				Madison
			Cameron				Goliad				Suwannee
			Jefferson Davis				Gonzales				Taylor
			Vernon				Jackson		FL-3	Ocala	Citrus
	LA-2	Lafayette	Acadia				Lavaca				Marion
			Evangeline				Victoria			Gainesville	Alachua
			Iberia		TX-3	Beaumont-Port Arthur	Hardin				Bradford
			Lafayette				Jasper				Dixie
			St. Landry				Jefferson				Gilchrist
			St. Martin				Newton				Levy
			Vermilion				Orange				Union

Table 4-18. Classification of the Gulf Economic Impact Areas (continued).

State	Economic Area	Labor Market	County/Parish	State	Economic Area	Labor Market	County	State	Economic Area	Labor Market	County
Louisiana	LA-3	Baton Rouge	Ascension	Texas	TX-3		Polk	Florida	FL-3	Tampa-St. Petersburg	Hernando
			East Baton Rouge				Tyler				Hillsborough
			Iberville			Houston-Galveston	Austin				Pasco
			Livingston				Chambers				Pinellas
			Tangipahoa				Fort Band		FL-4	Ft. Myers	Collier
			West Baton Rouge				Galveston				Lee
		Houma	Assumption				Harris			Miami	Broward
			Lafourche				Liberty				Miami-Dade
			St. Mary				Montgomery				Monroe
			Terrebonne				San Jacinto			Sarasota	Charlotte
	LA-4	New Orleans	Jefferson				Waller				De Soto
			Orleans				Washington				Manatee
			Plaquemines								Sarasota
			St. Bernard								
			St. Charles								
			St. James								
			St. John the Baptist								
			St. Tammany								
			Washington								

Table 4-19

Demographic and Employment Baseline Projections for Economic Impact Area TX-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	1,644	1,800	1,833	1,866	1,901	1,935	1,969	2,108	2,319	2,494	2,844
Age Under 19 Years	36.0%	35.0%	34.8%	34.6%	34.4%	34.3%	34.2%	33.7%	32.5%	32.2%	31.3%
Age 20 to 34	21.1%	20.5%	20.4%	20.3%	20.2%	20.2%	20.1%	19.8%	20.3%	19.9%	19.8%
Age 35 to 49	18.9%	18.7%	18.7%	18.6%	18.5%	18.4%	18.3%	18.1%	17.2%	16.9%	17.2%
Age 50 to 64	13.6%	15.0%	15.2%	15.3%	15.4%	15.4%	15.4%	15.3%	15.4%	15.2%	14.6%
Age 65 and over	10.3%	10.8%	11.0%	11.2%	11.5%	11.7%	12.0%	13.0%	14.6%	15.7%	17.2%
Median Age of Population (years)	33.6	35.6	35.8	35.9	36.0	36.0	36.1	36.4	36.9	37.1	37.2
White Population (in thousands)	18.4%	16.2%	15.9%	15.6%	15.3%	15.0%	14.7%	13.7%	12.3%	11.2%	9.3%
Black Population (in thousands)	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.9%
Native American Population (in thousands)	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Asian and Pacific Islander Population (in thousands)	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.0%
Hispanic or Latino Population (in thousands)	79.4%	81.5%	81.9%	82.2%	82.5%	82.8%	83.1%	84.1%	85.6%	86.7%	88.7%
Male Population (in thousands)	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.8%	48.7%	48.6%	48.5%
Total Employment (in thousands of jobs)	728.92	799.36	793.09	806.49	821.31	836.42	851.79	916.13	1,021.87	1,119.42	1,344.45
Farm Employment	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.5%	1.4%	1.2%	1.0%	0.8%
Forestry, Fishing, Related Activities	1.2%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%
Mining	1.8%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%	2.1%	1.9%	1.7%	1.4%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%
Construction	7.2%	6.5%	6.3%	6.3%	6.3%	6.3%	6.3%	6.2%	6.2%	6.1%	6.0%
Manufacturing	4.0%	3.2%	3.3%	3.2%	3.2%	3.1%	3.1%	2.9%	2.6%	2.4%	1.9%
Wholesale Trade	2.8%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%	2.3%	2.2%	2.0%
Retail Trade	12.0%	11.4%	11.3%	11.2%	11.2%	11.1%	11.1%	10.9%	10.6%	10.3%	9.7%
Transportation and Warehousing	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.4%	3.4%	3.4%	3.4%
Information Employment	1.2%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%
Finance and Insurance	3.1%	3.7%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.5%	3.4%

Table 4-19. Demographic and Employment Baseline Projections for Economic Impact Area TX-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Real Estate / Rental and Lease	3.0%	3.1%	3.4%	3.4%	3.4%	3.3%	3.3%	3.3%	3.2%	3.2%	3.1%
Professional and Technical Services	3.4%	3.5%	3.6%	3.6%	3.6%	3.6%	3.7%	3.8%	3.9%	4.0%	4.2%
Management	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.5%	0.5%
Administrative and Waste Services	5.4%	5.5%	5.7%	5.8%	5.8%	5.9%	5.9%	6.2%	6.5%	6.7%	7.3%
Educational Services	0.9%	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.2%	1.3%	1.5%
Health Care and Social Assistance	15.6%	17.3%	17.5%	17.8%	18.0%	18.2%	18.5%	19.4%	20.9%	22.1%	24.6%
Arts, Entertainment, and Recreation	1.1%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Accommodation and Food Services	7.2%	7.7%	7.7%	7.7%	7.8%	7.8%	7.8%	7.8%	7.9%	8.0%	8.0%
Other Services, Except Public Administration	6.5%	6.1%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Federal Civilian Government	1.7%	1.8%	1.8%	1.8%	1.8%	1.7%	1.7%	1.6%	1.5%	1.4%	1.3%
Federal Military	1.3%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.8%	0.7%	0.6%
State and Local Government	15.1%	14.7%	14.3%	14.2%	14.1%	14.0%	13.9%	13.5%	12.9%	12.4%	11.3%
Total Earnings (in millions of 2005 dollars)	24,168	27,085	28,227	28,852	29,670	30,511	31,377	35,100	41,562	47,889	63,768
Farm	1.6%	0.5%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.4%	0.3%	0.3%
Forestry, Fishing, Related Activities	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Mining	3.6%	4.7%	4.8%	4.8%	4.8%	4.7%	4.6%	4.4%	4.0%	3.6%	3.0%
Utilities	0.6%	0.7%	0.8%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%
Construction	7.5%	6.3%	6.1%	6.0%	5.9%	5.9%	5.8%	5.5%	5.1%	4.8%	4.2%
Manufacturing	5.9%	5.2%	5.2%	5.2%	5.2%	5.1%	5.0%	4.8%	4.5%	4.2%	3.7%
Wholesale Trade	4.2%	3.7%	3.8%	3.8%	3.8%	3.7%	3.7%	3.6%	3.5%	3.4%	3.2%
Retail Trade	8.8%	7.8%	7.8%	7.7%	7.6%	7.5%	7.4%	7.0%	6.4%	5.9%	5.0%
Transportation and Warehousing	3.6%	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%	3.8%	3.7%	3.6%	3.4%
Information	1.5%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.7%
Finance and Insurance	3.4%	3.1%	3.1%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Real Estate / Rental and Lease	1.4%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%	1.0%	1.0%
Professional and Technical Services	4.6%	4.4%	4.5%	4.6%	4.6%	4.7%	4.7%	5.0%	5.3%	5.5%	6.0%

Table 4-19. Demographic and Employment Baseline Projections for Economic Impact Area TX-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Management	0.1%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.4%	0.5%	0.5%	0.8%
Administrative and Waste Services	3.0%	3.3%	3.5%	3.6%	3.6%	3.7%	3.7%	3.9%	4.2%	4.4%	4.9%
Educational Services	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.9%	1.0%	1.2%
Health Care and Social Assistance	14.9%	17.6%	17.7%	18.1%	18.4%	18.7%	19.0%	20.1%	21.9%	23.5%	26.7%
Arts, Entertainment, and Recreation	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Accommodation and Food Services	3.4%	3.6%	3.7%	3.7%	3.8%	3.8%	3.8%	3.8%	3.9%	3.9%	3.9%
Other Services, Except Public Administration	4.5%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.0%	4.0%	3.9%
Federal Civilian Government	4.9%	5.6%	5.4%	5.5%	5.4%	5.4%	5.4%	5.3%	5.1%	5.0%	4.7%
Federal Military	2.8%	2.5%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%	2.1%	2.0%
State and Local Government	17.8%	18.6%	17.9%	18.0%	17.9%	17.9%	17.8%	17.6%	17.3%	16.9%	16.2%
Total Personal Income per Capita (in 2005 dollars)	20,907	23,257	23,914	23,887	24,058	24,302	24,593	26,031	28,749	31,518	38,559
Woods & Poole Economics Wealth Index (U.S. = 100)	67.9	78.0	79.0	78.9	79.2	79.4	79.6	80.3	81.2	81.9	83.0
Persons per Household (in number of people)	3.2	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.3
Mean Household Total Personal Income (in 2005 dollars)	67,317	75,702	77,591	77,212	77,464	77,910	78,531	82,496	91,564	101,445	126,955
Number of Households (in thousands)	510.57	552.84	564.82	577.44	590.27	603.52	616.71	665.25	728.15	775.02	863.66
Income <$10,000 (thousands of households, 2000$)	15.7%	13.7%	13.3%	13.1%	12.9%	12.7%	12.5%	11.3%	9.4%	8.0%	5.8%
Income $10,000 to $19,999	17.7%	15.5%	15.0%	14.8%	14.6%	14.4%	14.1%	12.8%	10.6%	9.1%	6.6%
Income $20,000 to $29,999	15.0%	13.4%	13.0%	12.8%	12.6%	12.4%	12.2%	11.0%	9.1%	7.8%	5.7%
Income $30,000 to $44,999	18.8%	19.9%	20.0%	20.0%	20.1%	20.2%	20.2%	20.0%	17.9%	15.4%	11.3%
Income $45,000 to $59,999	12.4%	14.2%	14.7%	14.8%	15.0%	15.2%	15.5%	16.7%	19.1%	20.2%	17.8%
Income $60,000 to $74,999	7.7%	8.8%	9.1%	9.2%	9.3%	9.5%	9.6%	10.6%	12.8%	14.8%	18.8%
Income $75,000 to $99,999	6.6%	7.5%	7.8%	7.9%	8.0%	8.1%	8.2%	9.0%	10.9%	12.7%	17.5%
Income $100,000 or more	6.1%	7.0%	7.2%	7.3%	7.4%	7.5%	7.7%	8.5%	10.2%	11.9%	16.5%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita was calculated using personal income/total population for the EIA; persons per household was calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-20

Demographic and Employment Baseline Projections for Economic Impact Area TX-2

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	581.75	626.81	635.42	644.27	653.22	662.24	671.29	708.03	763.95	810.43	902.92
Age Under 19 Years	29.5%	29.2%	29.4%	29.4%	29.3%	29.3%	29.3%	29.5%	29.4%	29.3%	29.1%
Age 20 to 34	18.7%	18.2%	18.1%	18.1%	18.2%	18.3%	18.3%	18.1%	18.9%	19.2%	19.9%
Age 35 to 49	22.5%	20.7%	20.3%	19.9%	19.5%	19.2%	19.0%	18.6%	17.4%	17.2%	17.7%
Age 50 to 64	17.1%	19.1%	19.4%	19.5%	19.6%	19.6%	19.5%	18.8%	17.2%	16.0%	14.9%
Age 65 and over	12.2%	12.8%	12.9%	13.1%	13.4%	13.6%	13.9%	15.0%	17.1%	18.2%	18.4%
Median Age of Population (years)	39.1	40.5	40.5	40.5	40.4	40.3	40.2	39.9	38.9	37.9	36.3
White Population (in thousands)	58.8%	54.4%	53.7%	53.1%	52.5%	52.0%	51.4%	49.0%	45.5%	42.5%	36.7%
Black Population (in thousands)	9.2%	10.1%	10.2%	10.3%	10.4%	10.4%	10.5%	10.8%	11.4%	12.0%	13.2%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%
Asian and Pacific Islander Population (in thousands)	2.3%	3.3%	3.4%	3.4%	3.5%	3.6%	3.7%	3.9%	4.3%	4.5%	4.9%
Hispanic or Latino Population (in thousands)	29.5%	31.9%	32.4%	32.9%	33.3%	33.7%	34.2%	35.9%	38.6%	40.8%	45.0%
Male Population (in thousands)	50.2%	50.2%	50.2%	50.1%	50.1%	50.1%	50.1%	50.1%	49.9%	49.8%	49.6%
Total Employment (in thousands of jobs)	287.62	303.96	303.60	307.79	312.42	317.11	321.84	341.33	372.17	399.35	457.64
Farm Employment	7.4%	6.9%	6.7%	6.6%	6.6%	6.5%	6.5%	6.3%	6.0%	5.7%	5.3%
Forestry, Fishing, Related Activities	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%
Mining	2.4%	3.1%	3.1%	3.2%	3.2%	3.2%	3.2%	3.3%	3.4%	3.5%	3.5%
Utilities	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%
Construction	9.6%	8.3%	7.9%	7.9%	7.9%	8.0%	8.0%	8.1%	8.2%	8.4%	8.6%
Manufacturing	9.7%	9.1%	9.4%	9.4%	9.3%	9.3%	9.2%	9.0%	8.7%	8.4%	7.8%
Wholesale Trade	2.7%	2.7%	2.8%	2.8%	2.8%	2.8%	2.8%	2.7%	2.6%	2.5%	2.2%
Retail Trade	11.3%	11.1%	11.2%	11.2%	11.2%	11.2%	11.2%	11.3%	11.3%	11.4%	11.4%
Transportation and Warehousing	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	3.0%	3.0%	3.0%
Information Employment	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Finance and Insurance	3.4%	4.3%	4.4%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.4%

Table 4-20. Demographic and Employment Baseline Projections for Economic Impact Area TX-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Real Estate / Rental and Lease	3.4%	3.7%	4.1%	4.2%	4.2%	4.2%	4.2%	4.4%	4.6%	4.8%	5.2%
Professional and Technical Services	3.9%	4.3%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.5%	4.5%
Management	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Administrative and Waste Services	4.6%	4.2%	4.3%	4.3%	4.4%	4.4%	4.4%	4.5%	4.6%	4.7%	4.8%
Educational Services	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.4%	1.5%	1.8%
Health Care and Social Assistance	7.7%	8.1%	7.9%	7.9%	8.0%	8.0%	8.0%	8.2%	8.5%	8.7%	9.1%
Arts, Entertainment, and Recreation	1.2%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.5%	1.5%	1.6%
Accommodation and Food Services	5.6%	6.3%	6.3%	6.4%	6.5%	6.5%	6.6%	6.8%	7.2%	7.6%	8.4%
Other Services, Except Public Administration	6.5%	6.0%	5.9%	5.9%	5.9%	5.9%	6.0%	6.0%	6.0%	6.1%	6.1%
Federal Civilian Government	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Federal Military	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%
State and Local Government	12.9%	12.8%	12.4%	12.3%	12.2%	12.0%	11.9%	11.4%	10.7%	10.1%	9.0%
Total Earnings (in millions of 2005 dollars)	10,282	10,582	10,999	11,119	11,391	11,669	11,952	13,148	15,135	16,981	21,240
Farm	3.5%	0.8%	0.8%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.0%
Forestry, Fishing, Related Activities	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%
Mining	4.3%	4.9%	4.9%	5.1%	5.1%	5.2%	5.2%	5.5%	5.8%	6.1%	6.6%
Utilities	1.6%	1.8%	1.8%	1.7%	1.7%	1.7%	1.8%	1.9%	2.1%	2.2%	2.6%
Construction	11.7%	10.2%	9.6%	9.8%	9.8%	9.7%	9.7%	9.5%	9.3%	9.1%	8.7%
Manufacturing	20.2%	18.9%	19.0%	19.3%	19.3%	19.3%	19.3%	19.2%	19.0%	18.8%	18.3%
Wholesale Trade	3.5%	4.0%	4.2%	3.9%	3.9%	3.9%	3.9%	3.8%	3.7%	3.6%	3.4%
Retail Trade	8.1%	7.8%	7.9%	7.9%	7.9%	7.8%	7.7%	7.5%	7.2%	6.9%	6.3%
Transportation and Warehousing	3.5%	3.9%	4.0%	3.6%	3.6%	3.6%	3.6%	3.6%	3.5%	3.5%	3.4%
Information	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%
Finance and Insurance	3.0%	3.4%	3.6%	3.7%	3.7%	3.7%	3.7%	3.8%	3.8%	3.9%	4.0%
Real Estate / Rental and Lease	1.5%	1.4%	1.6%	1.6%	1.7%	1.7%	1.7%	1.7%	1.8%	1.8%	2.0%
Professional and Technical Services	3.9%	4.4%	4.4%	4.2%	4.2%	4.2%	4.3%	4.4%	4.5%	4.7%	4.9%
Management	0.1%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%

Table 4-20. Demographic and Employment Baseline Projections for Economic Impact Area TX-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Administrative and Waste Services	2.5%	2.4%	2.5%	2.5%	2.5%	2.5%	2.5%	2.6%	2.7%	2.8%	2.9%
Educational Services	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.8%	1.0%
Health Care and Social Assistance	7.5%	9.2%	9.2%	8.9%	9.0%	9.0%	9.1%	9.4%	9.8%	10.1%	10.8%
Arts, Entertainment, and Recreation	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%
Accommodation and Food Services	2.2%	2.7%	2.8%	2.7%	2.8%	2.8%	2.8%	2.9%	3.1%	3.3%	3.7%
Other Services, Except Public Administration	5.2%	4.8%	4.7%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%
Federal Civilian Government	0.9%	1.0%	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%
Federal Military	0.6%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
State and Local Government	13.9%	15.2%	14.6%	14.7%	14.5%	14.4%	14.3%	13.8%	13.2%	12.6%	11.6%
Total Personal Income per Capita (in 2005 dollars)	29,554	33,231	34,468	34,221	34,427	34,739	35,117	36,968	40,349	43,692	51,861
Woods & Poole Economics Wealth Index (U.S. = 100)	78.4	86.6	87.4	87.4	87.6	87.8	88.1	89.0	90.4	91.5	93.6
Persons per Household (in number of people)	2.7	2.8	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.8
Mean Household Total Personal Income (in 2005$)	81,195	92,621	95,720	94,639	94,810	95,225	95,851	100,031	109,574	119,784	145,184
Number of Households (in thousands)	211.75	224.89	228.81	232.96	237.20	241.59	245.94	261.66	281.32	295.61	322.53
Income < $10,000 (thousands of households, 2000$)	9.6%	8.2%	7.9%	7.9%	7.7%	7.6%	7.5%	6.8%	5.7%	4.9%	3.6%
Income $10,000 to $19,999	12.9%	11.1%	10.7%	10.6%	10.5%	10.3%	10.1%	9.2%	7.9%	6.8%	5.0%
Income $20,000 to $29,999	12.9%	11.2%	10.8%	10.7%	10.5%	10.4%	10.2%	9.4%	8.0%	6.9%	5.2%
Income $30,000 to $44,999	17.5%	16.1%	15.7%	15.6%	15.4%	15.2%	15.0%	13.8%	11.8%	10.2%	7.6%
Income $45,000 to $59,999	14.3%	15.2%	15.3%	15.4%	15.4%	15.4%	15.5%	15.6%	14.5%	12.9%	9.3%
Income $60,000 to $74,999	11.2%	13.0%	13.5%	13.6%	13.8%	14.0%	14.2%	15.3%	16.8%	17.3%	15.4%
Income $75,000 to $99,999	10.9%	12.8%	13.3%	13.3%	13.5%	13.8%	14.0%	15.2%	17.9%	20.8%	26.8%
Income $100,000 or more	10.5%	12.3%	12.8%	12.9%	13.1%	13.3%	13.6%	14.7%	17.4%	20.2%	27.2%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-21

Demographic and Employment Baseline Projections for Economic Impact Area TX-3

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	5,518	6,202	6,319	6,437	6,557	6,676	6,797	7,283	8,019	8,630	9,846
Age Under 19 Years	31.0%	30.4%	30.5%	30.5%	30.4%	30.4%	30.3%	30.3%	29.9%	29.6%	29.2%
Age 20 to 34	22.1%	21.8%	21.6%	21.5%	21.5%	21.5%	21.3%	20.9%	21.2%	21.3%	21.4%
Age 35 to 49	22.7%	21.3%	21.1%	20.8%	20.6%	20.4%	20.3%	20.1%	19.0%	18.6%	18.6%
Age 50 to 64	15.6%	17.4%	17.6%	17.7%	17.7%	17.7%	17.7%	17.2%	16.4%	15.9%	15.3%
Age 65 and over	8.5%	9.1%	9.2%	9.5%	9.7%	10.0%	10.3%	11.5%	13.5%	14.5%	15.5%
Median Age of Population (years)	37.3	38.2	38.3	38.4	38.4	38.5	38.5	38.5	38.5	38.6	38.3
White Population (in thousands)	46.0%	41.9%	41.2%	40.6%	39.9%	39.3%	38.7%	36.2%	32.7%	30.0%	25.2%
Black Population (in thousands)	17.6%	17.9%	17.8%	17.7%	17.6%	17.6%	17.5%	17.1%	16.6%	16.1%	15.1%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Asian and Pacific Islander Population (in thousands)	5.6%	6.3%	6.5%	6.6%	6.7%	6.8%	7.0%	7.5%	8.2%	8.8%	9.9%
Hispanic or Latino Population (in thousands)	30.5%	33.6%	34.3%	34.9%	35.5%	36.1%	36.6%	38.9%	42.2%	44.8%	49.6%
Male Population (in thousands)	49.8%	49.8%	49.8%	49.8%	49.8%	49.7%	49.7%	49.7%	49.7%	49.6%	49.4%
Total Employment (in thousands of jobs)	3,219	3,605	3,649	3,709	3,776	3,844	3,913	4,199	4,660	5,076	6,001
Farm Employment	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%
Forestry, Fishing, Related Activities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	2.8%	3.6%	3.6%	3.6%	3.6%	3.7%	3.7%	3.7%	3.7%	3.8%	3.7%
Utilities	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Construction	8.0%	7.5%	7.1%	7.2%	7.2%	7.2%	7.3%	7.4%	7.6%	7.7%	8.0%
Manufacturing	7.4%	7.1%	7.3%	7.2%	7.1%	7.0%	7.0%	6.6%	6.1%	5.7%	5.0%
Wholesale Trade	4.5%	4.4%	4.5%	4.5%	4.5%	4.4%	4.4%	4.3%	4.1%	4.0%	3.7%
Retail Trade	10.2%	9.6%	9.7%	9.6%	9.6%	9.6%	9.6%	9.5%	9.4%	9.2%	9.0%
Transportation and Warehousing	4.3%	4.3%	4.3%	4.3%	4.4%	4.4%	4.4%	4.5%	4.7%	4.8%	5.0%
Information Employment	1.5%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%	1.0%	0.9%
Finance and Insurance	4.5%	5.0%	5.0%	5.0%	5.0%	4.9%	4.9%	4.8%	4.6%	4.5%	4.2%
Real Estate / Rental and Lease	4.1%	4.3%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.6%	4.6%	4.5%

Table 4-21. Demographic and Employment Baseline Projections for Economic Impact Area TX-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	7.8%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	8.0%	8.0%	8.1%	8.1%
Management	0.6%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%
Administrative and Waste Services	7.4%	7.1%	7.2%	7.3%	7.3%	7.4%	7.4%	7.6%	7.8%	8.0%	8.4%
Educational Services	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.7%	1.8%	1.9%	2.1%
Health Care and Social Assistance	8.2%	8.9%	8.9%	8.9%	9.0%	9.1%	9.2%	9.6%	10.1%	10.6%	11.5%
Arts, Entertainment, and Recreation	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%
Accommodation and Food Services	6.5%	7.0%	7.0%	7.1%	7.1%	7.1%	7.1%	7.2%	7.4%	7.5%	7.7%
Other Services, Except Public Administration	6.0%	5.7%	5.6%	5.7%	5.7%	5.7%	5.7%	5.9%	6.1%	6.2%	6.5%
Federal Civilian Government	1.0%	0.9%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%	0.5%
Federal Military	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%
State and Local Government	10.3%	9.7%	9.4%	9.3%	9.2%	9.2%	9.1%	8.8%	8.4%	8.1%	7.5%
Total Earnings (in millions of 2005 dollars)	186,536	220,484	232,312	238,826	245,613	252,572	259,707	290,089	341,626	390,638	507,723
Farm	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Forestry, Fishing, Related Activities	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Mining	12.3%	15.2%	15.4%	15.5%	15.6%	15.7%	15.7%	16.1%	16.5%	16.8%	17.3%
Utilities	1.6%	2.1%	2.1%	2.1%	2.1%	2.2%	2.2%	2.3%	2.4%	2.5%	2.7%
Construction	8.2%	6.8%	6.3%	6.3%	6.3%	6.3%	6.2%	6.1%	6.0%	5.9%	5.6%
Manufacturing	11.7%	11.3%	11.6%	11.5%	11.4%	11.3%	11.2%	10.8%	10.2%	9.7%	8.8%
Wholesale Trade	6.2%	6.1%	6.2%	6.1%	6.1%	6.1%	6.1%	5.9%	5.7%	5.6%	5.3%
Retail Trade	5.2%	4.5%	4.5%	4.5%	4.4%	4.4%	4.3%	4.1%	3.8%	3.6%	3.2%
Transportation and Warehousing	5.6%	5.6%	5.6%	5.6%	5.6%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%
Information	1.7%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%
Finance and Insurance	5.5%	4.8%	4.6%	4.6%	4.6%	4.5%	4.5%	4.4%	4.3%	4.1%	3.9%
Real Estate / Rental and Lease	2.4%	1.7%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%
Professional and Technical Services	10.8%	11.3%	11.4%	11.5%	11.5%	11.6%	11.7%	11.9%	12.2%	12.5%	13.0%
Management	0.6%	1.0%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%	1.4%	1.5%	1.7%
Administrative and Waste Services	4.4%	4.1%	4.2%	4.3%	4.3%	4.3%	4.4%	4.5%	4.7%	4.8%	5.2%

Table 4-21. Demographic and Employment Baseline Projections for Economic Impact Area TX-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Educational Services	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.2%	1.4%
Health Care and Social Assistance	6.5%	7.1%	7.0%	7.1%	7.2%	7.2%	7.3%	7.6%	8.0%	8.4%	9.2%
Arts, Entertainment, and Recreation	0.7%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Accommodation and Food Services	2.3%	2.2%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.4%	2.4%
Other Services, Except Public Administration	3.1%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	3.0%	3.0%	3.1%	3.1%
Federal Civilian Government	1.7%	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.3%	1.3%	1.2%
Federal Military	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
State and Local Government	8.3%	8.3%	7.9%	7.9%	7.8%	7.8%	7.7%	7.6%	7.3%	7.1%	6.7%
Total Personal Income per Capita (in 2005 dollars)	39,184	42,898	44,457	44,442	44,669	45,041	45,509	47,897	52,489	57,178	69,012
Woods & Poole Economics Wealth Index (U.S. = 100)	84.6	92.8	93.5	93.4	93.5	93.6	93.7	93.9	94.3	94.9	96.4
Persons per Household (in number of people)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9
Mean Household Total Personal Income (in 2005$)	107,917	122,164	126,117	125,537	125,633	126,076	126,822	132,266	145,382	159,816	196,851
Number of Households (in thousands)	2,004	2,178	2,227	2,279	2,331	2,385	2,439	2,637	2,895	3,088	3,452
Income < $10,000 (thousands of households, 2000$)	8.7%	7.6%	7.4%	7.3%	7.2%	7.1%	7.0%	6.4%	5.6%	5.0%	3.9%
Income $10,000 to $19,999	10.9%	9.7%	9.4%	9.3%	9.2%	9.0%	8.9%	8.2%	7.2%	6.4%	4.9%
Income $20,000 to $29,999	11.9%	10.6%	10.3%	10.2%	10.0%	9.9%	9.8%	9.0%	7.9%	7.0%	5.5%
Income $30,000 to $44,999	16.7%	15.1%	14.6%	14.5%	14.3%	14.2%	14.0%	12.9%	11.3%	10.1%	7.9%
Income $45,000 to $59,999	14.0%	14.5%	14.5%	14.4%	14.4%	14.4%	14.3%	13.7%	12.3%	10.9%	8.5%
Income $60,000 to $74,999	10.9%	12.1%	12.4%	12.5%	12.6%	12.8%	12.9%	13.8%	14.7%	14.7%	12.2%
Income $75,000 to $99,999	11.4%	12.9%	13.3%	13.5%	13.6%	13.8%	14.0%	15.1%	17.2%	19.1%	21.8%
Income $100,000 or more	15.5%	17.5%	18.1%	18.4%	18.6%	18.8%	19.1%	20.7%	23.8%	26.9%	35.3%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-22

Demographic and Employment Baseline Projections for Economic Impact Area LA-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	338.48	345.97	349.09	352.34	355.65	358.98	362.34	376.06	397.01	414.37	448.81
Age Under 19 Years	29.2%	28.6%	28.6%	28.6%	28.6%	28.5%	28.6%	28.9%	28.9%	28.4%	27.3%
Age 20 to 34	21.8%	21.3%	21.1%	21.0%	20.8%	20.6%	20.3%	18.9%	18.1%	18.3%	19.5%
Age 35 to 49	21.1%	19.4%	19.1%	18.8%	18.7%	18.5%	18.5%	18.9%	19.0%	18.4%	16.9%
Age 50 to 64	16.3%	18.4%	18.7%	18.9%	19.0%	19.2%	19.2%	18.7%	17.2%	16.7%	17.6%
Age 65 and over	11.7%	12.4%	12.5%	12.8%	13.0%	13.2%	13.4%	14.6%	16.8%	18.1%	18.6%
Median Age of Population (years)	34.9	36.2	36.3	36.4	36.5	36.6	36.7	37.3	38.0	38.1	38.5
White Population (in thousands)	74.7%	74.0%	73.9%	73.9%	73.8%	73.7%	73.6%	73.2%	72.6%	72.0%	70.8%
Black Population (in thousands)	20.9%	21.0%	21.0%	21.0%	21.0%	21.0%	21.0%	21.0%	21.0%	21.1%	21.1%
Native American Population (in thousands)	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Asian and Pacific Islander Population (in thousands)	1.0%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%	1.4%	1.6%	1.8%
Hispanic or Latino Population (in thousands)	2.7%	3.1%	3.2%	3.2%	3.3%	3.4%	3.4%	3.7%	4.2%	4.6%	5.6%
Male Population (in thousands)	49.9%	50.0%	50.0%	50.0%	50.0%	50.0%	50.1%	50.1%	50.1%	50.2%	50.2%
Total Employment (in thousands of jobs)	171.65	178.79	176.78	178.85	181.19	183.55	185.95	195.88	211.77	226.00	257.49
Farm Employment	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%	1.6%	1.4%
Forestry, Fishing, Related Activities	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Mining	1.1%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.2%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.2%
Construction	8.7%	8.3%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.0%
Manufacturing	6.7%	6.4%	6.6%	6.5%	6.3%	6.2%	6.0%	5.5%	4.8%	4.2%	3.3%
Wholesale Trade	2.2%	2.1%	2.2%	2.2%	2.2%	2.2%	2.1%	2.1%	2.0%	2.0%	1.9%
Retail Trade	11.0%	10.5%	10.5%	10.6%	10.6%	10.6%	10.7%	10.8%	11.0%	11.1%	11.3%
Transportation and Warehousing	3.2%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
Information Employment	1.0%	1.0%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%
Finance and Insurance	2.5%	3.1%	3.2%	3.2%	3.2%	3.2%	3.2%	3.1%	3.0%	3.0%	2.8%
Real Estate / Rental and Lease	2.4%	2.8%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	3.0%

Table 4-22. Demographic and Employment Baseline Projections for Economic Impact Area LA-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	4.7%	4.3%	4.2%	4.2%	4.2%	4.3%	4.3%	4.4%	4.6%	4.8%	5.1%
Management	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%
Administrative and Waste Services	3.8%	4.3%	4.4%	4.5%	4.5%	4.5%	4.6%	4.8%	5.0%	5.2%	5.6%
Educational Services	1.0%	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
Health Care and Social Assistance	9.5%	10.1%	10.0%	10.2%	10.3%	10.4%	10.6%	11.1%	12.0%	12.7%	14.2%
Arts, Entertainment, and Recreation	2.3%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.2%	1.1%
Accommodation and Food Services	7.9%	8.4%	8.6%	8.7%	8.8%	8.8%	8.9%	9.3%	9.9%	10.3%	11.3%
Other Services, Except Public Administration	6.2%	6.3%	6.3%	6.4%	6.4%	6.5%	6.5%	6.7%	7.0%	7.2%	7.7%
Federal Civilian Government	2.1%	2.0%	2.0%	1.9%	1.9%	1.9%	1.9%	1.7%	1.6%	1.4%	1.2%
Federal Military	5.7%	5.6%	5.5%	5.5%	5.4%	5.3%	5.3%	5.0%	4.7%	4.4%	3.9%
State and Local Government	14.0%	14.0%	13.6%	13.5%	13.4%	13.3%	13.2%	12.8%	12.2%	11.6%	10.6%
Total Earnings (in millions of 2005 dollars)	6,873	7,632	7,785	7,971	8,140	8,313	8,490	9,233	10,471	11,627	14,333
Farm	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Forestry, Fishing, Related Activities	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Mining	1.7%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%
Utilities	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%
Construction	7.6%	8.9%	8.5%	8.5%	8.4%	8.4%	8.3%	8.1%	7.8%	7.6%	7.0%
Manufacturing	14.6%	13.1%	13.6%	13.3%	13.1%	12.9%	12.6%	11.8%	10.6%	9.6%	7.8%
Wholesale Trade	2.7%	2.6%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.6%
Retail Trade	6.3%	5.6%	5.7%	5.6%	5.6%	5.6%	5.5%	5.4%	5.3%	5.1%	4.8%
Transportation and Warehousing	3.6%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	2.9%	2.9%	2.8%	2.7%
Information	2.6%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%	2.2%
Finance and Insurance	2.3%	2.6%	3.0%	3.0%	3.0%	3.0%	2.9%	2.9%	2.9%	2.9%	2.8%
Real Estate / Rental and Lease	1.2%	1.2%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Professional and Technical Services	5.4%	5.1%	5.0%	5.0%	5.1%	5.2%	5.2%	5.5%	6.0%	6.4%	7.3%
Management	1.5%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.9%	1.0%
Administrative and Waste Services	2.3%	2.3%	2.3%	2.4%	2.4%	2.4%	2.5%	2.6%	2.8%	2.9%	3.3%

Table 4-22. Demographic and Employment Baseline Projections for Economic Impact Area LA-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Educational Services	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%
Health Care and Social Assistance	8.7%	9.5%	9.5%	9.6%	9.8%	10.0%	10.1%	10.7%	11.7%	12.6%	14.3%
Arts, Entertainment, and Recreation	1.5%	0.5%	0.4%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%
Accommodation and Food Services	3.7%	4.0%	4.1%	4.1%	4.2%	4.2%	4.3%	4.5%	4.8%	5.1%	5.7%
Other Services, Except Public Administration	3.7%	3.5%	3.4%	3.5%	3.5%	3.5%	3.5%	3.7%	3.8%	3.9%	4.2%
Federal Civilian Government	3.8%	3.5%	3.3%	3.3%	3.3%	3.2%	3.2%	3.1%	2.9%	2.8%	2.5%
Federal Military	10.6%	13.0%	13.1%	13.3%	13.3%	13.4%	13.4%	13.6%	13.8%	14.0%	14.3%
State and Local Government	13.8%	13.9%	13.1%	13.0%	12.9%	12.9%	12.8%	12.6%	12.3%	12.0%	11.4%
Total Personal Income per Capita (in 2005 dollars)	27,227	30,983	31,400	31,443	31,728	32,115	32,568	34,726	38,608	42,397	51,597
Woods & Poole Economics Wealth Index (U.S. = 100)	69.2	81.2	80.1	80.2	80.6	81.0	81.4	82.6	84.4	85.8	88.6
Persons per Household (in number of people)	2.6	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7
Mean Household Total Personal Income (in 2005 dollars)	71,904	82,728	83,519	83,273	83,662	84,276	85,084	89,884	100,192	110,989	137,730
Number of Households (in thousands)	128.17	129.57	131.24	133.04	134.87	136.80	138.70	145.29	152.99	158.29	168.14
Income < $10,000 (thousands of households, 2000$)	12.2%	10.6%	10.4%	10.2%	10.1%	9.9%	9.8%	8.8%	7.4%	6.3%	4.6%
Income $10,000 to $19,999	15.0%	12.9%	12.7%	12.5%	12.3%	12.1%	11.9%	10.8%	9.0%	7.7%	5.6%
Income $20,000 to $29,999	13.2%	11.3%	11.1%	10.9%	10.8%	10.6%	10.4%	9.4%	7.8%	6.7%	4.8%
Income $30,000 to $44,999	19.6%	18.4%	18.1%	17.9%	17.7%	17.4%	17.1%	15.6%	13.0%	11.1%	8.0%
Income $45,000 to $59,999	14.9%	17.6%	17.9%	18.2%	18.4%	18.6%	18.9%	20.1%	20.1%	18.0%	13.1%
Income $60,000 to $74,999	9.5%	11.1%	11.3%	11.5%	11.7%	11.9%	12.1%	13.5%	16.3%	19.1%	19.8%
Income $75,000 to $99,999	8.7%	10.2%	10.4%	10.6%	10.7%	10.9%	11.1%	12.3%	14.9%	17.6%	25.1%
Income $100,000 or more	6.8%	8.0%	8.1%	8.2%	8.4%	8.5%	8.6%	9.6%	11.5%	13.6%	19.1%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-23

Demographic and Employment Baseline Projections for Economic Impact Area LA-2

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	558.42	584.86	591.72	598.82	606.02	613.28	620.58	650.33	695.86	733.82	809.68
Age Under 19 Years	30.2%	29.1%	28.9%	28.8%	28.8%	28.7%	28.8%	28.9%	28.9%	28.4%	27.3%
Age 20 to 34	20.5%	21.0%	21.1%	21.1%	21.0%	20.9%	20.6%	19.4%	18.0%	17.9%	19.0%
Age 35 to 49	21.9%	19.6%	19.2%	18.8%	18.5%	18.4%	18.3%	18.6%	19.8%	19.6%	17.7%
Age 50 to 64	16.1%	18.5%	18.9%	19.1%	19.3%	19.4%	19.4%	19.0%	16.9%	16.2%	18.0%
Age 65 and over	11.4%	11.8%	11.9%	12.2%	12.4%	12.6%	12.9%	14.0%	16.4%	17.9%	18.1%
Median Age of Population (years)	35.1	35.7	35.8	35.8	35.9	36.0	36.2	36.9	37.8	38.5	38.7
White Population (in thousands)	69.1%	68.0%	67.8%	67.6%	67.5%	67.3%	67.2%	66.5%	65.4%	64.5%	62.6%
Black Population (in thousands)	27.5%	27.7%	27.7%	27.8%	27.8%	27.9%	27.9%	28.1%	28.5%	28.7%	29.3%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Asian and Pacific Islander Population (in thousands)	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%	1.5%	1.6%	1.8%
Hispanic or Latino Population (in thousands)	2.0%	2.8%	2.9%	3.0%	3.1%	3.2%	3.3%	3.6%	4.2%	4.8%	6.1%
Male Population (in thousands)	48.7%	48.8%	48.8%	48.9%	48.9%	48.9%	49.0%	49.1%	49.3%	49.3%	49.5%
Total Employment (in thousands of jobs)	297.51	326.06	323.47	328.23	333.53	338.91	344.32	366.60	401.84	432.94	500.08
Farm Employment	1.9%	1.8%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.4%	1.3%	1.2%
Forestry, Fishing, Related Activities	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	6.9%	8.3%	8.2%	8.2%	8.1%	8.0%	7.9%	7.6%	7.1%	6.6%	5.7%
Utilities	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Construction	6.7%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.2%	6.1%	6.0%	5.9%
Manufacturing	6.1%	5.6%	5.6%	5.6%	5.5%	5.5%	5.4%	5.2%	4.9%	4.6%	4.2%
Wholesale Trade	3.7%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.5%	3.5%
Retail Trade	11.5%	10.8%	10.9%	10.9%	10.9%	11.0%	11.0%	11.1%	11.2%	11.3%	11.5%
Transportation and Warehousing	3.5%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	3.0%	3.0%	3.1%
Information Employment	1.5%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.1%
Finance and Insurance	3.4%	3.6%	3.7%	3.7%	3.6%	3.6%	3.6%	3.5%	3.3%	3.1%	2.9%
Real Estate / Rental and Lease	4.0%	4.5%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.8%

Table 4-23. Demographic and Employment Baseline Projections for Economic Impact Area LA-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	4.7%	5.3%	5.4%	5.4%	5.4%	5.4%	5.5%	5.5%	5.5%	5.6%	5.6%
Management	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Administrative and Waste Services	4.6%	4.5%	4.4%	4.5%	4.5%	4.5%	4.6%	4.7%	4.9%	5.1%	5.4%
Educational Services	1.2%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%	1.5%	1.6%
Health Care and Social Assistance	11.2%	11.7%	11.7%	11.8%	11.9%	12.0%	12.1%	12.5%	13.2%	13.8%	14.9%
Arts, Entertainment, and Recreation	1.5%	1.8%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	2.0%
Accommodation and Food Services	6.4%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
Other Services, Except Public Administration	7.0%	6.9%	6.7%	6.8%	6.9%	6.9%	7.0%	7.2%	7.6%	7.9%	8.6%
Federal Civilian Government	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Federal Military	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%	0.5%
State and Local Government	10.8%	10.3%	9.9%	9.9%	9.8%	9.8%	9.8%	9.6%	9.3%	9.1%	8.7%
Total Earnings (in millions of 2005 dollars)	11,484	13,312	13,615	13,889	14,240	14,598	14,964	16,506	19,069	21,453	26,985
Farm	0.8%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
Forestry, Fishing, Related Activities	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	13.7%	16.0%	16.3%	16.2%	16.1%	16.0%	15.8%	15.3%	14.5%	13.7%	12.2%
Utilities	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Construction	7.1%	6.7%	6.8%	6.6%	6.6%	6.5%	6.5%	6.2%	5.9%	5.6%	5.1%
Manufacturing	7.5%	7.4%	7.3%	7.3%	7.3%	7.3%	7.2%	7.2%	7.1%	7.0%	6.7%
Wholesale Trade	4.7%	4.5%	4.4%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.7%
Retail Trade	7.9%	7.0%	7.0%	7.0%	7.0%	6.9%	6.9%	6.7%	6.4%	6.2%	5.8%
Transportation and Warehousing	4.6%	3.8%	3.7%	3.6%	3.6%	3.6%	3.6%	3.6%	3.5%	3.5%	3.5%
Information	1.7%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.4%	1.4%
Finance and Insurance	4.1%	3.0%	3.2%	3.2%	3.2%	3.2%	3.2%	3.1%	2.9%	2.8%	2.6%
Real Estate / Rental and Lease	3.5%	3.2%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.4%
Professional and Technical Services	6.0%	6.5%	6.7%	6.7%	6.8%	6.8%	6.8%	7.0%	7.2%	7.4%	7.8%
Management	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.8%	1.9%	2.0%	2.2%	2.4%
Administrative and Waste Services	3.1%	3.2%	3.3%	3.3%	3.3%	3.4%	3.4%	3.6%	3.9%	4.1%	4.6%

Table 4-23. Demographic and Employment Baseline Projections for Economic Impact Area LA-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Educational Services	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	1.0%	1.1%
Health Care and Social Assistance	11.3%	11.6%	11.4%	11.6%	11.8%	11.9%	12.0%	12.5%	13.2%	13.8%	15.1%
Arts, Entertainment, and Recreation	0.6%	0.6%	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%
Accommodation and Food Services	2.5%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.6%	2.7%	2.7%	2.7%
Other Services, Except Public Administration	4.5%	4.4%	4.3%	4.4%	4.4%	4.4%	4.5%	4.6%	4.9%	5.1%	5.5%
Federal Civilian Government	1.2%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Federal Military	0.9%	0.9%	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
State and Local Government	11.3%	11.9%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%
Total Personal Income per Capita (in 2005 dollars)	28,507	33,562	34,279	34,171	34,409	34,764	35,193	37,276	41,041	44,716	53,577
Woods & Poole Economics Wealth Index (U.S. = 100)	72.9	84.6	84.0	83.8	83.9	84.0	84.1	84.2	84.3	84.2	84.1
Persons per Household (in number of people)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.6	2.6	2.6
Mean Household Total Personal Income (in 2005 dollars)	74,766	88,125	89,674	89,017	89,252	89,749	90,459	94,958	104,880	115,331	141,051
Number of Households (in thousands)	212.92	222.74	226.19	229.87	233.64	237.56	241.44	255.29	272.30	284.51	307.55
Income < $10,000 (thousands of households, 2000$)	15.8%	13.4%	13.1%	13.0%	12.8%	12.6%	12.4%	11.2%	9.3%	7.9%	5.7%
Income $10,000 to $19,999	15.2%	13.0%	12.7%	12.6%	12.4%	12.2%	12.0%	10.9%	9.1%	7.8%	5.7%
Income $20,000 to $29,999	13.0%	11.3%	11.0%	10.9%	10.7%	10.6%	10.4%	9.4%	7.9%	6.8%	4.9%
Income $30,000 to $44,999	18.3%	18.3%	18.1%	18.0%	17.9%	17.8%	17.7%	16.6%	14.1%	12.1%	8.7%
Income $45,000 to $59,999	14.0%	16.4%	16.7%	16.9%	17.1%	17.3%	17.5%	18.7%	19.8%	19.1%	14.8%
Income $60,000 to $74,999	9.1%	10.6%	10.9%	11.0%	11.2%	11.4%	11.5%	12.7%	15.3%	17.7%	20.5%
Income $75,000 to $99,999	7.4%	8.7%	8.9%	9.1%	9.2%	9.3%	9.5%	10.4%	12.6%	14.7%	20.5%
Income $100,000 or more	7.1%	8.3%	8.5%	8.6%	8.7%	8.8%	9.0%	9.9%	11.9%	13.9%	19.3%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-24

Demographic and Employment Baseline Projections for Economic Impact Area LA-3

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	1,051.06	1,142.20	1,152.19	1,162.61	1,173.21	1,183.90	1,194.65	1,238.45	1,305.17	1,360.25	1,468.98
Age Under 19 Years	29.1%	28.5%	28.2%	28.2%	28.1%	28.1%	28.1%	28.2%	28.3%	27.9%	27.2%
Age 20 to 34	22.6%	22.6%	22.7%	22.6%	22.5%	22.3%	22.1%	20.5%	19.2%	19.2%	20.3%
Age 35 to 49	21.7%	19.7%	19.4%	19.1%	18.9%	18.7%	18.6%	19.2%	20.0%	19.7%	17.5%
Age 50 to 64	16.4%	18.3%	18.6%	18.6%	18.7%	18.8%	18.8%	18.3%	16.7%	16.0%	17.8%
Age 65 and over	10.2%	11.0%	11.2%	11.5%	11.8%	12.1%	12.4%	13.7%	15.8%	17.1%	17.3%
Median Age of Population (years)	34.8	35.7	35.8	35.9	36.0	36.1	36.3	37.1	38.3	39.0	39.2
White Population (in thousands)	65.2%	62.6%	62.3%	62.0%	61.7%	61.4%	61.1%	59.8%	58.0%	56.3%	53.0%
Black Population (in thousands)	29.7%	31.0%	31.2%	31.3%	31.5%	31.6%	31.8%	32.3%	33.1%	33.7%	34.7%
Native American Population (in thousands)	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%
Asian and Pacific Islander Population (in thousands)	1.4%	1.6%	1.6%	1.6%	1.7%	1.7%	1.8%	1.9%	2.1%	2.3%	2.7%
Hispanic or Latino Population (in thousands)	2.6%	3.7%	3.8%	3.9%	4.1%	4.2%	4.3%	4.8%	5.7%	6.5%	8.4%
Male Population (in thousands)	48.7%	48.8%	48.9%	48.9%	48.9%	48.9%	48.9%	49.0%	49.1%	49.2%	49.3%
Total Employment (in thousands of jobs)	606.81	667.39	662.76	671.33	680.95	690.70	700.56	741.18	805.80	863.29	989.11
Farm Employment	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.4%
Forestry, Fishing, Related Activities	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Mining	1.5%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.8%	1.6%	1.4%	1.1%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%
Construction	9.8%	9.2%	9.3%	9.3%	9.2%	9.2%	9.2%	9.0%	8.7%	8.4%	7.9%
Manufacturing	6.8%	6.4%	6.7%	6.6%	6.5%	6.4%	6.3%	5.9%	5.4%	4.9%	4.1%
Wholesale Trade	3.2%	2.9%	2.9%	2.8%	2.8%	2.8%	2.8%	2.8%	2.7%	2.6%	2.5%
Retail Trade	10.9%	10.3%	10.5%	10.5%	10.4%	10.4%	10.3%	10.1%	9.8%	9.5%	8.9%
Transportation and Warehousing	4.4%	4.6%	4.6%	4.6%	4.6%	4.6%	4.7%	4.7%	4.7%	4.7%	4.6%
Information Employment	1.4%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	0.9%	0.9%
Finance and Insurance	3.5%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.7%	3.6%	3.5%	3.3%
Real Estate / Rental and Lease	3.6%	4.3%	4.6%	4.7%	4.7%	4.7%	4.7%	4.8%	5.0%	5.1%	5.3%

Table 4-24. Demographic and Employment Baseline Projections for Economic Impact Area LA-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	4.8%	5.2%	5.1%	5.1%	5.1%	5.1%	5.1%	5.2%	5.2%	5.2%	5.2%
Management	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%
Administrative and Waste Services	5.8%	5.9%	6.0%	6.1%	6.2%	6.3%	6.4%	6.8%	7.5%	8.0%	9.2%
Educational Services	1.1%	1.2%	1.2%	1.3%	1.3%	1.3%	1.3%	1.4%	1.5%	1.7%	1.9%
Health Care and Social Assistance	8.8%	9.6%	9.6%	9.7%	9.8%	9.9%	10.0%	10.4%	10.9%	11.4%	12.4%
Arts, Entertainment, and Recreation	1.3%	1.6%	1.5%	1.5%	1.5%	1.5%	1.6%	1.6%	1.6%	1.6%	1.7%
Accommodation and Food Services	6.6%	6.6%	6.6%	6.6%	6.7%	6.7%	6.7%	6.9%	7.1%	7.3%	7.7%
Other Services, Except Public Administration	6.7%	6.7%	6.5%	6.6%	6.6%	6.7%	6.8%	7.0%	7.5%	7.8%	8.6%
Federal Civilian Government	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Federal Military	0.8%	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%
State and Local Government	15.6%	14.4%	13.8%	13.7%	13.6%	13.5%	13.4%	13.1%	12.6%	12.2%	11.3%
Total Earnings (in millions of 2005 dollars)	24,056	28,491	29,000	29,611	30,272	30,947	31,635	34,526	39,312	43,749	54,019
Farm	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%
Forestry, Fishing, Related Activities	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	2.6%	3.4%	3.5%	3.6%	3.6%	3.6%	3.5%	3.4%	3.2%	3.0%	2.6%
Utilities	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%
Construction	10.3%	11.2%	11.6%	11.5%	11.4%	11.3%	11.2%	10.7%	10.0%	9.4%	8.4%
Manufacturing	12.4%	11.7%	12.1%	12.1%	12.0%	11.9%	11.8%	11.4%	10.7%	10.1%	9.0%
Wholesale Trade	4.4%	3.9%	3.9%	3.8%	3.9%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%
Retail Trade	7.2%	6.3%	6.5%	6.4%	6.3%	6.2%	6.2%	5.9%	5.4%	5.1%	4.4%
Transportation and Warehousing	6.0%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.8%	6.7%	6.5%
Information	1.7%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%
Finance and Insurance	4.3%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.7%	3.7%	3.7%	3.6%
Real Estate / Rental and Lease	2.1%	1.9%	2.1%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.3%	2.3%
Professional and Technical Services	6.0%	6.6%	6.5%	6.5%	6.6%	6.6%	6.7%	6.9%	7.2%	7.4%	7.8%
Management	1.4%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.7%	1.8%	1.8%	1.9%
Administrative and Waste Services	3.5%	4.0%	4.3%	4.3%	4.4%	4.5%	4.5%	4.9%	5.6%	6.1%	7.3%
Educational Services	0.6%	0.7%	0.6%	0.7%	0.7%	0.7%	0.7%	0.8%	0.9%	1.0%	1.2%

Table 4-24. Demographic and Employment Baseline Projections for Economic Impact Area LA-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	9.2%	9.5%	9.3%	9.4%	9.6%	9.7%	9.8%	10.3%	11.0%	11.6%	12.9%
Arts, Entertainment, and Recreation	0.7%	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Accommodation and Food Services	2.7%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.6%	2.7%	2.8%	3.0%
Other Services, Except Public Administration	4.1%	3.9%	3.8%	3.8%	3.8%	3.9%	3.9%	4.1%	4.3%	4.5%	5.0%
Federal Civilian Government	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%	1.3%
Federal Military	0.9%	1.0%	1.0%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.9%
State and Local Government	17.5%	17.0%	16.1%	16.1%	16.1%	16.1%	16.1%	16.0%	15.8%	15.7%	15.4%
Total Personal Income per Capita (in 2005 dollars)	30,406	34,392	35,095	34,955	35,161	35,491	35,898	37,912	41,589	45,186	53,839
Woods & Poole Economics Wealth Index (U.S. = 100)	78.2	88.8	88.3	88.2	88.4	88.6	88.8	89.3	89.8	90.0	89.7
Persons per Household (in number of people)	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.7
Mean Household Total Personal Income (in 2005$)	81,039	92,128	93,644	92,854	92,978	93,385	94,022	98,318	108,048	118,351	143,639
Number of Households (in thousands)	394.36	426.39	431.80	437.66	443.66	449.93	456.12	477.56	502.38	519.34	550.61
Income < $10,000 (thousands of households, 2000$)	12.5%	10.9%	10.7%	10.6%	10.4%	10.3%	10.1%	9.2%	7.7%	6.7%	4.7%
Income $10,000 to $19,999	13.3%	11.7%	11.4%	11.3%	11.1%	11.0%	10.8%	9.9%	8.3%	7.2%	5.1%
Income $20,000 to $29,999	12.2%	10.7%	10.5%	10.4%	10.2%	10.1%	9.9%	9.1%	7.7%	6.7%	4.7%
Income $30,000 to $44,999	17.6%	16.1%	15.9%	15.7%	15.6%	15.4%	15.2%	14.0%	11.8%	10.3%	7.2%
Income $45,000 to $59,999	14.6%	16.4%	16.7%	16.8%	16.9%	17.1%	17.2%	17.6%	16.8%	15.1%	10.7%
Income $60,000 to $74,999	11.0%	12.7%	13.0%	13.1%	13.3%	13.5%	13.8%	15.2%	17.9%	19.7%	18.7%
Income $75,000 to $99,999	9.9%	11.3%	11.6%	11.7%	11.9%	12.0%	12.2%	13.4%	16.0%	18.6%	26.6%
Income $100,000 or more	9.0%	10.1%	10.3%	10.4%	10.5%	10.7%	10.8%	11.7%	13.7%	15.7%	22.3%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-25

Demographic and Employment Baseline Projections for Economic Impact Area LA-4

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	1,431	1,242	1,248	1,254	1,261	1,267	1,274	1,301	1,344	1,379	1,449
Age Under 19 Years	28.5%	26.2%	26.0%	26.0%	26.0%	25.9%	26.0%	26.3%	26.4%	26.0%	25.4%
Age 20 to 34	20.8%	21.3%	21.3%	21.3%	21.1%	20.9%	20.6%	19.0%	17.2%	17.3%	18.6%
Age 35 to 49	21.9%	20.2%	19.8%	19.4%	19.2%	19.1%	19.0%	19.6%	20.7%	20.3%	17.6%
Age 50 to 64	17.3%	20.2%	20.5%	20.6%	20.6%	20.7%	20.7%	19.9%	17.9%	17.2%	19.2%
Age 65 and over	11.5%	12.3%	12.4%	12.7%	13.1%	13.4%	13.7%	15.3%	17.8%	19.2%	19.4%
Median Age of Population (years)	35.8	36.7	36.8	36.9	37.0	37.1	37.2	37.9	39.2	39.9	39.7
White Population (in thousands)	53.6%	55.0%	54.8%	54.6%	54.5%	54.3%	54.1%	53.3%	52.0%	50.9%	48.4%
Black Population (in thousands)	38.1%	34.5%	34.4%	34.3%	34.3%	34.2%	34.2%	34.0%	33.6%	33.3%	32.6%
Native American Population (in thousands)	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Asian and Pacific Islander Population (in thousands)	2.4%	2.6%	2.7%	2.7%	2.7%	2.8%	2.8%	2.9%	3.1%	3.3%	3.4%
Hispanic or Latino Population (in thousands)	5.5%	7.5%	7.7%	7.9%	8.2%	8.4%	8.6%	9.4%	10.8%	12.2%	15.2%
Male Population (in thousands)	48.2%	48.7%	48.8%	48.8%	48.8%	48.9%	48.9%	49.1%	49.3%	49.3%	49.5%
Total Employment (in thousands of jobs)	740.50	739.02	736.37	741.28	747.23	753.21	759.21	783.50	820.83	852.92	920.39
Farm Employment	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Forestry, Fishing, Related Activities	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%
Mining	1.3%	1.6%	1.6%	1.6%	1.5%	1.5%	1.5%	1.4%	1.3%	1.2%	1.1%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.2%
Construction	6.2%	6.4%	6.3%	6.3%	6.2%	6.2%	6.2%	6.2%	6.1%	6.0%	5.8%
Manufacturing	5.6%	5.3%	5.4%	5.3%	5.1%	5.0%	4.9%	4.5%	3.9%	3.5%	2.7%
Wholesale Trade	3.6%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Retail Trade	10.0%	9.6%	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%	9.3%	9.3%	9.1%
Transportation and Warehousing	4.1%	4.1%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%
Information Employment	1.6%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	0.9%
Finance and Insurance	3.9%	4.1%	4.2%	4.2%	4.1%	4.1%	4.1%	4.0%	3.8%	3.7%	3.4%
Real Estate / Rental and Lease	4.0%	4.6%	5.0%	5.0%	5.0%	5.0%	5.0%	5.1%	5.1%	5.2%	5.4%

Table 4-25. Demographic and Employment Baseline Projections for Economic Impact Area LA-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	5.7%	6.7%	6.9%	6.9%	6.9%	7.0%	7.0%	7.0%	7.1%	7.2%	7.3%
Management	1.1%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%	1.1%	1.0%
Administrative and Waste Services	6.4%	6.3%	6.4%	6.4%	6.5%	6.6%	6.7%	7.0%	7.5%	7.9%	8.9%
Educational Services	3.1%	3.2%	3.1%	3.2%	3.2%	3.2%	3.2%	3.3%	3.5%	3.6%	3.9%
Health Care and Social Assistance	8.8%	9.2%	9.3%	9.3%	9.4%	9.4%	9.4%	9.5%	9.6%	9.7%	9.8%
Arts, Entertainment, and Recreation	2.5%	2.4%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Accommodation and Food Services	8.8%	9.4%	9.6%	9.6%	9.7%	9.7%	9.8%	10.0%	10.2%	10.5%	10.9%
Other Services, Except Public Administration	6.5%	6.4%	6.3%	6.3%	6.4%	6.5%	6.5%	6.8%	7.2%	7.5%	8.1%
Federal Civilian Government	2.1%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%
Federal Military	1.4%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%
State and Local Government	11.9%	11.1%	10.7%	10.6%	10.6%	10.5%	10.5%	10.2%	9.8%	9.5%	8.8%
Total Earnings (in millions of 2005 dollars)	33,666	35,386	36,299	36,886	37,499	38,120	38,749	41,359	45,564	49,364	57,886
Farm	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Mining	4.4%	5.3%	5.4%	5.3%	5.2%	5.2%	5.1%	4.9%	4.6%	4.3%	3.8%
Utilities	1.2%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.9%	0.7%
Construction	6.5%	5.9%	5.6%	5.6%	5.5%	5.5%	5.4%	5.2%	5.0%	4.7%	4.3%
Manufacturing	8.6%	8.8%	8.9%	8.7%	8.6%	8.4%	8.3%	7.8%	7.0%	6.4%	5.3%
Wholesale Trade	5.3%	5.0%	4.9%	5.0%	5.0%	5.0%	5.1%	5.1%	5.2%	5.3%	5.5%
Retail Trade	6.2%	5.5%	5.4%	5.4%	5.3%	5.3%	5.2%	5.0%	4.8%	4.5%	4.1%
Transportation and Warehousing	5.1%	5.5%	5.6%	5.6%	5.6%	5.5%	5.5%	5.4%	5.3%	5.2%	5.0%
Information	1.7%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Finance and Insurance	5.1%	4.6%	4.8%	4.9%	4.8%	4.8%	4.8%	4.7%	4.6%	4.4%	4.2%
Real Estate / Rental and Lease	2.6%	1.5%	1.8%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.8%
Professional and Technical Services	8.0%	9.7%	10.1%	10.2%	10.3%	10.4%	10.5%	10.8%	11.3%	11.6%	12.4%
Management	1.8%	1.8%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.1%	2.1%	2.2%
Administrative and Waste Services	4.0%	3.9%	3.8%	4.0%	4.0%	4.1%	4.2%	4.5%	4.9%	5.3%	6.3%
Educational Services	2.2%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.7%	2.9%	3.0%	3.4%

Table 4-25. Demographic and Employment Baseline Projections for Economic Impact Area LA-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	8.7%	9.8%	10.0%	10.0%	10.1%	10.1%	10.2%	10.4%	10.7%	10.9%	11.2%
Arts, Entertainment, and Recreation	2.1%	1.8%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Accommodation and Food Services	4.4%	4.8%	4.9%	4.9%	5.0%	5.0%	5.0%	5.2%	5.4%	5.5%	5.8%
Other Services, Except Public Administration	3.7%	3.8%	3.7%	3.8%	3.8%	3.9%	3.9%	4.1%	4.3%	4.5%	4.8%
Federal Civilian Government	4.2%	3.6%	3.4%	3.4%	3.5%	3.5%	3.5%	3.6%	3.7%	3.8%	3.9%
Federal Military	1.8%	1.6%	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.8%	1.9%	2.0%
State and Local Government	12.1%	12.0%	11.3%	11.2%	11.2%	11.2%	11.1%	11.0%	10.7%	10.5%	10.0%
Total Personal Income per Capita (in 2005 dollars)	31,461	39,542	40,370	40,549	40,793	41,194	41,690	44,148	48,623	52,995	63,504
Woods & Poole Economics Wealth Index (U.S. = 100)	77.3	94.4	93.4	93.2	93.3	93.3	93.3	93.2	92.9	92.4	90.8
Persons per Household (in number of people)	2.7	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.6
Mean Household Total Personal Income (in 2005$)	84,130	101,676	103,420	103,452	103,642	104,176	104,983	110,217	121,818	134,024	163,930
Number of Households (in thousands)	535.25	483.19	487.22	491.67	496.25	501.14	505.92	521.30	536.46	545.36	561.22
Income < $10,000 (thousands of households, 2000$)	12.9%	10.4%	10.2%	10.1%	9.9%	9.8%	9.6%	8.8%	7.4%	6.4%	4.7%
Income $10,000 to $19,999	13.7%	11.3%	11.1%	10.9%	10.8%	10.6%	10.5%	9.7%	8.2%	7.1%	5.3%
Income $20,000 to $29,999	13.0%	10.8%	10.6%	10.5%	10.4%	10.2%	10.1%	9.3%	8.0%	7.0%	5.2%
Income $30,000 to $44,999	17.6%	14.8%	14.7%	14.5%	14.4%	14.3%	14.2%	13.2%	11.4%	9.9%	7.4%
Income $45,000 to $59,999	13.6%	15.4%	15.5%	15.5%	15.5%	15.5%	15.5%	15.2%	14.3%	12.9%	9.8%
Income $60,000 to $74,999	10.0%	12.2%	12.4%	12.6%	12.8%	12.9%	13.1%	14.1%	15.8%	16.0%	14.1%
Income $75,000 to $99,999	9.2%	11.7%	11.9%	12.1%	12.3%	12.4%	12.6%	13.8%	16.3%	19.0%	23.5%
Income $100,000 or more	10.1%	13.3%	13.6%	13.8%	14.0%	14.2%	14.4%	15.8%	18.6%	21.7%	29.9%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-26

Demographic and Employment Baseline Projections for Economic Impact Area MS-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	483.49	482.25	484.98	487.89	490.88	493.92	496.99	509.64	529.13	545.25	577.12
Age Under 19 Years	28.3%	27.7%	27.5%	27.4%	27.4%	27.4%	27.4%	27.7%	27.7%	27.3%	26.6%
Age 20 to 34	20.3%	19.9%	20.0%	20.0%	19.9%	19.7%	19.5%	18.5%	17.8%	17.7%	18.8%
Age 35 to 49	22.0%	20.4%	20.1%	19.8%	19.5%	19.3%	19.1%	19.2%	19.3%	19.1%	17.7%
Age 50 to 64	17.4%	19.3%	19.6%	19.6%	19.7%	19.9%	19.9%	19.5%	18.2%	17.4%	18.0%
Age 65 and over	11.9%	12.6%	12.8%	13.2%	13.5%	13.8%	14.1%	15.1%	17.1%	18.5%	19.0%
Median Age of Population (years)	36.1	37.3	37.4	37.6	37.7	37.8	37.9	38.3	38.8	39.5	39.5
White Population (in thousands)	75.8%	74.4%	74.2%	74.0%	73.8%	73.6%	73.4%	72.6%	71.4%	70.4%	68.4%
Black Population (in thousands)	18.8%	19.0%	19.1%	19.2%	19.3%	19.4%	19.4%	19.8%	20.4%	20.8%	21.5%
Native American Population (in thousands)	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Asian and Pacific Islander Population (in thousands)	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.1%	2.1%	2.2%	2.2%
Hispanic or Latino Population (in thousands)	3.0%	4.2%	4.3%	4.4%	4.5%	4.6%	4.7%	5.1%	5.7%	6.3%	7.6%
Male Population (in thousands)	49.7%	49.9%	49.9%	49.9%	49.9%	49.9%	49.9%	49.8%	49.8%	49.8%	49.7%
Total Employment (in thousands of jobs)	238.83	247.21	251.36	253.67	256.30	258.98	261.68	272.70	290.05	305.32	338.26
Farm Employment	1.4%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%
Forestry, Fishing, Related Activities	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Mining	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%
Utilities	0.9%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%
Construction	7.5%	8.5%	8.4%	8.4%	8.4%	8.4%	8.4%	8.3%	8.1%	8.0%	7.7%
Manufacturing	9.5%	9.7%	10.2%	10.0%	9.8%	9.6%	9.4%	8.6%	7.6%	6.8%	5.4%
Wholesale Trade	1.4%	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.2%	1.2%
Retail Trade	10.9%	10.2%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.0%
Transportation and Warehousing	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%
Information Employment	1.4%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Finance and Insurance	2.5%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.8%
Real Estate / Rental and Lease	3.1%	3.5%	3.8%	3.8%	3.8%	3.8%	3.9%	3.9%	4.1%	4.1%	4.3%

Table 4-26. Demographic and Employment Baseline Projections for Economic Impact Area MS-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	3.8%	4.2%	4.4%	4.4%	4.4%	4.5%	4.5%	4.7%	4.9%	5.1%	5.5%
Management	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Administrative and Waste Services	5.4%	6.4%	6.7%	6.8%	6.9%	7.0%	7.1%	7.5%	8.2%	8.7%	9.9%
Educational Services	0.5%	0.8%	0.8%	0.8%	0.8%	0.9%	0.9%	1.0%	1.2%	1.4%	1.9%
Health Care and Social Assistance	6.2%	6.4%	6.3%	6.4%	6.5%	6.5%	6.6%	6.9%	7.4%	7.7%	8.5%
Arts, Entertainment, and Recreation	2.2%	2.1%	1.8%	1.9%	1.9%	1.9%	1.9%	1.9%	2.0%	2.0%	2.1%
Accommodation and Food Services	12.1%	10.2%	10.0%	10.0%	10.0%	9.9%	9.9%	9.7%	9.5%	9.2%	8.8%
Other Services, Except Public Administration	5.5%	5.1%	5.0%	5.0%	5.1%	5.1%	5.2%	5.4%	5.8%	6.1%	6.7%
Federal Civilian Government	3.9%	3.8%	3.8%	3.8%	3.8%	3.7%	3.7%	3.6%	3.4%	3.3%	3.0%
Federal Military	5.7%	5.2%	5.1%	5.0%	5.0%	4.9%	4.9%	4.7%	4.5%	4.3%	3.9%
State and Local Government	12.3%	12.9%	12.8%	12.8%	12.8%	12.8%	12.7%	12.7%	12.6%	12.6%	12.3%
Total Earnings (in millions of 2005 dollars)	9,320	10,054	10,011	10,262	10,463	10,667	10,874	11,742	13,163	14,469	17,460
Farm	0.3%	0.0%	0.0%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	0.2%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Utilities	2.1%	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Construction	6.0%	6.6%	6.5%	6.5%	6.5%	6.4%	6.3%	6.1%	5.7%	5.5%	4.9%
Manufacturing	15.4%	17.2%	18.0%	17.6%	17.4%	17.2%	17.0%	16.1%	14.9%	13.9%	12.0%
Wholesale Trade	1.6%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%
Retail Trade	7.0%	6.1%	6.0%	5.9%	5.9%	5.9%	5.8%	5.6%	5.3%	5.1%	4.6%
Transportation and Warehousing	2.3%	2.2%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%	2.2%
Information	1.4%	1.0%	0.9%	0.9%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Finance and Insurance	2.2%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.5%
Real Estate / Rental and Lease	1.0%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%
Professional and Technical Services	4.6%	5.7%	6.0%	6.0%	6.1%	6.2%	6.3%	6.6%	7.1%	7.6%	8.6%
Management	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%
Administrative and Waste Services	3.1%	3.5%	3.6%	3.6%	3.7%	3.8%	3.8%	4.1%	4.5%	4.9%	5.7%
Educational Services	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.6%	0.7%	1.1%

Table 4-26. Demographic and Employment Baseline Projections for Economic Impact Area MS-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	6.7%	6.7%	6.7%	6.8%	6.8%	6.9%	7.0%	7.4%	7.9%	8.4%	9.4%
Arts, Entertainment, and Recreation	1.5%	1.0%	0.8%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
Accommodation and Food Services	8.0%	5.8%	5.7%	5.6%	5.6%	5.6%	5.6%	5.5%	5.4%	5.2%	5.0%
Other Services, Except Public Administration	3.3%	3.0%	2.9%	3.0%	3.0%	3.0%	3.1%	3.2%	3.4%	3.5%	3.8%
Federal Civilian Government	8.4%	8.4%	8.0%	8.0%	8.0%	8.0%	8.0%	7.9%	7.8%	7.7%	7.6%
Federal Military	10.2%	9.6%	9.5%	9.6%	9.6%	9.6%	9.6%	9.7%	9.7%	9.7%	9.8%
State and Local Government	13.2%	14.7%	14.5%	14.4%	14.5%	14.5%	14.5%	14.7%	14.8%	15.0%	15.1%
Total Personal Income per Capita (in 2005 dollars)	27,439	30,299	30,763	30,916	31,102	31,401	31,771	33,599	36,930	40,183	47,993
Woods & Poole Economics Wealth Index (U.S. = 100)	67.8	74.3	73.8	74.0	74.0	74.0	74.0	73.9	73.7	73.4	72.8
Persons per Household (in number of people)	2.6	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7
Mean Household Total Personal Income (in 2005 dollars)	72,261	80,860	81,772	81,818	81,940	82,321	82,911	86,829	95,620	104,891	127,583
Number of Households (in thousands)	183.59	180.70	182.45	184.36	186.32	188.40	190.44	197.21	204.36	208.88	217.10
Income < $10,000 (thousands of households, 2000$)	10.9%	9.6%	9.3%	9.2%	9.1%	8.9%	8.8%	8.0%	6.7%	5.7%	4.1%
Income $10,000 to $19,999	13.3%	11.7%	11.4%	11.2%	11.1%	10.9%	10.8%	9.8%	8.2%	7.0%	5.1%
Income $20,000 to $29,999	13.9%	12.1%	11.8%	11.6%	11.4%	11.3%	11.1%	10.1%	8.4%	7.2%	5.2%
Income $30,000 to $44,999	20.5%	18.9%	18.6%	18.4%	18.2%	17.9%	17.7%	16.2%	13.5%	11.5%	8.3%
Income $45,000 to $59,999	15.7%	18.0%	18.3%	18.6%	18.8%	19.0%	19.2%	20.2%	20.1%	18.4%	13.5%
Income $60,000 to $74,999	10.2%	11.9%	12.2%	12.4%	12.6%	12.8%	12.9%	14.3%	17.2%	19.9%	21.2%
Income $75,000 to $99,999	8.5%	9.9%	10.1%	10.3%	10.4%	10.6%	10.7%	11.8%	14.3%	16.8%	23.6%
Income $100,000 or more	6.9%	8.0%	8.2%	8.3%	8.5%	8.6%	8.7%	9.6%	11.5%	13.6%	19.0%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-27

Demographic and Employment Baseline Projections for Economic Impact Area AL-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	692.65	725.94	731.91	738.17	744.54	750.98	757.47	783.98	824.55	858.15	924.76
Age Under 19 Years	28.1%	27.2%	27.0%	26.8%	26.7%	26.6%	26.5%	26.4%	26.1%	25.7%	24.8%
Age 20 to 34	18.9%	18.6%	18.6%	18.7%	18.6%	18.5%	18.4%	17.6%	16.9%	16.5%	17.0%
Age 35 to 49	21.4%	19.8%	19.5%	19.2%	19.0%	18.8%	18.6%	18.6%	18.6%	18.6%	17.6%
Age 50 to 64	18.2%	20.0%	20.3%	20.3%	20.4%	20.4%	20.4%	19.8%	18.4%	17.6%	18.2%
Age 65 and over	13.4%	14.4%	14.6%	15.0%	15.4%	15.7%	16.1%	17.5%	20.0%	21.5%	22.4%
Median Age of Population (years)	38.0	39.8	40.1	40.3	40.5	40.6	40.8	41.4	42.5	43.2	44.3
White Population (in thousands)	66.3%	65.4%	65.3%	65.2%	65.1%	65.0%	64.9%	64.4%	63.6%	62.9%	61.7%
Black Population (in thousands)	29.7%	29.5%	29.5%	29.5%	29.6%	29.6%	29.6%	29.7%	29.9%	30.1%	30.2%
Native American Population (in thousands)	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.2%
Asian and Pacific Islander Population (in thousands)	1.2%	1.3%	1.3%	1.4%	1.4%	1.4%	1.4%	1.5%	1.6%	1.7%	2.0%
Hispanic or Latino Population (in thousands)	1.8%	2.7%	2.8%	2.8%	2.9%	2.9%	3.0%	3.2%	3.7%	4.1%	5.0%
Male Population (in thousands)	48.3%	48.5%	48.5%	48.5%	48.5%	48.5%	48.5%	48.6%	48.7%	48.7%	48.7%
Total Employment (in thousands of jobs)	363.84	369.87	373.47	378.59	384.36	390.18	396.12	420.72	460.50	496.54	577.46
Farm Employment	1.4%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.2%	1.1%	0.9%
Forestry, Fishing, Related Activities	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%
Mining	0.3%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.4%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Construction	8.5%	7.8%	7.2%	7.1%	7.1%	7.1%	7.1%	7.0%	6.8%	6.6%	6.3%
Manufacturing	8.7%	7.1%	7.0%	6.9%	6.8%	6.6%	6.5%	5.9%	5.2%	4.6%	3.7%
Wholesale Trade	3.5%	3.3%	3.4%	3.3%	3.3%	3.3%	3.3%	3.1%	3.0%	2.8%	2.5%
Retail Trade	12.4%	11.8%	11.9%	11.9%	11.8%	11.7%	11.7%	11.4%	11.1%	10.7%	10.0%
Transportation and Warehousing	3.7%	3.6%	3.6%	3.6%	3.5%	3.5%	3.5%	3.4%	3.2%	3.1%	2.8%
Information Employment	1.3%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%	0.8%
Finance and Insurance	3.4%	4.2%	4.4%	4.4%	4.4%	4.4%	4.5%	4.6%	4.7%	4.8%	4.9%
Real Estate / Rental and Lease	4.4%	4.7%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.7%	4.6%

Table 4-27. Demographic and Employment Baseline Projections for Economic Impact Area AL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	4.4%	4.6%	4.6%	4.6%	4.7%	4.7%	4.7%	4.8%	4.9%	5.0%	5.1%
Management	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%
Administrative and Waste Services	6.4%	6.9%	7.2%	7.3%	7.4%	7.5%	7.6%	8.1%	8.8%	9.5%	10.8%
Educational Services	1.4%	1.7%	1.7%	1.7%	1.7%	1.8%	1.8%	1.9%	2.0%	2.1%	2.4%
Health Care and Social Assistance	8.5%	9.2%	9.2%	9.3%	9.4%	9.5%	9.6%	10.0%	10.6%	11.1%	12.1%
Arts, Entertainment, and Recreation	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Accommodation and Food Services	6.8%	7.6%	7.8%	7.9%	8.0%	8.0%	8.1%	8.4%	8.8%	9.1%	9.8%
Other Services, Except Public Administration	7.7%	8.0%	8.0%	8.1%	8.1%	8.2%	8.3%	8.5%	8.9%	9.1%	9.7%
Federal Civilian Government	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%	0.6%
Federal Military	1.3%	1.2%	1.2%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
State and Local Government	12.0%	11.5%	11.3%	11.2%	11.1%	11.0%	11.0%	10.7%	10.2%	9.8%	9.1%
Total Earnings (in millions of 2005 dollars)	12,929	13,356	13,406	13,645	13,958	14,279	14,606	15,991	18,316	20,507	25,712
Farm	0.8%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Forestry, Fishing, Related Activities	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%
Mining	0.4%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%
Utilities	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%
Construction	8.9%	7.8%	7.0%	7.0%	6.9%	6.9%	6.8%	6.6%	6.2%	5.9%	5.2%
Manufacturing	13.6%	12.1%	12.3%	12.1%	12.0%	11.8%	11.7%	11.1%	10.2%	9.5%	8.1%
Wholesale Trade	5.1%	5.0%	5.2%	5.2%	5.2%	5.1%	5.1%	5.0%	4.8%	4.6%	4.3%
Retail Trade	8.9%	8.1%	8.1%	8.0%	7.9%	7.9%	7.8%	7.4%	6.8%	6.4%	5.5%
Transportation and Warehousing	4.8%	5.0%	5.0%	4.9%	4.9%	4.8%	4.8%	4.6%	4.3%	4.1%	3.6%
Information	1.6%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Finance and Insurance	4.9%	5.7%	6.4%	6.5%	6.5%	6.6%	6.7%	6.9%	7.2%	7.5%	8.0%
Real Estate / Rental and Lease	2.3%	1.7%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%
Professional and Technical Services	5.5%	6.1%	6.0%	6.1%	6.1%	6.2%	6.3%	6.5%	6.9%	7.2%	7.8%
Management	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.6%	0.8%
Administrative and Waste Services	3.7%	3.9%	4.0%	4.1%	4.2%	4.2%	4.3%	4.6%	5.2%	5.6%	6.6%
Educational Services	0.9%	1.0%	1.0%	1.0%	1.0%	1.1%	1.1%	1.2%	1.3%	1.4%	1.6%

Table 4-27. Demographic and Employment Baseline Projections for Economic Impact Area AL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	9.9%	11.0%	10.9%	11.0%	11.2%	11.3%	11.5%	12.1%	13.0%	13.7%	15.3%
Arts, Entertainment, and Recreation	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Accommodation and Food Services	3.2%	3.4%	3.5%	3.6%	3.6%	3.6%	3.7%	3.8%	4.0%	4.2%	4.6%
Other Services, Except Public Administration	4.8%	4.9%	4.9%	5.0%	5.0%	5.0%	5.1%	5.2%	5.5%	5.6%	6.0%
Federal Civilian Government	2.2%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%
Federal Military	1.8%	1.9%	1.9%	1.5%	1.5%	1.5%	1.5%	1.5%	1.6%	1.6%	1.6%
State and Local Government	13.8%	14.9%	14.6%	14.6%	14.6%	14.5%	14.5%	14.4%	14.1%	13.9%	13.3%
Total Personal Income per Capita (in 2005 dollars)	26,923	28,692	29,258	29,222	29,448	29,779	30,177	32,106	35,612	39,054	47,421
Woods & Poole Economics Wealth Index (U.S. = 100)	68.7	70.9	71.0	70.8	71.0	71.1	71.3	71.7	72.2	72.6	73.1
Persons per Household (in number of people)	2.5	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6
Mean Household Total Personal Income (in 2005$)	68,479	73,703	74,889	74,479	74,731	75,212	75,880	79,999	88,990	98,466	121,943
Number of Households (in thousands)	272.33	282.60	285.94	289.62	293.39	297.34	301.24	314.63	329.97	340.36	359.62
Income < $10,000 (thousands of households, 2000$)	13.4%	11.8%	11.5%	11.3%	11.2%	11.0%	10.8%	9.7%	8.0%	6.8%	4.8%
Income $10,000 to $19,999	14.6%	13.1%	12.8%	12.6%	12.4%	12.2%	12.1%	10.9%	9.1%	7.8%	5.6%
Income $20,000 to $29,999	13.1%	11.8%	11.6%	11.4%	11.3%	11.1%	11.0%	9.9%	8.4%	7.2%	5.1%
Income $30,000 to $44,999	18.8%	18.4%	18.2%	18.0%	17.9%	17.7%	17.5%	16.1%	13.7%	11.8%	8.4%
Income $45,000 to $59,999	14.8%	16.5%	16.9%	17.1%	17.3%	17.5%	17.8%	19.0%	19.6%	18.1%	13.4%
Income $60,000 to $74,999	9.5%	10.6%	10.9%	11.1%	11.2%	11.4%	11.6%	12.8%	15.4%	17.9%	19.1%
Income $75,000 to $99,999	8.3%	9.3%	9.5%	9.7%	9.8%	10.0%	10.1%	11.3%	13.5%	15.9%	22.6%
Income $100,000 or more	7.5%	8.4%	8.6%	8.7%	8.9%	9.0%	9.2%	10.2%	12.3%	14.5%	21.0%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-28

Demographic and Employment Baseline Projections for Economic Impact Area FL-1

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	861.80	882.64	894.95	907.59	920.37	933.24	946.15	998.49	1,078.03	1,144.07	1,275.33
Age Under 19 Years	26.2%	25.0%	24.7%	24.5%	24.4%	24.4%	24.4%	24.7%	24.9%	24.7%	24.0%
Age 20 to 34	20.2%	20.4%	20.8%	21.0%	21.0%	20.9%	20.7%	19.7%	17.8%	17.4%	18.6%
Age 35 to 49	22.5%	20.2%	19.6%	19.1%	18.6%	18.2%	18.0%	18.2%	19.3%	19.8%	17.3%
Age 50 to 64	18.0%	20.0%	20.4%	20.6%	20.6%	20.8%	20.8%	20.2%	18.0%	16.2%	17.7%
Age 65 and over	13.1%	14.3%	14.5%	14.9%	15.4%	15.7%	16.1%	17.3%	19.9%	21.9%	22.2%
Median Age of Population (years)	39.4	40.3	40.4	40.5	40.6	40.6	40.6	40.8	41.5	42.2	42.2
White Population (in thousands)	79.4%	78.0%	77.8%	77.6%	77.4%	77.2%	77.0%	76.2%	74.9%	73.7%	71.3%
Black Population (in thousands)	13.5%	13.8%	13.8%	13.8%	13.9%	13.9%	14.0%	14.2%	14.4%	14.6%	15.0%
Native American Population (in thousands)	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%
Asian and Pacific Islander Population (in thousands)	2.4%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%	2.2%
Hispanic or Latino Population (in thousands)	3.9%	5.1%	5.3%	5.4%	5.6%	5.7%	5.9%	6.5%	7.6%	8.7%	11.0%
Male Population (in thousands)	49.9%	50.2%	50.2%	50.3%	50.3%	50.4%	50.4%	50.5%	50.8%	50.9%	51.3%
Total Employment (in thousands of jobs)	487.45	475.97	478.36	484.81	491.97	499.21	506.56	536.85	585.25	628.44	723.31
Farm Employment	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	0.2%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Utilities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%
Construction	9.0%	6.1%	5.7%	5.7%	5.7%	5.7%	5.6%	5.6%	5.4%	5.3%	5.1%
Manufacturing	3.4%	2.9%	2.8%	2.8%	2.7%	2.6%	2.6%	2.4%	2.0%	1.8%	1.4%
Wholesale Trade	2.6%	2.3%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%	2.0%	2.0%	1.8%
Retail Trade	12.0%	11.9%	12.1%	12.1%	12.1%	12.1%	12.0%	12.0%	11.8%	11.7%	11.3%
Transportation and Warehousing	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	1.9%	1.9%	1.9%	2.0%	2.0%
Information Employment	1.9%	1.6%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%
Finance and Insurance	3.6%	4.3%	4.3%	4.4%	4.4%	4.4%	4.4%	4.5%	4.7%	4.8%	5.1%
Real Estate/Rental and Lease	5.5%	5.0%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.2%	5.2%	5.3%

Table 4-28. Demographic and Employment Baseline Projections for Economic Impact Area FL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	5.2%	5.8%	5.9%	5.9%	6.0%	6.1%	6.1%	6.4%	6.8%	7.2%	8.0%
Management	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Administrative and Waste Services	7.0%	6.7%	6.8%	6.9%	7.0%	7.0%	7.1%	7.3%	7.7%	8.0%	8.6%
Educational Services	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.3%
Health Care and Social Assistance	8.9%	10.0%	9.9%	9.9%	10.0%	10.0%	10.1%	10.3%	10.5%	10.8%	11.2%
Arts, Entertainment, and Recreation	1.7%	2.0%	2.1%	2.1%	2.1%	2.1%	2.2%	2.2%	2.3%	2.4%	2.6%
Accommodation and Food Services	8.8%	10.1%	10.6%	10.6%	10.7%	10.7%	10.8%	10.9%	11.2%	11.3%	11.7%
Other Services, Except Public Administration	6.2%	6.3%	6.2%	6.2%	6.2%	6.3%	6.3%	6.4%	6.5%	6.6%	6.8%
Federal Civilian Government	3.5%	3.6%	3.6%	3.6%	3.6%	3.5%	3.5%	3.3%	3.1%	3.0%	2.6%
Federal Military	6.9%	7.0%	6.9%	6.8%	6.7%	6.6%	6.5%	6.2%	5.7%	5.3%	4.6%
State and Local Government	9.1%	9.3%	8.9%	8.9%	8.8%	8.8%	8.7%	8.5%	8.2%	7.9%	7.4%
Total Earnings (in millions of 2005 dollars)	19,145	18,966	19,160	19,669	20,150	20,642	21,146	23,280	26,873	30,269	38,353
Farm	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Forestry, Fishing, Related Activities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%
Utilities	0.5%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%
Construction	8.1%	5.0%	4.6%	4.6%	4.5%	4.5%	4.4%	4.2%	3.9%	3.7%	3.3%
Manufacturing	4.8%	4.4%	4.4%	4.3%	4.2%	4.2%	4.1%	3.8%	3.5%	3.2%	2.6%
Wholesale Trade	3.0%	2.7%	2.7%	2.6%	2.6%	2.6%	2.6%	2.5%	2.5%	2.4%	2.3%
Retail Trade	7.9%	7.2%	7.5%	7.3%	7.3%	7.2%	7.1%	6.8%	6.3%	6.0%	5.2%
Transportation and Warehousing	1.8%	2.0%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.0%	2.0%
Information	2.4%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.1%	2.1%
Finance and Insurance	3.9%	3.9%	4.1%	4.1%	4.1%	4.1%	4.2%	4.3%	4.5%	4.6%	4.9%
Real Estate / Rental and Lease	3.1%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
Professional and Technical Services	6.6%	7.9%	8.6%	8.7%	8.8%	9.0%	9.1%	9.7%	10.7%	11.5%	13.3%
Management	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	1.0%	1.1%	1.1%	1.2%
Administrative and Waste Services	4.5%	4.3%	4.6%	4.7%	4.7%	4.8%	4.9%	5.1%	5.4%	5.7%	6.3%
Educational Services	0.7%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%

Table 4-28. Demographic and Employment Baseline Projections for Economic Impact Area FL-1 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	10.0%	11.2%	11.2%	11.2%	11.3%	11.3%	11.4%	11.6%	12.0%	12.3%	12.8%
Arts, Entertainment, and Recreation	0.6%	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.8%
Accommodation and Food Services	4.6%	4.9%	5.2%	5.2%	5.2%	5.3%	5.3%	5.3%	5.4%	5.5%	5.6%
Other Services, Except Public Administration	4.4%	4.1%	4.1%	4.1%	4.1%	4.2%	4.2%	4.2%	4.2%	4.3%	4.3%
Federal Civilian Government	6.8%	7.7%	7.2%	7.2%	7.1%	7.1%	7.1%	6.9%	6.7%	6.5%	6.1%
Federal Military	14.5%	16.8%	16.5%	16.6%	16.5%	16.5%	16.4%	16.1%	15.7%	15.4%	14.7%
State and Local Government	10.5%	10.8%	10.2%	10.2%	10.1%	10.1%	10.1%	9.9%	9.7%	9.5%	9.0%
Total Personal Income per Capita (in 2005 dollars)	31,073	32,887	33,322	33,192	33,305	33,561	33,905	35,709	39,118	42,516	50,840
Woods & Poole Economics Wealth Index (U.S. = 100)	85.9	87.7	87.1	86.7	86.5	86.4	86.4	86.3	86.3	86.4	86.7
Persons per Household (in number of people)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.6
Mean Household Total Personal Income (in 2005 dollars)	78,593	83,780	84,588	83,933	83,877	84,141	84,654	88,455	97,347	106,910	130,791
Number of Households (in thousands)	340.73	346.48	352.55	358.91	365.45	372.23	378.94	403.09	433.20	454.98	495.74
Income < $10,000 (thousands of households, 2000$)	8.6%	7.7%	7.5%	7.4%	7.3%	7.2%	7.1%	6.4%	5.4%	4.6%	3.3%
Income $10,000 to $19,999	12.3%	11.0%	10.7%	10.6%	10.5%	10.3%	10.2%	9.2%	7.7%	6.7%	4.8%
Income $20,000 to $29,999	13.7%	12.2%	11.9%	11.8%	11.7%	11.5%	11.3%	10.3%	8.6%	7.4%	5.3%
Income $30,000 to $44,999	19.6%	18.1%	17.7%	17.6%	17.3%	17.1%	16.9%	15.3%	12.9%	11.1%	7.9%
Income $45,000 to $59,999	16.6%	18.3%	18.6%	18.8%	18.9%	19.1%	19.2%	19.7%	18.6%	16.4%	11.8%
Income $60,000 to $74,999	11.3%	12.7%	13.0%	13.1%	13.3%	13.5%	13.7%	15.1%	18.1%	20.4%	19.8%
Income $75,000 to $99,999	9.3%	10.3%	10.6%	10.7%	10.8%	11.0%	11.1%	12.3%	14.8%	17.2%	24.1%
Income $100,000 or more	8.7%	9.7%	10.0%	10.1%	10.2%	10.4%	10.5%	11.6%	14.0%	16.3%	23.0%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-29

Demographic and Employment Baseline Projections for Economic Impact Area FL-2

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	619.13	660.01	667.83	675.90	684.08	692.32	700.61	734.26	785.55	828.12	912.75
Age Under 19 Years	25.5%	25.1%	24.3%	23.9%	23.8%	23.8%	23.9%	24.2%	24.1%	23.9%	23.3%
Age 20 to 34	24.4%	23.9%	24.6%	24.8%	24.6%	24.3%	23.9%	22.1%	19.7%	19.1%	19.8%
Age 35 to 49	21.0%	19.1%	18.8%	18.5%	18.3%	18.2%	18.1%	18.9%	20.7%	21.2%	17.8%
Age 50 to 64	17.5%	19.2%	19.4%	19.3%	19.3%	19.3%	19.3%	18.4%	16.8%	16.1%	19.0%
Age 65 and over	11.7%	12.7%	13.0%	13.5%	13.9%	14.4%	14.8%	16.4%	18.5%	19.7%	20.1%
Median Age of Population (years)	37.9	39.2	39.4	39.7	39.8	40.0	40.2	40.7	41.7	42.6	43.0
White Population (in thousands)	66.7%	65.5%	65.2%	65.0%	64.7%	64.5%	64.2%	63.2%	61.5%	60.1%	57.5%
Black Population (in thousands)	26.8%	26.9%	27.0%	27.2%	27.3%	27.5%	27.6%	28.2%	29.1%	29.9%	31.4%
Native American Population (in thousands)	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Asian and Pacific Islander Population (in thousands)	1.4%	1.6%	1.6%	1.6%	1.6%	1.7%	1.7%	1.8%	1.9%	1.9%	2.0%
Hispanic or Latino Population (in thousands)	4.6%	5.6%	5.7%	5.8%	5.9%	6.0%	6.1%	6.5%	7.1%	7.7%	8.7%
Male Population (in thousands)	50.4%	50.9%	51.0%	51.0%	51.1%	51.2%	51.2%	51.4%	51.6%	51.7%	51.9%
Total Employment (in thousands of jobs)	322.62	317.69	314.73	318.31	322.52	326.77	331.07	348.86	377.27	402.75	459.46
Farm Employment	2.6%	2.8%	2.8%	2.7%	2.7%	2.7%	2.6%	2.5%	2.3%	2.1%	1.9%
Forestry, Fishing, Related Activities	1.3%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Mining	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Utilities	0.4%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Construction	6.5%	4.7%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.3%	4.3%	4.2%
Manufacturing	4.6%	3.7%	3.6%	3.6%	3.6%	3.5%	3.5%	3.3%	3.0%	2.8%	2.4%
Wholesale Trade	2.1%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.7%	1.6%
Retail Trade	11.0%	10.3%	10.4%	10.4%	10.4%	10.4%	10.4%	10.4%	10.4%	10.4%	10.2%
Transportation and Warehousing	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%
Information Employment	1.8%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.3%
Finance and Insurance	3.2%	3.8%	3.9%	3.9%	3.9%	3.9%	3.9%	3.8%	3.8%	3.7%	3.6%
Real Estate / Rental and Lease	3.1%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.8%	2.8%	2.6%

Table 4-29. Demographic and Employment Baseline Projections for Economic Impact Area FL-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	5.8%	6.4%	6.7%	6.8%	6.9%	6.9%	7.0%	7.4%	7.9%	8.3%	9.1%
Management	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.4%	0.4%
Administrative and Waste Services	4.8%	5.0%	5.2%	5.2%	5.2%	5.3%	5.3%	5.4%	5.6%	5.8%	6.2%
Educational Services	1.1%	1.5%	1.5%	1.5%	1.6%	1.6%	1.7%	1.9%	2.3%	2.6%	3.5%
Health Care and Social Assistance	8.6%	9.8%	9.8%	9.8%	9.9%	10.0%	10.0%	10.3%	10.6%	10.9%	11.4%
Arts, Entertainment, and Recreation	1.2%	1.4%	1.5%	1.5%	1.5%	1.5%	1.6%	1.6%	1.7%	1.8%	1.9%
Accommodation and Food Services	6.6%	7.4%	7.6%	7.6%	7.7%	7.8%	7.8%	8.1%	8.4%	8.7%	9.3%
Other Services, Except Public Administration	6.2%	6.1%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	5.9%	5.9%	5.8%
Federal Civilian Government	1.2%	1.3%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.1%	1.0%	0.9%
Federal Military	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
State and Local Government	25.3%	25.3%	24.7%	24.6%	24.4%	24.3%	24.1%	23.5%	22.6%	21.8%	20.2%
Total Earnings (in millions of 2005 dollars)	11,928	11,797	11,847	12,084	12,357	12,636	12,921	14,122	16,124	17,997	22,405
Farm	1.3%	0.8%	0.8%	1.0%	1.0%	0.9%	0.9%	0.9%	0.8%	0.8%	0.7%
Forestry, Fishing, Related Activities	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%
Utilities	0.8%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Construction	6.4%	4.4%	4.1%	4.0%	4.0%	4.0%	3.9%	3.8%	3.6%	3.4%	3.1%
Manufacturing	5.9%	5.2%	5.2%	5.2%	5.1%	5.1%	5.1%	5.0%	4.8%	4.6%	4.3%
Wholesale Trade	2.7%	2.3%	2.3%	2.4%	2.4%	2.4%	2.3%	2.3%	2.2%	2.1%	2.0%
Retail Trade	7.2%	6.7%	6.9%	6.9%	6.8%	6.8%	6.7%	6.5%	6.1%	5.8%	5.2%
Transportation and Warehousing	1.5%	1.4%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.3%	1.2%
Information	2.4%	2.2%	2.2%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.4%	2.4%
Finance and Insurance	4.2%	4.5%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
Real Estate / Rental and Lease	1.1%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%
Professional and Technical Services	7.9%	8.5%	8.8%	8.9%	9.0%	9.1%	9.3%	9.8%	10.7%	11.4%	13.0%
Management	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.8%
Administrative and Waste Services	2.8%	2.7%	2.8%	2.8%	2.8%	2.8%	2.9%	3.0%	3.1%	3.3%	3.6%
Educational Services	0.5%	0.7%	0.7%	0.7%	0.7%	0.8%	0.8%	0.9%	1.1%	1.3%	1.8%

Table 4-29. Demographic and Employment Baseline Projections for Economic Impact Area FL-2 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	9.5%	11.2%	11.3%	11.4%	11.5%	11.5%	11.6%	11.9%	12.3%	12.7%	13.3%
Arts, Entertainment, and Recreation	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%
Accommodation and Food Services	2.7%	3.0%	3.2%	3.2%	3.2%	3.2%	3.3%	3.4%	3.5%	3.6%	3.9%
Other Services, Except Public Administration	5.2%	5.0%	4.9%	4.9%	4.9%	4.9%	4.9%	4.8%	4.8%	4.7%	4.6%
Federal Civilian Government	2.7%	3.1%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%	2.8%	2.7%
Federal Military	0.5%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
State and Local Government	32.3%	33.9%	33.2%	33.1%	33.0%	32.9%	32.8%	32.3%	31.5%	30.8%	29.3%
Total Personal Income per Capita (in 2005 dollars)	26,967	27,328	27,699	27,633	27,735	27,943	28,216	29,624	32,258	34,871	41,243
Woods & Poole Economics Wealth Index (U.S. = 100)	66.4	66.7	66.6	66.7	66.7	66.6	66.5	66.2	65.8	65.4	64.7
Persons per Household (in number of people)	2.6	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.7
Mean Household Total Personal Income (in 2005 dollars)	70,426	72,591	73,342	72,882	72,869	73,092	73,512	76,590	83,807	91,537	110,692
Number of Households (in thousands)	237.07	248.47	252.22	256.26	260.38	264.68	268.91	284.00	302.36	315.47	340.09
Income < $10,000 (thousands of households, 2000$)	13.7%	12.5%	12.2%	12.1%	11.9%	11.7%	11.6%	10.8%	9.1%	7.9%	5.9%
Income $10,000 to $19,999	14.3%	13.1%	12.8%	12.7%	12.5%	12.3%	12.1%	11.3%	9.5%	8.2%	6.1%
Income $20,000 to $29,999	13.9%	12.7%	12.5%	12.3%	12.2%	12.0%	11.8%	11.0%	9.3%	8.0%	6.0%
Income $30,000 to $44,999	18.7%	18.6%	18.5%	18.4%	18.3%	18.2%	18.1%	17.4%	14.9%	12.8%	9.4%
Income $45,000 to $59,999	14.1%	15.5%	15.8%	16.0%	16.2%	16.5%	16.7%	17.7%	19.4%	19.2%	15.4%
Income $60,000 to $74,999	9.3%	10.2%	10.4%	10.6%	10.7%	10.9%	11.0%	11.8%	14.1%	16.4%	20.2%
Income $75,000 to $99,999	8.1%	8.9%	9.1%	9.2%	9.3%	9.4%	9.6%	10.3%	12.2%	14.2%	19.2%
Income $100,000 or more	7.7%	8.4%	8.6%	8.7%	8.8%	9.0%	9.1%	9.7%	11.5%	13.3%	17.8%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-30

Demographic and Employment Baseline Projections for Economic Impact Area FL-3

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	3,435.22	3,627.12	3,688.14	3,750.54	3,813.50	3,876.76	3,940.23	4,196.90	4,586.14	4,909.33	5,552.03
Age Under 19 Years	24.1%	23.3%	23.1%	23.0%	22.9%	22.9%	22.9%	23.0%	23.1%	23.2%	23.4%
Age 20 to 34	18.5%	18.5%	18.8%	19.0%	19.1%	19.2%	19.1%	18.9%	18.3%	18.0%	18.5%
Age 35 to 49	21.4%	19.9%	19.5%	19.0%	18.7%	18.4%	18.1%	17.8%	18.1%	18.6%	18.0%
Age 50 to 64	18.5%	20.1%	20.4%	20.4%	20.4%	20.4%	20.5%	19.9%	18.3%	16.7%	16.7%
Age 65 and over	17.5%	18.1%	18.2%	18.6%	18.9%	19.2%	19.4%	20.4%	22.3%	23.5%	23.4%
Median Age of Population (years)	41.5	42.9	43.0	43.2	43.3	43.5	43.6	43.9	43.9	44.0	43.7
White Population (in thousands)	74.3%	70.6%	70.0%	69.4%	68.9%	68.3%	67.8%	65.5%	62.2%	59.3%	53.4%
Black Population (in thousands)	11.3%	11.9%	12.0%	12.1%	12.1%	12.2%	12.3%	12.6%	13.0%	13.3%	13.9%
Native American Population (in thousands)	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Asian and Pacific Islander Population (in thousands)	2.4%	2.9%	3.0%	3.0%	3.1%	3.2%	3.2%	3.5%	3.9%	4.3%	5.0%
Hispanic or Latino Population (in thousands)	11.7%	14.4%	14.8%	15.2%	15.6%	16.1%	16.5%	18.1%	20.7%	22.9%	27.5%
Male Population (in thousands)	48.6%	48.6%	48.6%	48.6%	48.7%	48.7%	48.8%	48.9%	49.1%	49.1%	49.2%
Total Employment (in thousands of jobs)	1,944.15	1,836.01	1,837.13	1,865.09	1,897.15	1,929.67	1,962.67	2,099.53	2,320.20	2,519.25	2,962.99
Farm Employment	1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.0%	1.0%	0.9%	0.8%
Forestry, Fishing, Related Activities	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%
Utilities	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.3%
Construction	7.3%	5.0%	4.7%	4.8%	4.8%	4.8%	4.8%	5.0%	5.1%	5.2%	5.5%
Manufacturing	5.0%	4.2%	4.2%	4.1%	4.1%	4.0%	3.9%	3.7%	3.4%	3.1%	2.7%
Wholesale Trade	3.4%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.2%	3.2%	3.1%
Retail Trade	11.4%	11.2%	11.3%	11.3%	11.3%	11.3%	11.4%	11.5%	11.6%	11.7%	11.8%
Transportation and Warehousing	2.3%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Information Employment	2.2%	2.0%	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.7%	1.6%
Finance and Insurance	5.8%	6.9%	6.9%	6.9%	6.9%	6.8%	6.8%	6.7%	6.5%	6.4%	6.0%
Real Estate / Rental and Lease	4.5%	4.3%	4.4%	4.4%	4.4%	4.3%	4.3%	4.2%	4.1%	3.9%	3.7%

Table 4-30. Demographic and Employment Baseline Projections for Economic Impact Area FL-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	6.4%	7.4%	7.6%	7.6%	7.6%	7.6%	7.7%	7.7%	7.8%	7.8%	7.9%
Management	0.8%	1.1%	1.2%	1.2%	1.2%	1.2%	1.2%	1.3%	1.3%	1.4%	1.5%
Administrative and Waste Services	10.8%	7.8%	7.7%	7.8%	7.9%	8.0%	8.1%	8.6%	9.2%	9.9%	11.2%
Educational Services	1.3%	1.7%	1.6%	1.7%	1.7%	1.7%	1.7%	1.8%	1.9%	2.0%	2.2%
Health Care and Social Assistance	10.3%	12.1%	12.1%	12.1%	12.2%	12.2%	12.2%	12.4%	12.6%	12.7%	12.9%
Arts, Entertainment, and Recreation	2.0%	2.5%	2.7%	2.7%	2.7%	2.8%	2.8%	2.8%	2.9%	3.0%	3.2%
Accommodation and Food Services	6.8%	7.5%	7.6%	7.6%	7.5%	7.5%	7.5%	7.4%	7.2%	7.1%	6.8%
Other Services, Except Public Administration	5.9%	5.9%	5.7%	5.7%	5.7%	5.7%	5.7%	5.8%	5.9%	5.9%	6.0%
Federal Civilian Government	1.3%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.3%	1.2%
Federal Military	0.7%	0.8%	0.8%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.6%	0.5%
State and Local Government	9.9%	10.5%	10.3%	10.2%	10.1%	10.1%	10.0%	9.7%	9.3%	9.0%	8.3%
Total Earnings (in millions of 2005 dollars)	79,115	75,732	76,230	78,164	80,283	82,456	84,684	94,161	110,241	125,561	162,390
Farm	0.5%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%	0.3%
Forestry, Fishing, Related Activities	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.2%
Mining	0.3%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.7%
Utilities	0.9%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.8%
Construction	7.5%	5.0%	4.6%	4.6%	4.6%	4.6%	4.6%	4.5%	4.4%	4.4%	4.2%
Manufacturing	6.8%	6.1%	5.9%	5.9%	5.9%	5.8%	5.8%	5.6%	5.3%	5.0%	4.5%
Wholesale Trade	4.9%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
Retail Trade	8.3%	7.5%	7.5%	7.5%	7.4%	7.4%	7.3%	7.1%	6.8%	6.5%	6.0%
Transportation and Warehousing	2.3%	2.0%	2.0%	2.0%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%
Information	3.3%	3.1%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.1%
Finance and Insurance	8.0%	7.8%	8.0%	8.0%	8.0%	8.0%	7.9%	7.8%	7.6%	7.4%	7.1%
Real Estate / Rental and Lease	2.3%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.5%	1.5%	1.4%	1.3%
Professional and Technical Services	8.1%	9.7%	10.1%	10.2%	10.2%	10.3%	10.3%	10.5%	10.8%	11.0%	11.4%
Management	1.6%	2.3%	2.5%	2.6%	2.6%	2.7%	2.7%	2.9%	3.3%	3.6%	4.3%
Administrative and Waste Services	7.1%	5.0%	5.0%	5.1%	5.2%	5.2%	5.3%	5.7%	6.2%	6.7%	7.8%
Educational Services	0.8%	1.1%	1.1%	1.1%	1.1%	1.1%	1.2%	1.2%	1.3%	1.4%	1.6%

Table 4-30. Demographic and Employment Baseline Projections for Economic Impact Area FL-3 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	12.1%	14.4%	14.4%	14.4%	14.5%	14.5%	14.6%	14.8%	15.0%	15.2%	15.5%
Arts, Entertainment, and Recreation	1.5%	1.7%	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%
Accommodation and Food Services	3.9%	4.1%	4.2%	4.2%	4.2%	4.2%	4.2%	4.1%	4.0%	3.9%	3.7%
Other Services, Except Public Administration	4.0%	3.8%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%	3.7%
Federal Civilian Government	2.7%	3.5%	3.4%	3.4%	3.4%	3.4%	3.4%	3.3%	3.3%	3.3%	3.2%
Federal Military	1.2%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.3%
State and Local Government	11.8%	13.0%	12.6%	12.6%	12.5%	12.4%	12.4%	12.1%	11.8%	11.5%	10.8%
Total Personal Income per Capita (in 2005 dollars)	33,038	33,094	33,458	33,277	33,361	33,603	33,943	35,779	39,308	42,864	51,665
Woods & Poole Economics Wealth Index (U.S.=100)	78.9	78.5	77.9	78.0	77.9	77.9	77.8	77.8	77.8	78.0	78.4
Persons per Household (in number of people)	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.4	2.4	2.4
Mean Household Total Personal Income (in 2005$)	78,298	80,154	80,736	79,958	79,810	80,006	80,459	84,037	92,602	101,904	125,355
Number of Households (in thousands)	1,450	1,498	1,528	1,561	1,594	1,628	1,662	1,787	1,947	2,065	2,288
Income < $10,000 (thousands of households, 2000$)	9.0%	8.2%	8.1%	8.0%	7.9%	7.8%	7.6%	7.0%	5.9%	5.1%	3.7%
Income $10,000 to $19,999	13.6%	12.4%	12.2%	12.1%	11.9%	11.8%	11.6%	10.6%	8.9%	7.7%	5.6%
Income $20,000 to $29,999	14.5%	13.3%	13.0%	12.9%	12.7%	12.5%	12.4%	11.3%	9.5%	8.2%	6.0%
Income $30,000 to $44,999	19.6%	18.8%	18.6%	18.5%	18.3%	18.1%	17.9%	16.5%	14.0%	12.1%	8.8%
Income $45,000 to $59,999	15.3%	16.7%	17.0%	17.2%	17.4%	17.6%	17.8%	18.8%	19.3%	18.1%	13.5%
Income $60,000 to $74,999	9.9%	10.8%	11.0%	11.1%	11.3%	11.5%	11.6%	12.8%	15.2%	17.4%	19.2%
Income $75,000 to $99,999	8.5%	9.3%	9.5%	9.6%	9.7%	9.8%	10.0%	10.9%	13.0%	14.9%	20.7%
Income $100,000 or more	9.6%	10.4%	10.6%	10.7%	10.8%	10.9%	11.1%	12.1%	14.3%	16.4%	22.6%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-31

Demographic and Employment Baseline Projections for Economic Impact Area FL-4

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Total Population (in thousands)	5,934.95	6,173.13	6,255.79	6,340.82	6,426.81	6,513.36	6,600.26	6,952.71	7,488.55	7,933.26	8,817.05
Age Under 19 Years	24.9%	23.4%	23.3%	23.1%	22.9%	22.8%	22.8%	22.5%	22.3%	22.3%	22.1%
Age 20 to 34	18.3%	18.3%	18.4%	18.5%	18.6%	18.7%	18.7%	18.6%	18.0%	17.5%	17.2%
Age 35 to 49	22.2%	21.1%	20.8%	20.4%	20.0%	19.6%	19.2%	18.5%	18.3%	18.6%	17.9%
Age 50 to 64	17.8%	19.3%	19.5%	19.6%	19.8%	19.9%	20.1%	19.9%	19.0%	17.4%	16.7%
Age 65 and over	16.8%	17.8%	18.0%	18.4%	18.7%	19.0%	19.2%	20.4%	22.4%	24.2%	26.0%
Median Age of Population (years)	43.8	45.4	45.6	45.8	45.9	46.0	46.1	46.4	46.4	46.2	45.8
White Population (in thousands)	46.3%	42.5%	41.9%	41.4%	40.9%	40.3%	39.8%	37.9%	35.1%	32.7%	28.5%
Black Population (in thousands)	16.7%	16.8%	16.9%	16.9%	16.9%	17.0%	17.0%	17.2%	17.4%	17.6%	17.9%
Native American Population (in thousands)	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%
Asian and Pacific Islander Population (in thousands)	1.8%	2.0%	2.0%	2.0%	2.1%	2.1%	2.1%	2.2%	2.4%	2.5%	2.7%
Hispanic or Latino Population (in thousands)	35.1%	38.5%	39.0%	39.5%	40.0%	40.4%	40.9%	42.5%	45.0%	47.0%	50.7%
Male Population (in thousands)	48.6%	48.6%	48.6%	48.6%	48.6%	48.6%	48.6%	48.5%	48.5%	48.4%	48.1%
Total Employment (in thousands of jobs)	3,395.35	3,306.18	3,330.93	3,382.52	3,439.80	3,497.84	3,556.64	3,799.78	4,189.08	4,537.36	5,304.35
Farm Employment	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%
Forestry, Fishing, Related Activities	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%
Mining	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.4%
Utilities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
Construction	8.0%	5.2%	4.9%	4.9%	4.9%	4.9%	4.9%	5.0%	5.0%	5.1%	5.2%
Manufacturing	3.6%	2.9%	2.8%	2.8%	2.7%	2.7%	2.6%	2.4%	2.1%	1.9%	1.5%
Wholesale Trade	4.5%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.3%
Retail Trade	11.2%	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%	10.8%	10.8%	10.6%
Transportation and Warehousing	3.8%	3.7%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.7%	3.7%	3.6%
Information Employment	2.0%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.5%	1.4%
Finance and Insurance	5.0%	5.9%	5.9%	5.9%	5.9%	5.9%	5.8%	5.7%	5.6%	5.5%	5.2%
Real Estate / Rental and Lease	6.0%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.5%	5.4%	5.3%	5.1%

Table 4-31. Demographic and Employment Baseline Projections for Economic Impact Area FL-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Professional and Technical Services	6.5%	6.8%	6.9%	6.9%	6.9%	6.8%	6.8%	6.8%	6.7%	6.7%	6.6%
Management	0.7%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Administrative and Waste Services	9.0%	7.8%	7.7%	7.8%	7.8%	7.9%	8.0%	8.2%	8.6%	9.0%	9.7%
Educational Services	1.8%	2.4%	2.4%	2.4%	2.5%	2.5%	2.5%	2.7%	2.9%	3.1%	3.6%
Health Care and Social Assistance	9.1%	10.9%	11.0%	11.1%	11.1%	11.2%	11.3%	11.5%	11.9%	12.2%	12.7%
Arts, Entertainment, and Recreation	2.2%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.4%	2.4%	2.4%	2.3%
Accommodation and Food Services	7.2%	8.3%	8.6%	8.6%	8.6%	8.5%	8.5%	8.4%	8.3%	8.2%	7.9%
Other Services, Except Public Administration	7.7%	8.4%	8.3%	8.4%	8.4%	8.4%	8.5%	8.6%	8.9%	9.0%	9.4%
Federal Civilian Government	1.0%	1.1%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	0.9%	0.9%	0.8%
Federal Military	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.3%
State and Local Government	9.0%	9.1%	8.7%	8.6%	8.6%	8.6%	8.5%	8.3%	8.1%	7.9%	7.5%
Total Earnings (in millions of 2005 dollars)	146,349	137,031	138,715	142,258	146,050	149,935	153,914	170,817	199,395	226,516	291,324
Farm	0.5%	0.4%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.3%
Forestry, Fishing, Related Activities	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
Mining	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%
Utilities	0.4%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%
Construction	9.4%	5.7%	5.3%	5.3%	5.3%	5.2%	5.2%	5.1%	4.9%	4.8%	4.5%
Manufacturing	4.4%	3.8%	3.6%	3.6%	3.5%	3.5%	3.4%	3.3%	3.0%	2.8%	2.4%
Wholesale Trade	6.8%	7.0%	7.1%	7.2%	7.2%	7.2%	7.2%	7.3%	7.4%	7.4%	7.5%
Retail Trade	8.5%	8.0%	8.1%	8.0%	7.9%	7.8%	7.8%	7.5%	7.0%	6.7%	6.0%
Transportation and Warehousing	4.0%	4.0%	4.1%	4.1%	4.1%	4.1%	4.1%	4.0%	3.8%	3.7%	3.5%
Information	3.6%	3.4%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.6%	3.6%	3.7%
Finance and Insurance	6.9%	6.4%	6.4%	6.4%	6.3%	6.3%	6.3%	6.1%	6.0%	5.8%	5.6%
Real Estate / Rental and Lease	3.7%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.2%	2.2%	2.1%	2.0%
Professional and Technical Services	8.3%	9.5%	9.7%	9.7%	9.7%	9.7%	9.8%	9.9%	10.0%	10.2%	10.4%
Management	1.3%	1.8%	2.0%	2.0%	2.0%	2.1%	2.1%	2.2%	2.4%	2.6%	3.0%
Administrative and Waste Services	6.2%	4.9%	4.8%	4.8%	4.9%	4.9%	5.0%	5.2%	5.5%	5.8%	6.4%
Educational Services	1.5%	2.1%	2.2%	2.2%	2.2%	2.3%	2.3%	2.5%	2.7%	3.0%	3.5%

Table 4-31. Demographic and Employment Baseline Projections for Economic Impact Area FL-4 (continued).

	2005	2010	2011	2012	2013	2014	2015	2020	2025	2030	2040
Health Care and Social Assistance	9.5%	12.0%	12.2%	12.2%	12.3%	12.4%	12.5%	12.8%	13.3%	13.7%	14.5%
Arts, Entertainment, and Recreation	1.6%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.8%	1.8%	1.7%
Accommodation and Food Services	4.3%	4.9%	5.2%	5.2%	5.1%	5.1%	5.1%	5.1%	5.0%	4.9%	4.8%
Other Services, Except Public Administration	4.2%	4.5%	4.4%	4.4%	4.4%	4.5%	4.5%	4.5%	4.6%	4.7%	4.8%
Federal Civilian Government	2.2%	2.6%	2.5%	2.5%	2.5%	2.5%	2.4%	2.4%	2.3%	2.3%	2.1%
Federal Military	0.6%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
State and Local Government	11.8%	13.3%	12.7%	12.6%	12.6%	12.6%	12.6%	12.5%	12.3%	12.2%	11.8%
Total Personal Income per Capita (in 2005 dollars)	37,492	37,959	38,681	38,357	38,468	38,798	39,260	41,739	46,458	51,194	62,955
Woods & Poole Economics Wealth Index (U.S. = 100)	118.7	116.5	115.5	114.8	114.5	114.4	114.5	115.3	117.0	118.6	122.2
Persons per Household (in number of people)	2.5	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.6
Mean Household Total Personal Income (in 2005$)	94,609	98,360	99,844	98,565	98,405	98,756	99,473	104,717	116,781	129,752	162,573
Number of Households (in thousands)	2,352	2,382	2,424	2,468	2,512	2,559	2,605	2,771	2,979	3,130	3,414
Income < $10,000 (thousands of households, 2000$)	9.1%	8.4%	8.2%	8.2%	8.1%	8.0%	7.8%	7.1%	6.1%	5.4%	4.0%
Income $10,000 to $19,999	12.1%	11.1%	10.9%	10.9%	10.7%	10.6%	10.5%	9.6%	8.2%	7.2%	5.3%
Income $20,000 to $29,999	12.6%	11.6%	11.4%	11.4%	11.3%	11.1%	11.0%	10.0%	8.6%	7.6%	5.6%
Income $30,000 to $44,999	17.3%	16.2%	15.9%	15.8%	15.7%	15.5%	15.3%	14.0%	12.0%	10.5%	7.8%
Income $45,000 to $59,999	15.0%	16.0%	16.2%	16.2%	16.3%	16.4%	16.4%	16.5%	15.4%	13.6%	10.1%
Income $60,000 to $74,999	10.7%	11.6%	11.8%	11.8%	12.0%	12.1%	12.3%	13.5%	15.5%	16.6%	14.7%
Income $75,000 to $99,999	10.1%	10.9%	11.1%	11.2%	11.3%	11.4%	11.6%	12.7%	14.8%	17.0%	22.2%
Income $100,000 or more	13.2%	14.3%	14.5%	14.6%	14.7%	14.9%	15.1%	16.6%	19.3%	22.2%	30.3%

Notes: Median Age and The Wealth Index are defined using averages of the original Woods & Poole values for the counties in the EIA; income per capita calculated using personal income/total population for the EIA; persons per household calculated using total population/number of households for the EIA.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-32

Baseline Population Projections (in thousands) by Economic Impact Area

Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4	Total
2010	1,799.51	626.81	6,202.46	345.97	584.86	1,142.20	1,242.45	482.25	725.94	882.64	660.01	3,627.12	6,173.13	24,495.33
2011	1,832.65	635.42	6,318.61	349.09	591.72	1,152.19	1,248.17	484.98	731.91	894.95	667.83	3,688.14	6,255.79	24,851.43
2012	1,866.48	644.27	6,437.11	352.34	598.82	1,162.61	1,254.39	487.89	738.17	907.59	675.90	3,750.54	6,340.82	25,216.93
2013	1,900.59	653.22	6,556.53	355.65	606.02	1,173.21	1,260.81	490.88	744.54	920.37	684.08	3,813.50	6,426.81	25,586.21
2014	1,934.86	662.24	6,676.47	358.98	613.28	1,183.90	1,267.35	493.92	750.98	933.24	692.32	3,876.76	6,513.36	25,957.66
2015	1,969.24	671.29	6,796.74	362.34	620.58	1,194.65	1,273.97	496.99	757.47	946.15	700.61	3,940.23	6,600.26	26,330.52
2016	2,003.72	680.38	6,917.33	365.73	627.93	1,205.45	1,280.66	500.08	763.99	959.10	708.92	4,003.87	6,687.49	26,704.68
2017	2,038.47	689.56	7,038.82	369.15	635.36	1,216.41	1,287.53	503.24	770.62	972.19	717.34	4,068.05	6,775.61	27,082.36
2018	2,073.33	698.78	7,160.61	372.60	642.83	1,227.41	1,294.46	506.43	777.28	985.32	725.79	4,132.40	6,864.04	27,461.28
2019	2,108.26	708.03	7,282.65	376.06	650.33	1,238.45	1,301.43	509.64	783.98	998.49	734.26	4,196.90	6,952.71	27,841.18
2020	2,143.31	717.32	7,405.08	379.54	657.88	1,249.55	1,308.49	512.87	790.71	1,011.71	742.78	4,261.62	7,041.77	28,222.62
2021	2,177.37	726.41	7,523.94	382.97	665.31	1,260.48	1,315.52	516.08	797.37	1,024.64	751.15	4,324.64	7,128.94	28,594.80
2022	2,211.98	735.62	7,644.70	386.43	672.82	1,271.51	1,322.59	519.31	804.08	1,037.74	759.60	4,388.58	7,217.19	28,972.14
2023	2,247.13	744.95	7,767.41	389.92	680.41	1,282.63	1,329.69	522.57	810.84	1,051.00	768.15	4,453.47	7,306.53	29,354.71
2024	2,282.84	754.39	7,892.08	393.45	688.09	1,293.85	1,336.84	525.84	817.67	1,064.43	776.80	4,519.32	7,396.98	29,742.59
2025	2,319.13	763.95	8,018.76	397.01	695.86	1,305.17	1,344.02	529.13	824.55	1,078.03	785.55	4,586.14	7,488.55	30,135.85
2026	2,353.18	773.03	8,137.46	400.42	703.29	1,316.01	1,350.99	532.32	831.16	1,090.93	793.88	4,649.03	7,575.46	30,507.14
2027	2,387.73	782.22	8,257.91	403.87	710.80	1,326.93	1,357.99	535.52	837.83	1,103.98	802.31	4,712.78	7,663.36	30,883.21
2028	2,422.79	791.51	8,380.15	407.34	718.39	1,337.94	1,365.03	538.75	844.54	1,117.18	810.82	4,777.41	7,752.29	31,264.14
2029	2,458.36	800.91	8,504.20	410.84	726.06	1,349.05	1,372.10	541.99	851.32	1,130.54	819.43	4,842.92	7,842.26	31,649.98
2030	2,494.45	810.43	8,630.09	414.37	733.82	1,360.25	1,379.21	545.25	858.15	1,144.07	828.12	4,909.33	7,933.26	32,040.79
2031	2,528.35	819.45	8,748.17	417.75	741.21	1,370.93	1,386.05	548.38	864.68	1,156.87	836.39	4,971.85	8,019.51	32,409.59
2032	2,562.71	828.57	8,867.88	421.15	748.69	1,381.69	1,392.92	551.54	871.27	1,169.81	844.74	5,035.16	8,106.69	32,782.81
2033	2,597.53	837.79	8,989.21	424.58	756.24	1,392.54	1,399.83	554.71	877.90	1,182.90	853.18	5,099.28	8,194.83	33,160.51
2034	2,632.83	847.11	9,112.21	428.04	763.86	1,403.47	1,406.77	557.89	884.59	1,196.14	861.69	5,164.21	8,283.92	33,542.74

Table 4-32. Baseline Population Projections (in thousands) by Economic Impact Area (continued).

Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4	Total
2035	2,668.61	856.54	9,236.90	431.53	771.56	1,414.49	1,413.75	561.10	891.32	1,209.52	870.30	5,229.98	8,373.98	33,929.57
2036	2,702.72	865.62	9,355.65	434.93	779.04	1,425.22	1,420.68	564.27	897.91	1,222.41	878.63	5,292.86	8,460.77	34,300.70
2037	2,737.27	874.80	9,475.93	438.36	786.59	1,436.04	1,427.64	567.45	904.55	1,235.43	887.04	5,356.49	8,548.47	34,676.05
2038	2,772.27	884.07	9,597.75	441.82	794.21	1,446.94	1,434.64	570.65	911.24	1,248.59	895.53	5,420.89	8,637.07	35,055.67
2039	2,807.71	893.45	9,721.14	445.30	801.91	1,457.92	1,441.67	573.88	917.97	1,261.89	904.10	5,486.07	8,726.60	35,439.59
2040	2,843.60	902.92	9,846.12	448.81	809.68	1,468.98	1,448.74	577.12	924.76	1,275.33	912.75	5,552.03	8,817.05	35,827.88
2041	2,879.95	912.49	9,972.71	452.35	817.52	1,480.13	1,455.84	580.37	931.59	1,288.91	921.48	5,618.78	8,908.43	36,220.57
2042	2,916.76	922.17	10,100.92	455.92	825.45	1,491.37	1,462.98	583.65	938.48	1,302.64	930.30	5,686.34	9,000.77	36,617.74
2043	2,954.05	931.94	10,230.78	459.51	833.44	1,502.68	1,470.15	586.94	945.42	1,316.52	939.21	5,754.71	9,094.06	37,019.41
2044	2,991.81	941.83	10,362.31	463.13	841.52	1,514.09	1,477.36	590.26	952.41	1,330.54	948.19	5,823.89	9,188.32	37,425.66
2045	3,030.06	951.81	10,495.53	466.78	849.68	1,525.58	1,484.60	593.59	959.45	1,344.71	957.27	5,893.92	9,283.56	37,836.53
2046	3,068.80	961.90	10,630.46	470.46	857.91	1,537.16	1,491.87	596.94	966.54	1,359.04	966.43	5,964.78	9,379.78	38,252.07
2047	3,108.03	972.10	10,767.13	474.17	866.22	1,548.83	1,499.19	600.31	973.68	1,373.51	975.68	6,036.49	9,477.00	38,672.35
2048	3,147.76	982.41	10,905.56	477.91	874.62	1,560.58	1,506.54	603.70	980.88	1,388.14	985.02	6,109.07	9,575.23	39,097.41
2049	3,188.00	992.82	11,045.76	481.68	883.09	1,572.42	1,513.92	607.10	988.13	1,402.93	994.44	6,182.52	9,674.48	39,527.31
2050	3,228.75	1,003.35	11,187.77	485.48	891.65	1,584.36	1,521.34	610.53	995.44	1,417.87	1,003.96	6,256.85	9,774.75	39,962.11
2051	3,270.02	1,013.99	11,331.61	489.31	900.29	1,596.38	1,528.80	613.98	1,002.79	1,432.98	1,013.57	6,332.08	9,876.07	40,401.86
2052	3,311.83	1,024.74	11,477.29	493.16	909.02	1,608.50	1,536.29	617.44	1,010.21	1,448.24	1,023.27	6,408.21	9,978.43	40,846.63
2053	3,354.16	1,035.61	11,624.84	497.05	917.82	1,620.71	1,543.82	620.93	1,017.67	1,463.67	1,033.06	6,485.26	10,081.86	41,296.47
2054	3,397.04	1,046.59	11,774.30	500.97	926.72	1,633.01	1,551.39	624.43	1,025.20	1,479.26	1,042.95	6,563.23	10,186.36	41,751.43
2055	3,440.47	1,057.68	11,925.67	504.92	935.70	1,645.40	1,559.00	627.96	1,032.77	1,495.01	1,052.93	6,642.14	10,291.94	42,211.59

Notes: Actual Woods & Poole data for 2010 through 2020, 2025, 2030, 2035, and 2040.
Missing estimates through 2040 were calculated using average annual growth rate for the 5-year period; projections after 2040 were calculated using the average annual growth rate from 2035 to 2040.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-33

Peak Population Projected from an EPA Proposed Action as a Percent of Total Population

EIA	Low Case				High Case			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	44	2021	2,177,370	0.00%	220	2025	2,319,130	0.01%
TX-2	26	2021	726,410	0.00%	135	2025	763,950	0.02%
TX-3	777	2021	7,523,940	0.01%	2,779	2025	8,018,760	0.03%
Louisiana (LA)								
LA-1	36	2021	382,970	0.01%	181	2025	397,010	0.05%
LA-2	109	2021	665,310	0.02%	578	2025	695,860	0.08%
LA-3	137	2021	1,260,480	0.01%	663	2025	1,305,170	0.05%
LA-4	75	2021	1,315,520	0.01%	373	2025	1,344,020	0.03%
Florida (FL)								
FL-1	21	2021	1,024,640	0.00%	96	2025	1,078,030	0.01%
FL-2	39	2021	751,150	0.01%	186	2025	785,550	0.02%
FL-3	34	2021	4,324,640	0.00%	166	2025	4,586,140	0.00%
FL-4	23	2021	7,128,940	0.00%	119	2025	7,488,550	0.00%
Alabama (AL)								
AL-1	44	2021	797,370	0.01%	259	2025	824,550	0.03%
Mississippi (MS)								
MS-1	31	2021	516,080	0.01%	174	2025	529,130	0.03%

Sources: Peak employment output from BOEM’s economic impact model (MAG-PLAN)
Baseline employment projections based on Woods & Poole Economics, Inc. (2011).

Table 4-34

Peak Population Projected from Cumulative OCS Programs as a Percent of Total Employment

EIA	Low Case				High Case			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	16,250	2030	2,494,450	0.65%	25,369	2031	2,528,350	1.00%
TX-2	6,620	2031	819,450	0.81%	10,759	2031	819,450	1.31%
TX-3	137,573	2030	8,630,090	1.59%	203,022	2031	8,748,170	2.32%
Louisiana (LA)								
LA-1	8,959	2030	414,370	2.16%	14,763	2031	417,750	3.53%
LA-2	25,960	2030	733,820	3.54%	40,748	2031	741,210	5.50%
LA-3	33,867	2030	1,360,250	2.49%	54,048	2031	1,370,930	3.94%
LA-4	17,490	2030	1,379,210	1.27%	27,980	2031	1,386,050	2.02%
Florida (FL)								
FL-1	4,773	2031	1,156,870	0.41%	7,726	2031	1,156,870	0.67%
FL-2	9,402	2031	836,390	1.12%	15,307	2031	836,390	1.83%
FL-3	8,265	2031	4,971,850	0.17%	13,509	2031	4,971,850	0.27%
FL-4	5,916	2031	8,019,510	0.07%	9,658	2031	8,019,510	0.12%
Alabama (AL)								
AL-1	11,251	2030	858,150	1.31%	18,405	2031	864,680	2.13%
Mississippi (MS)								
MS-1	8,726	2030	545,250	1.60%	14,116	2031	548,380	2.57%

Sources: Peak employment output from BOEM’s economic impact model (MAG-PLAN)
Baseline employment projections based on Woods & Poole Economics, Inc. (2011).

Table 4-35

Baseline Employment Projections (in thousands) by Economic Impact Area

Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4
2010	799.36	303.96	3,604.75	178.79	326.06	667.39	739.02	247.21	369.87	475.97	317.69	1,836.01	3,306.18
2011	793.09	303.60	3,648.80	176.78	323.47	662.76	736.37	251.36	373.47	478.36	314.73	1,837.13	3,330.93
2012	806.49	307.79	3,709.48	178.85	328.23	671.33	741.28	253.67	378.59	484.81	318.31	1,865.09	3,382.52
2013	821.31	312.42	3,776.39	181.19	333.53	680.95	747.23	256.30	384.36	491.97	322.52	1,897.15	3,439.80
2014	836.42	317.11	3,844.28	183.55	338.91	690.70	753.21	258.98	390.18	499.21	326.77	1,929.67	3,497.84
2015	851.79	321.84	3,913.17	185.95	344.32	700.56	759.21	261.68	396.12	506.56	331.07	1,962.67	3,556.64
2016	867.44	326.63	3,983.09	188.39	349.80	710.53	765.25	264.40	402.12	513.99	335.44	1,996.15	3,616.23
2017	883.38	331.48	4,054.02	190.85	355.35	720.63	771.30	267.13	408.23	521.51	339.84	2,030.11	3,676.61
2018	899.59	336.38	4,126.01	193.34	360.94	730.84	777.39	269.90	414.43	529.13	344.33	2,064.57	3,737.78
2019	916.13	341.33	4,199.04	195.88	366.60	741.18	783.50	272.70	420.72	536.85	348.86	2,099.53	3,799.78
2020	932.96	346.34	4,273.13	198.43	372.32	751.62	789.65	275.53	427.11	544.67	353.43	2,134.99	3,862.56
2021	950.10	351.36	4,347.87	201.03	378.05	762.16	795.79	278.37	433.58	552.56	358.07	2,170.81	3,925.76
2022	967.55	356.45	4,423.91	203.66	383.86	772.84	801.98	281.25	440.16	560.55	362.78	2,207.23	3,990.00
2023	985.33	361.62	4,501.28	206.33	389.76	783.68	808.21	284.15	446.84	568.67	367.55	2,244.26	4,055.28
2024	1,003.43	366.86	4,580.00	209.03	395.76	794.66	814.50	287.09	453.62	576.90	372.38	2,281.91	4,121.64
2025	1,021.87	372.17	4,660.10	211.77	401.84	805.80	820.83	290.05	460.50	585.25	377.27	2,320.20	4,189.08
2026	1,040.67	377.46	4,740.42	214.54	407.88	816.99	827.15	293.04	467.49	593.65	382.23	2,358.71	4,256.53
2027	1,059.82	382.81	4,822.12	217.35	414.01	828.32	833.52	296.06	474.59	602.16	387.26	2,397.86	4,325.06
2028	1,079.32	388.25	4,905.23	220.20	420.22	839.82	839.94	299.12	481.80	610.80	392.36	2,437.66	4,394.70
2029	1,099.19	393.76	4,989.77	223.08	426.54	851.47	846.41	302.20	489.11	619.56	397.52	2,478.12	4,465.46
2030	1,119.42	399.35	5,075.77	226.00	432.94	863.29	852.92	305.32	496.54	628.44	402.75	2,519.25	4,537.36
2031	1,140.07	404.89	5,162.03	228.97	439.30	875.16	859.45	308.46	504.08	637.38	408.08	2,560.65	4,609.30
2032	1,161.11	410.51	5,249.75	231.97	445.75	887.20	866.02	311.64	511.74	646.44	413.47	2,602.72	4,682.39
2033	1,182.53	416.21	5,338.97	235.02	452.29	899.40	872.65	314.84	519.52	655.64	418.93	2,645.49	4,756.64
2034	1,204.35	421.99	5,429.70	238.10	458.93	911.77	879.33	318.09	527.42	664.96	424.47	2,688.96	4,832.06

Table 4-35. Baseline Employment Projections (in thousands) by Economic Impact Area (continued).

Calendar Year	TX-1	TX-2	TX-3	LA-1	LA-2	LA-3	LA-4	MS-1	AL-1	FL-1	FL-2	FL-3	FL-4
2035	1,226.57	427.85	5,521.98	241.23	465.66	924.32	886.06	321.36	535.43	674.42	430.08	2,733.14	4,908.68
2036	1,249.29	433.65	5,614.56	244.40	472.35	936.93	892.82	324.67	543.59	683.92	435.80	2,777.64	4,985.38
2037	1,272.43	439.52	5,708.69	247.61	479.14	949.71	899.63	328.02	551.86	693.56	441.60	2,822.86	5,063.27
2038	1,296.00	445.48	5,804.41	250.86	486.02	962.67	906.50	331.40	560.27	703.34	447.48	2,868.82	5,142.39
2039	1,320.00	451.52	5,901.73	254.15	493.00	975.80	913.42	334.81	568.80	713.25	453.43	2,915.52	5,222.74
2040	1,344.45	457.64	6,000.68	257.49	500.08	989.11	920.39	338.26	577.46	723.31	459.46	2,962.99	5,304.35
2041	1,369.35	463.84	6,101.29	260.87	507.26	1,002.61	927.41	341.75	586.25	733.50	465.58	3,011.23	5,387.23
2042	1,394.71	470.13	6,203.59	264.30	514.54	1,016.28	934.49	345.27	595.18	743.84	471.77	3,060.25	5,471.40
2043	1,420.54	476.50	6,307.60	267.77	521.93	1,030.15	941.62	348.83	604.24	754.32	478.05	3,110.07	5,556.89
2044	1,446.85	482.96	6,413.35	271.28	529.43	1,044.20	948.81	352.42	613.44	764.96	484.41	3,160.70	5,643.72
2045	1,473.65	489.50	6,520.88	274.85	537.03	1,058.45	956.05	356.05	622.78	775.74	490.86	3,212.16	5,731.91
2046	1,500.94	496.14	6,630.21	278.46	544.75	1,072.89	963.34	359.72	632.26	786.67	497.39	3,264.45	5,821.47
2047	1,528.74	502.86	6,741.38	282.11	552.57	1,087.53	970.70	363.43	641.89	797.76	504.01	3,317.60	5,912.43
2048	1,557.05	509.67	6,854.41	285.82	560.51	1,102.37	978.10	367.17	651.66	809.01	510.71	3,371.61	6,004.81
2049	1,585.89	516.58	6,969.33	289.57	568.55	1,117.40	985.57	370.95	661.59	820.41	517.51	3,426.50	6,098.64
2050	1,615.26	523.58	7,086.18	293.37	576.72	1,132.65	993.09	374.78	671.66	831.97	524.40	3,482.29	6,193.93
2051	1,645.18	530.68	7,204.99	297.22	585.00	1,148.10	1,000.67	378.64	681.89	843.70	531.37	3,538.98	6,290.71
2052	1,675.65	537.87	7,325.79	301.13	593.40	1,163.77	1,008.31	382.54	692.27	855.59	538.44	3,596.59	6,389.01
2053	1,706.69	545.16	7,448.62	305.08	601.93	1,179.64	1,016.00	386.48	702.81	867.65	545.61	3,655.15	6,488.84
2054	1,738.30	552.55	7,573.51	309.09	610.57	1,195.74	1,023.76	390.46	713.51	879.88	552.87	3,714.65	6,590.22
2055	1,770.49	560.04	7,700.49	313.15	619.34	1,212.05	1,031.57	394.49	724.37	892.28	560.23	3,775.13	6,693.20

Notes: Actual Woods & Poole data for 2010 through 2020, 2025, 2030, 2035, and 2040.
Missing estimates through 2040 were calculated using average annual growth rate for the 5-year period; projections after 2040 were calculated using the average annual growth rate from 2035 to 2040.

Source: Woods & Poole Economics, Inc., 2011.

Table 4-36

Unemployment Rate Impacts: Gulf Coast Monthly Unemployment Rates during 2010

Labor Market Area	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
National Unemployment Rate	9.7	9.7	9.7	9.8	9.6	9.5	9.5	9.6	9.6	9.7	9.8	9.4
Texas	8.6	8.4	8.3	7.9	7.9	8.4	8.4	8.3	8.0	7.9	8.2	8.0
Beaumont-Port Arthur	10.8	10.6	10.8	10.3	10.4	10.9	10.8	10.7	10.5	10.3	10.9	10.9
Brownsville	11.2	11.2	10.9	10.5	10.5	11.4	11.3	11.4	11.1	11.0	11.7	11.7
Corpus Christi	8.2	8.0	7.8	7.6	7.7	8.4	8.3	8.1	8.0	7.9	8.3	8.2
Houston-Sugar Land-Baytown	8.8	8.6	8.6	8.2	8.2	8.7	8.7	8.6	8.3	8.2	8.5	8.3
Victoria	8.1	8.2	7.9	7.4	7.3	7.7	7.8	7.6	7.3	7.3	7.4	7.1
Louisiana	7.9	6.9	6.8	6.6	7.2	8.3	8.0	8.2	7.7	7.5	7.3	7.2
Baton Rouge	7.6	6.6	6.6	6.4	7.3	8.5	8.1	8.3	7.8	7.6	7.4	7.2
Houma-Bayou Cane-Thibodaux	6.0	5.0	5.0	4.9	5.3	6.0	5.3	5.8	5.4	5.4	5.3	5.0
Lafayette	6.5	5.6	5.5	5.3	5.7	6.6	6.2	6.5	6.1	6.1	5.9	5.6
Lake Charles	7.4	6.3	6.3	6.2	6.7	7.8	7.4	7.7	7.3	7.0	6.9	6.7
New Orleans	8.1	8.2	7.9	7.4	7.3	7.7	7.8	7.6	7.3	7.3	7.4	7.1
Mississippi	12.0	11.3	10.8	9.9	10.4	10.7	11.1	9.7	9.9	9.8	9.8	9.8
Biloxi-Gulfport	10.2	9.6	9.2	8.6	9.0	9.0	9.2	8.0	8.6	8.9	8.7	8.6
Alabama	10.9	10.6	10.1	9.3	9.0	9.6	9.3	9.4	9.0	8.9	9.0	8.8
Mobile	11.7	11.2	10.8	10.2	9.9	10.0	9.8	10.1	9.7	9.6	9.9	9.7
Florida	11.5	11.4	11.3	10.9	10.9	11.4	11.9	12.1	11.8	11.6	12.1	11.7
Miami-Fort Lauderdale-Pompano Beach	10.8	10.8	11.0	10.8	11.0	11.5	11.9	12.2	11.7	11.8	11.9	11.8
Panama City	11.5	10.8	9.8	9.2	9.1	9.1	9.4	9.8	10.4	10.6	11.7	11.8
Pensacola	10.9	10.8	10.4	9.9	9.8	10.4	10.9	10.6	10.4	10.2	11.1	10.8
Tampa-St. Petersburg-Clearwater	12.4	12.1	11.9	11.6	11.5	11.9	12.3	12.4	12.2	12.0	12.6	12.2
Tallahassee	8.5	8.5	8.2	7.7	7.9	8.5	9.2	8.9	8.6	8.3	9.1	8.9

Source: U.S. Dept. of Labor, Bureau of Labor Statistics, 2011b.

Table 4-37

Low-Case Employment Projections for an EPA Proposed Action by Economic Impact Area

Onshore Area	Employment (jobs)												
	Total (40-year sum)				Direct		Indirect		Induced		Total		
	Direct	Indirect	Induced	All	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Peak Years
Industry Expenditure Effects													
Texas (TX)													
TX-1	19	9	22	50	0	6	0	3	1	7	1	17	2021, 2022
TX-2	14	6	11	31	0	5	0	2	0	4	1	10	2021, 2022, 2023
TX-3	285	118	497	901	7	95	3	39	13	166	23	300	2021, 2022
All Texas EIA's	319	133	530	981	8	106	3	44	14	177	25	327	2021, 2022
The Rest of Texas	24	13	62	100	1	8	0	4	2	21	3	33	2021, 2022
Texas Total	343	146	592	1,081	9	114	4	49	15	197	28	360	2021, 2022
Louisiana (LA)													
LA-1	16	9	18	43	0	5	0	3	0	6	1	14	2021, 2022, 2023
LA-2	30	13	82	125	1	10	0	4	2	27	3	42	2021, 2022
LA-3	31	19	110	160	1	10	0	6	3	37	4	53	2021, 2022
LA-4	24	12	51	87	1	8	0	4	1	17	2	29	2021, 2022
All Louisiana EIA's	101	52	261	415	3	34	1	17	7	87	11	138	2021, 2022
The Rest of Louisiana	13	5	25	42	0	4	0	2	1	8	1	14	2021, 2022, 2023
Louisiana Total	114	57	286	457	3	38	1	19	7	95	12	152	2021, 2022
Florida (FL)													
FL-1	10	4	10	23	0	3	0	1	0	3	1	8	2021, 2022, 2023
FL-2	21	8	17	46	1	7	0	3	0	6	1	15	2021, 2022, 2023
FL-3	17	7	16	40	0	6	0	2	0	5	1	13	2021, 2022, 2023
FL-4	11	5	12	28	0	4	0	2	0	4	1	9	2021, 2022, 2023
All Florida EIA's	59	24	55	138	2	20	1	8	1	18	4	46	2021, 2022, 2023
The Rest of Florida	18	8	17	43	0	6	0	3	0	6	1	14	2021, 2022, 2023
Florida Total	76	33	72	181	2	25	1	11	2	24	5	60	2021, 2022, 2023

Table 4-37. Low-Case Employment Projections for an EPA Proposed Action by Economic Impact Area (continued).

Onshore Area	Employment (jobs)												
	Total (40-year sum)				Direct		Indirect		Induced		Total		
	Direct	Indirect	Induced	All	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Peak Years
Industry Expenditure Effects													
Alabama (AL)													
AL-1	17	7	26	50	0	6	0	2	1	9	1	17	2021, 2022, 2023
The Rest of Alabama	28	11	27	66	1	9	0	4	1	9	2	22	2021, 2022, 2023
Alabama Total	45	17	53	116	1	15	0	6	1	18	3	39	2021, 2022, 2023
Mississippi (MS)													
MS-1	15	4	17	36	0	5	0	1	0	6	1	12	2021, 2022, 2023
The Rest of Mississippi	25	8	19	52	1	8	0	3	0	6	1	17	2021, 2022, 2023
Mississippi Total	40	12	36	88	1	13	0	4	1	12	2	29	2021, 2022, 2023
Totals													
All EIA’s for All States	511	220	890	1,620	13	170	6	73	23	297	42	540	2021, 2022
All States Above	619	265	1,039	1,923	16	206	7	88	27	346	49	641	2021, 2022

EIA = Economic Impact Area.

Table 4-38

High-Case Employment Projections for an EPA Proposed Action by Economic Impact Area

Onshore Area	Employment (jobs)												
	Total (40-year sum)				Direct		Indirect		Induced		Total		
	Direct	Indirect	Induced	All	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Peak Year
Industry Expenditure Effects													
Texas (TX)													
TX-1	172	88	211	471	4	30	2	16	5	40	12	85	2025
TX-2	133	53	104	289	3	24	1	9	3	19	7	52	2025
TX-3	1,819	931	3,561	6,311	47	292	24	174	91	607	162	1,073	2025
All Texas EIA’s	2,124	1,072	3,876	7,071	54	346	27	199	99	666	181	1,210	2025
The Rest of Texas	215	118	592	925	6	43	3	25	15	129	24	197	2025
Texas Total	2,339	1,190	4,467	7,996	60	389	31	223	115	795	205	1,407	2025
Louisiana (LA)													
LA-1	154	89	183	427	4	26	2	13	5	31	11	70	2025
LA-2	294	144	774	1,212	8	54	4	28	20	141	31	223	2025
LA-3	312	198	1,028	1,537	8	52	5	31	26	173	39	256	2025
LA-4	224	119	474	817	6	39	3	21	12	85	21	144	2025
All Louisiana EIA’s	985	550	2,458	3,994	25	170	14	94	63	428	102	692	2025
The Rest of Louisiana	113	43	225	381	3	22	1	9	6	45	10	76	2025
Louisiana Total	1,098	593	2,683	4,375	28	192	15	102	69	473	112	768	2025
Florida (FL)													
FL-1	76	29	89	193	2	13	1	5	2	18	5	37	2025
FL-2	161	64	151	377	4	28	2	11	4	33	10	72	2025
FL-3	126	57	147	330	3	21	1	10	4	33	8	64	2025
FL-4	89	41	106	236	2	16	1	7	3	23	6	46	2025
All Florida EIA’s	452	191	493	1,136	12	78	5	34	13	107	29	219	2025
The Rest of Florida	140	69	167	376	4	25	2	13	4	41	10	78	2025
Florida Total	593	259	660	1,512	15	103	7	47	17	148	39	297	2025
Alabama (AL)													
AL-1	155	62	260	478	4	30	2	12	7	58	12	100	2025
The Rest of Alabama	237	99	254	590	6	47	3	21	7	61	15	130	2025
Alabama Total	392	161	515	1,068	10	77	4	34	13	120	27	230	2025
Mississippi (MS)													
MS-1	126	34	162	322	3	25	1	7	4	35	8	67	2025
The Rest of Mississippi	213	68	178	459	5	42	2	14	5	43	12	99	2025
Mississippi Total	339	102	339	780	9	67	3	21	9	78	20	166	2025
Totals													
All EIA’s for All States	3,842	1,909	7,249	13,001	99	649	49	346	186	1,294	333	2,289	2025
All States Above	4,761	2,306	8,665	15,732	122	828	59	427	222	1,614	403	2,868	2025

EIA = Economic Impact Area.

Table 4-39

Peak Employment Projected for an EPA Proposed Action as a Percent of Total Employment

EIA	Low Case				High Case			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	17	2021	950,100	0.00%	85	2025	1,021,870	0.01%
TX-2	10	2021	351,360	0.00%	52	2025	372,170	0.01%
TX-3	300	2021	4,347,870	0.01%	1,073	2025	4,660,100	0.02%
Louisiana (LA)								
LA-1	14	2021	201,030	0.01%	70	2025	211,770	0.03%
LA-2	42	2021	378,050	0.01%	223	2025	401,840	0.06%
LA-3	53	2021	762,160	0.01%	256	2025	805,800	0.03%
LA-4	29	2021	795,790	0.00%	144	2025	820,830	0.02%
Florida (FL)								
FL-1	8	2021	552,560	0.00%	37	2025	585,250	0.01%
FL-2	15	2021	358,070	0.00%	72	2025	377,270	0.02%
FL-3	13	2021	2,170,810	0.00%	64	2025	2,320,200	0.00%
FL-4	9	2021	3,925,760	0.00%	46	2025	4,189,080	0.00%
Alabama (AL)								
AL-1	17	2021	433,580	0.00%	100	2025	460,500	0.02%
Mississippi (MS)								
MS-1	12	2021	278,370	0.00%	67	2025	290,050	0.02%

Sources: Peak employment comes from BOEM’s economic impact model (MAG-PLAN).
Baseline employment projections based on Woods & Poole Economics, Inc. (2011).

Table 4-40

Low-Case Cumulative Employment Projections by Economic Impact Area

Onshore Area	Employment (jobs)												
	Total (40-year sum)				Direct		Indirect		Induced		Total		
	Direct	Indirect	Induced	All	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Peak Year
Industry Expenditure Effects													
Texas (TX)													
TX-1	62,348	30,507	105,629	198,484	1,559	1,842	763	904	2,641	3,532	4,962	6,274	2030
TX-2	43,108	16,643	32,932	92,683	1,078	1,187	416	460	823	910	2,317	2,556	2031
TX-3	593,169	265,323	1,093,580	1,952,072	14,829	16,067	6,633	7,280	27,340	29,770	48,802	53,117	2030
All Texas EIA's	698,624	312,473	1,232,141	2,243,238	17,466	19,048	7,812	8,620	30,804	33,938	56,081	61,606	2030
The Rest of Texas	75,930	42,414	201,073	319,417	1,898	2,085	1,060	1,172	5,027	5,513	7,985	8,766	2031
Texas Total	774,555	354,887	1,433,214	2,562,655	19,364	21,132	8,872	9,792	35,830	39,447	64,066	70,371	2030
Louisiana (LA)													
LA-1	46,222	25,062	53,602	124,886	1,156	1,277	627	699	1,340	1,484	3,122	3,459	2030
LA-2	85,002	37,337	237,488	359,828	2,125	2,367	933	1,054	5,937	6,605	8,996	10,023	2030
LA-3	92,305	54,818	322,207	469,331	2,308	2,581	1,370	1,544	8,055	8,951	11,733	13,076	2030
LA-4	66,637	33,179	144,285	244,102	1,666	1,843	829	924	3,607	3,986	6,103	6,753	2030
All Louisiana EIA's	290,167	150,397	757,583	1,198,146	7,254	8,067	3,760	4,219	18,940	21,025	29,954	33,310	2030
The Rest of Louisiana	37,629	13,977	72,759	124,365	941	1,030	349	383	1,819	1,990	3,109	3,403	2031
Louisiana Total	327,796	164,374	830,342	1,322,512	8,195	9,097	4,109	4,602	20,759	23,013	33,063	36,710	2030
Florida (FL)													
FL-1	26,601	10,222	30,494	67,318	665	728	256	280	762	835	1,683	1,843	2031
FL-2	56,780	22,736	53,004	132,520	1,419	1,554	568	623	1,325	1,453	3,313	3,630	2031
FL-3	44,463	20,375	51,557	116,394	1,112	1,218	509	559	1,289	1,414	2,910	3,191	2031
FL-4	31,246	14,529	37,473	83,247	781	856	363	398	937	1,030	2,081	2,284	2031
All Florida EIA's	159,090	67,861	172,529	399,480	3,977	4,357	1,697	1,860	4,313	4,732	9,987	10,948	2031
The Rest of Florida	49,197	24,473	59,684	133,353	1,230	1,350	612	673	1,492	1,641	3,334	3,664	2031
Florida Total	208,286	92,334	232,212	532,832	5,207	5,707	2,308	2,532	5,805	6,372	13,321	14,612	2031

Table 4-40. Low-Case Cumulative Employment Projections by Economic Impact Area (continued).

Onshore Area	Employment (jobs)												
	Total (40-year sum)				Direct		Indirect		Induced		Total		
	Direct	Indirect	Induced	All	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Peak Year
Industry Expenditure Effects													
Alabama (AL)													
AL-1	51,839	20,281	85,875	157,995	1,296	1,423	507	559	2,147	2,363	3,950	4,344	2030
The Rest of Alabama	84,739	36,868	93,167	214,773	2,118	2,324	922	1,020	2,329	2,566	5,369	5,910	2030
Alabama Total	136,579	57,148	179,042	372,768	3,414	3,746	1,429	1,579	4,476	4,930	9,319	10,254	2030
Mississippi (MS)													
MS-1	45,687	12,545	61,736	119,967	1,142	1,261	314	347	1,543	1,766	2,999	3,369	2030
The Rest of Mississippi	75,647	24,751	69,033	169,432	1,891	2,075	619	681	1,726	1,953	4,236	4,694	2030
Mississippi Total	121,334	37,296	130,769	289,399	3,033	3,335	932	1,028	3,269	3,719	7,235	8,048	2030
Totals													
All EIA's for All States	1,245,407	563,556	2,309,863	4,118,827	31,135	34,146	14,089	15,602	57,747	63,795	102,971	113,543	2030
All States Above	1,568,550	706,039	2,805,579	5,080,167	39,214	43,006	17,651	19,530	70,139	77,438	127,004	139,974	2030

EIA = Economic Impact Area.

Table 4-41

High-Case Cumulative Employment Projections by Economic Impact Area

Onshore Area	Employment (jobs)												
	Total (40-year sum)				Direct		Indirect		Induced		Total		
	Direct	Indirect	Induced	All	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Average Annual	Peak Annual	Peak Year
Industry Expenditure Effects													
Texas (TX)													
TX-1	101,204	49,345	160,029	310,578	2,530	3,169	1,234	1,538	4,001	5,132	7,764	9,795	2031
TX-2	68,931	26,484	52,935	148,351	1,723	1,926	662	743	1,323	1,485	3,709	4,154	2031
TX-3	875,258	394,078	1,613,370	2,882,706	21,881	23,691	9,852	10,820	40,334	43,901	72,068	78,387	2031
All Texas EIA's	1,045,394	469,908	1,826,334	3,341,635	26,135	28,682	11,748	13,062	45,658	50,343	83,541	92,029	2031
The Rest of Texas	119,442	66,568	325,260	511,270	2,986	3,295	1,664	1,837	8,131	8,996	12,782	14,127	2031
Texas Total	1,164,836	536,475	2,151,593	3,852,905	29,121	31,922	13,412	14,880	53,790	59,212	96,323	105,995	2031
Louisiana (LA)													
LA-1	74,190	40,500	86,487	201,176	1,855	2,093	1,012	1,158	2,162	2,448	5,029	5,700	2031
LA-2	134,404	59,112	364,216	557,732	3,360	3,826	1,478	1,702	9,105	10,205	13,943	15,733	2031
LA-3	148,680	88,820	501,129	738,629	3,717	4,258	2,220	2,559	12,528	14,059	18,466	20,868	2031
LA-4	106,734	52,897	226,187	385,818	2,668	2,991	1,322	1,493	5,655	6,320	9,645	10,803	2031
All Louisiana EIA's	464,007	241,328	1,178,020	1,883,355	11,600	13,143	6,033	6,898	29,450	32,993	47,084	53,012	2031
The Rest of Louisiana	59,634	22,022	115,192	196,849	1,491	1,650	551	608	2,880	3,191	4,921	5,449	2031
Louisiana Total	523,641	263,350	1,293,212	2,080,203	13,091	14,774	6,584	7,501	32,330	36,184	52,005	58,400	2031
Florida (FL)													
FL-1	42,424	16,210	49,130	107,763	1,061	1,175	405	449	1,228	1,359	2,694	2,983	2031
FL-2	90,765	36,136	86,636	213,537	2,269	2,516	903	1,000	2,166	2,394	5,338	5,910	2031
FL-3	71,201	32,456	84,760	188,417	1,780	1,976	811	899	2,119	2,340	4,710	5,216	2031
FL-4	49,938	23,096	61,586	134,619	1,248	1,385	577	639	1,540	1,705	3,365	3,729	2031
All Florida EIA's	254,328	107,897	282,111	644,336	6,358	7,052	2,697	2,987	7,053	7,799	16,108	17,838	2031
The Rest of Florida	79,235	39,159	100,834	219,227	1,981	2,202	979	1,086	2,521	2,787	5,481	6,075	2031
Florida Total	333,563	147,056	382,945	863,563	8,339	9,254	3,676	4,074	9,574	10,586	21,589	23,913	2031
Alabama (AL)													
AL-1	83,091	32,364	140,712	256,167	2,077	2,305	809	899	3,518	3,902	6,404	7,106	2031
The Rest of Alabama	135,095	58,236	154,218	347,549	3,377	3,726	1,456	1,604	3,855	4,249	8,689	9,579	2031
Alabama-sum	218,186	90,600	294,930	603,716	5,455	6,031	2,265	2,502	7,373	8,149	15,093	16,680	2031
Mississippi (MS)													
MS-1	73,295	20,167	98,561	192,023	1,832	2,068	504	572	2,464	2,810	4,801	5,450	2031
The Rest of Mississippi	120,036	39,068	112,509	271,613	3,001	3,309	977	1,081	2,813	3,163	6,790	7,552	2031
Mississippi Total	193,331	59,235	211,070	463,636	4,833	5,377	1,481	1,653	5,277	5,973	11,591	13,002	2031
Totals													
All EIA's for All States	1,920,114	871,664	3,525,738	6,317,516	48,003	53,114	21,792	24,375	88,143	97,647	157,938	175,136	2031
All States Above	2,433,557	1,096,717	4,333,750	7,864,024	60,839	67,172	27,418	30,534	108,344	119,800	196,601	217,506	2031

EIA = Economic Impact Area.

Table 4-42

Peak Employment Projected from Cumulative OCS Programs as a Percent of Total Employment

EIA	Low Case				High Case			
	Peak Annual	Peak Year	Baseline in Peak Year	Percent	Peak Annual	Peak Year	Baseline in Peak Year	Percent
Texas (TX)								
TX-1	6,274	2030	1,119,420	0.56%	9,795	2031	1,140,070	0.86%
TX-2	2,556	2031	404,890	0.63%	4,154	2031	404,890	1.03%
TX-3	53,117	2030	5,075,770	1.05%	78,387	2031	5,162,030	1.52%
Louisiana (LA)								
LA-1	3,459	2030	226,000	1.53%	5,700	2031	228,970	2.49%
LA-2	10,023	2030	432,940	2.32%	15,733	2031	439,300	3.58%
LA-3	13,076	2030	863,290	1.51%	20,868	2031	875,160	2.38%
LA-4	6,753	2030	852,920	0.79%	10,803	2031	859,450	1.26%
Florida (FL)								
FL-1	1,843	2031	637,380	0.29%	2,983	2031	637,380	0.47%
FL-2	3,630	2031	408,080	0.89%	5,910	2031	408,080	1.45%
FL-3	3,191	2031	2,560,650	0.12%	5,216	2031	2,560,650	0.20%
FL-4	2,284	2031	4,609,300	0.05%	3,729	2031	4,609,300	0.08%
Alabama (AL)								
AL-1	4,344	2030	496,540	0.87%	7,106	2031	504,080	1.41%
Mississippi (MS)								
MS-1	3,369	2030	305,320	1.10%	5,450	2031	308,460	1.77%

Sources: Peak employment comes from BOEM's economic impact model (MAG-PLAN).
Baseline employment projections based on Woods & Poole Economics, Inc. (2011).

Table 4-43

Gulf of Mexico Counties and Parishes with Concentrated Levels of Oil- and Gas-Related Infrastructure

Low Concentration		Medium Concentration		High Concentration	
County/Parish	State	County/Parish	State	County/Parish	State
Escambia	FL	Bay	FL	Mobile	AL
Manatee	FL	Hillsborough	FL	Cameron	LA
Lafayette	LA	Calcasieu	LA	Jefferson	LA
St. John the Baptist	LA	Iberia	LA	Lafourche	LA
West Baton Rouge	LA	Orleans	LA	Plaquemines	LA
Harrison	MS	St. Bernard	LA	St. Mary	LA
Aransas	TX	St. Charles	LA	Brazoria	TX
Cameron	TX	St. James	LA	Galveston	TX
Fort Bend	TX	Vermilion	LA	Harris	TX
Matagorda	TX	Jackson	MS	Jefferson	TX
Montgomery	TX	Calhoun	TX		
Orange	TX	Nueces	TX		
		San Patricio	TX		

Source: Kaplan et al., 2011.

Table 4-44

Deepwater Horizon Waste Landfill Destination

Landfill Name and Location	Percent Minority Living within 1-Mile Radius of Site	Total Population Living within 1-Mile Radius of Site (2000 Census)	Percentage of Total *Deepwater Horizon* Liquid Waste Collected	Percentage of Total *Deepwater Horizon* Solid Waste Collected
Liquid Environmental Solutions, Mobile, LA	95.80%	4,257	13.17%	0.00%
Oil Recovery Company, Mobile, LA	93.90%	3,238	0.08%	0.00%
Cliff Berry, Inc. – Miami, FL	92.80%	24,768	>0.58%	0.00%
River Birch Industries Landfill, Avondale, LA	92.20%	167	16.99%	8.67%
Jefferson Parish Waste Management, Avondale, LA	91.40%	120	0.00%	0.02%
Sunbelt Crushing, Mobile, LA	76.80%	3,173	0.00%	0.29%
Chemical Waste Management, Emelle, LA	75.20%	33	1.02%	0.00%
WM Springhill Regional Landfill, Campbelton, FL	74.30%	109	0.00%	23.67%
Allied Waste/BFI Colonial Landfill, Sorrento, LA	74.10%	153	0.00%	21.98%
Allied Waste Recycling Center, Metairie, LA	63.50%	14,420	0.00%	0.06%
WH Chastang Landfill, Mount Vernon, AL	62.50%	123	0.00%	8.93%
Clearview Landfill Lake, MS	50.90%	55	0.44%	14.92%
Cliff Berry, Inc. – Tampa, FL	50.50%	1,817	>0.58%	0.00%
Apex Environmental Services, Theodore, AL	50.40%	383	17.44%	0.00%
Newpark Environmental Services Site Code 5102, Morgan City, LA	35.90%	4,237	2.74%	0.00%
Liquid Environmental Solutions, Mobile, AL	63.30%	4,257	13.17%	0.00%
Newpark Environmental Mud Facility, Venice, LA	50.00%	2	10.90%	0.00%
Oil Recovery Company, Mobile, AL	41.70%	3,238	0.08%	0.00%
Chemical Waste Management, Emelle, LA	36.40%	33	1.02%	0.00%
Newpark Environmental Services Site Code 2913, Fourchon, LA	33.30%	3	30.14%	0.00%
Vacco Marine, Houma, LA	29.20%	525	0.16%	0.00%
River Birch Industries Landfill, Avondale, LA	28.10%	167	16.99%	8.67%
Jefferson Parish Waste Management, Avondale, LA	26.70%	120	0.00%	0.02%
Apex Environmental Services, Theodore, AL	26.20%	383	17.44%	0.00%
Allied Waste/BFI Colonial Landfill, Sorrento, LA	25.00%	153	0.00%	21.98%
WM Pecan Grove, Pass Christian, MS	14.40%	290	0.00%	3.28%
Baldwin County Magnolia Landfill, Summerdale, AL	13.70%	446	0.00%	11.18%
MBO LLC (Lacassine Oilfield Services), Lacassine, LA	12.90%	85	3.82%	0.00%
Coast Guard Rd Sanitary Landfill, Sorrento, LA	0.00%	0	0.00%	8.05%

Source: British Petroleum, 2010.

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APPENDIX A

PHYSICAL AND ENVIRONMENTAL SETTINGS

A. PHYSICAL AND ENVIRONMENTAL SETTINGS

A.1. GEOGRAPHY AND GEOLOGY

General Physiographic Description

The present-day Gulf of Mexico (GOM) is a small ocean basin to the south of the North American continent measuring 1,600 kilometers (km) (990 miles [mi]) from east to west, 900 km (600 mi) north to south, and with a water-surface area of more than 1.5 million km^2 (371 million acres [ac]) (Moretzsohn et al., 2011). The greatest water depth is approximately 3,700 meters (m) (12,139 feet [ft]). The Gulf opens to the Atlantic Ocean through the Straits of Florida and to the Caribbean Sea through the Yucatan Channel. Approximately 38 percent of the GOM is comprised of shallow and intertidal areas (<20 m [66 ft] deep). The area of the continental shelf ≤200 m (656 ft) deep covers 22 percent, the continental slope (200-3,000 m [656-9,843 ft] deep) covers 20 percent, and the abyssal plain (≥3,000 m [9,843 ft] deep) covers the final 20 percent. The Sigsbee Deep, located in the southwestern quadrant, is the deepest region of the GOM, and reports by different authors state maximum depths that range from 3,750 to 4,384 m (12,303 to 14,383 ft) (Moretzsohn et al., 2011).

The continental shelf has a gentle slope of <1 degree (**Figure A-1**). The continental slope has a slope of 1-2 degrees and extends from the shelf edge to the Sigsbee and Florida Escarpments in water about 3,000 m (9,843 ft) deep. The transition between the continental shelf edge and abyssal depths is a broad to narrow continental slope. Where the Mississippi River has built its delta seaward, the continental shelf is narrow (**Figure A-1**). In the central and western GOM, the continental slope is broad and low-angle, underlain by an extensive canopy of mobilized salt. In contrast, in the eastern GOM, the continental slope is narrow and steep where there is no salt. In the central and western GOM, the edge of the salt canopy is recognized as the Sigsbee Escarpment. In the eastern GOM, the Florida Escarpment represents the ancient shelf edge during the Cretaceous Period (**Figure A-2**). The topography of the broad slope underlain by salt is irregular and is characterized by canyons, troughs, minibasins, and salt structures with higher relief than surrounding areas. The Sigsbee and Florida abyssal plains (ocean floor) are basically flat plains on which are subtle features having slightly higher topography.

General Geologic Description

The Atlantic and Gulf Coasts of North America are passive continental margins formed during the Triassic-Jurassic breakup of the supercontinent called Pangea (**Figure A-2**). As the Gulf was pulled apart, oceanic crust formed in the basin center, and deltas were built into the basin along its western and northern margins. Pull apart of the GOM took place along a series of northwest-southeast trending transform faults, interpreted on the basis of deep seismic data, that formed depositional corridors 40-64 km (25-40 mi) wide (Stephens, 2001, page 137) that profoundly influenced the deposition history of younger sediments (Stephens, 2001, Figures 2, 6, and 7; Stephens, 2009, Figures 1 and 4).

As the GOM opened, a basin was created that was subjected to repetitive episodes of inundation by marine waters and evaporation of those waters that formed salt deposits beginning in the Middle Jurassic (**Figure A-2**). During the Upper Jurassic, emergent highs (horsts) were exposed and subjected to erosion, while adjacent lows (grabens) were filled with overthickened salt and sediment (Stephens, 2009, Figure 2). Repeated flooding and evaporation of the shallow saline waters that filled the basin resulted in a thick, widespread, salt bed (Louann Salt) that was deposited thickest in grabens and thinnest on horsts (Stephens, 2009, Figure 2). Through time, the basin-center oceanic crust cooled, subsided, and was gradually filled with deeper water in which carbonates (limestone, chalk, and reefs) were deposited. The system of transfer faults exhibited varying degrees of relative extensional (pull apart) movement and tectonic subsidence, the results of which are reflected in Tertiary (**Figure A-2**) depositional patterns on top of the basement. Stephens (2010) uses the analogy of a series of piano keys each related to, but independent of, its neighbor as an explanation for how structural corridors responded to the weight of sediment deposited on top of them.

As sediments continued to be deposited atop the Louann Salt in the western and central GOM, the salt became mobilized in response to sedimentary weight beginning in the early Tertiary. A complex suite of salt structures were extruded into overlying sedimentary layers to form simple piercement structures (salt diapirs) along the coast and modern shoreline and, farther out, an extensive salt canopy the terminal edge of which is expressed as the Sigsbee Escarpment (**Figure A-1**). Stephens (2001 and 2009) showed how the architecture of the basement transform fault system has influenced the modern shorelines of the coastal Gulf States and how the modern Mississippi River has been influenced by this basement architecture (Stephens, 2009, page 746).

Major faults that have been mapped onshore Louisiana (Gagliano et al., 2003; Gagliano, 2005) are extensional faults, referred to as "growth faults," with a sense of movement that is down-to-the-basin that form contemporaneously with the rapid accumulation of large volumes of sediment. Growth faults up sedimentary dip are generally coupled to down dip compressional zones that, on the Mississippi Fan, have formed a complex belt of folds (Peel et al., 1995, Figure 12). Faulting caused by the formation of salt diapirs is the most common type of faulting on the upper slope. Faults can be concordant with growth faulting, called regional faults, or salt withdrawal and diapirism can form faults with an orientation in reverse, or counter-regional faults (Stephens, 2009).

The geology of the GOM has been studied in detail for the identification, exploration, and development of natural gas and oil resources. There are two major sedimentary provinces in the Gulf Coast region: a younger Cenozoic province in the western and central GOM; and an older Mesozoic province in the eastern GOM. The Cenozoic Province is a clastic regime, characterized by thick deposits of sand, silt, and mud of Paleocene to Holocene age (65 million years ago [Mya] to present) (**Figure A-2**) underlain by carbonate rocks (limestone, chalk, reefs) of Jurassic and Cretaceous age (205-65 Mya) (Apps et al., 1994; Salvador, 1991; Galloway et al., 1991). The Mesozoic Province is a largely carbonate (limestone and reef buildups) regime that extends eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida (**Figure A-1**) towards the coastline of Florida.

The Cenozoic Era is commonly divided into two geologic periods—Tertiary and Quaternary (**Figure A-2**). The Tertiary Period (65-1.77 Mya) comprises almost all of the Cenozoic, with the shortest period represented by the Quaternary Period (1.77 Mya-Recent) (**Figure A-2**). Over the last 65 million years, the Cenozoic Era, clastic sediments (sands, silts, and clays) from the interior North American continent have entered the GOM basin from the west and north (Apps et al., 1994; Galloway et al., 1991) to form clastic deltaic systems. During the Cenozoic, there were few deltaic systems in the eastern GOM and the terrain drained was largely carbonate rock, resulting in relatively clear water favorable to the formation of carbonate sediments and reef buildups in the marine environment.

Geologists also subdivide the Cenozoic into Epochs of variable duration: from oldest, Paleocene, Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and Holocene (**Figure A-2**). The centers of thick sediment deposition shifted progressively eastward and southward through time in response to changes in the source of sediment supply. In the Paleocene, Eocene, and Oligocene Epochs (65-24 Mya), the Rio Grande River and a system of smaller rivers (Brazos, Colorado, Nueces, etc.) drained the Texas coastal plain and were the main source of sediment supply that built small deltaic systems onto the Texas inner shelf. In the Miocene and Pliocene Epochs (24-1.77 Mya) (**Figure A-2**), the center of sediment deposition shifted eastward as the Mississippi River became the major source of sediments entering the GOM. The modern Mississippi River Delta complex is the present-day reflection of a depositional system that has been building and periodically abandoning successive delta lobes since the Miocene. The course of the river and deltaic lobes built by it were very likely influenced by the basement transform fault-delimited structural corridors identified by Stephens (2001 and 2009). The Mississippi River and Delta deposited a sequence of Tertiary-aged sediments up to 12 km (7.4 mi) thick at the coast that may be as much as 18 km (11.2 mi) thick offshore (Gagliano, 1999). The youngest deltaic lobes built by the Mississippi River over the last 7,000 years of the Holocene Epoch (Frazier, 1967) have been built and abandoned at intervals of about 1,000 years. The subtle topography and geomorphology of the shoreline in the northern GOM are products of ongoing vertical movements along basement transform faults that have operated over the geologic history of the basin (Stephens, 2009, page 747).

Hydrocarbon System

To produce economically viable accumulations of oil and gas, five physical characteristics must occur in the geologic setting. First, rocks must contain an enriched supply of organic material capable of forming oil and gas through the chemical and physical changes that occur during burial (the source rock). Second, a rock with pores and openings that are sufficiently connected to hold and transmit oil or gas after it is generated (the reservoir rock). Third, the hydrocarbons must migrate to reservoir rocks from the source. Fourth, the reservoir rock and the layers above and below it must be structurally and/or stratigraphically configured so as to capture a large accumulation of hydrocarbon resource (the trap). Fifth, the trapping structure (e.g., a fault) or fine-grained rock must overly a reservoir rock or be configured so that the trap prevents the escape of oil or gas (the seal). There is often one more element invoked—timing. That is, these events must be in the proper sequence. For example, a trap may form after oil and gas have migrated through the system to be lost.

Upper Jurassic deposits are considered the major source rocks for gas and oil generation in the GOM. Other source rocks that have been identified in the GOM that may have generated hydrocarbons are as young as Pleistocene-age (approximately 2 Mya) (**Figure A-2**). A geologic “play” is the structural or stratigraphic style of a reservoir rock or trap geometry that is characteristic of a particular geologic age or location on the basin. Different types of hydrocarbon plays occur in each region of the GOM.

Approximately 45,000 wells have been drilled in the GOM. Exploration and development have resulted in the naming of more than 1,270 fields, of which 1,053 were identified, produced, or developed in the GOM (USDOI, MMS, 2006). As of January 1, 2003, the mean undiscovered technically recoverable resources (UTRR) for all plays in the GOM’s Outer Continental Shelf (OCS) are estimated to be 86.30 billion barrel of oil equivalent (BBOE).

In the Gulf of Mexico and the Atlantic OCS, hydrates have been studied for two decades by academia, government agencies, and the oil industry. Naturally occurring gas hydrates have been observed and sampled from the Gulf of Mexico OCS in association with oil and gas seeps in localized deepwater areas of very cold temperature and high pressure at or near the seafloor, and in the shallow subsurface. Seep features, including hydrates, result in higher seismic amplitude (higher reflectivity) detected by seismic surveys. Most hydrate occurrences in the GOM are associated with faulting, which provides migration pathways for gas to reach the zone where hydrates are stable. The geothermal gradient increases with depth, allowing ideal temperatures only in the upper few thousand feet of sediments for hydrates to be stable.

Mesozoic Plays

Mesozoic plays in the Gulf of Mexico OCS extend eastward from the Cretaceous Shelf Edge off the coast of Mississippi, Alabama, and Florida towards the coastline of Florida (**Figure A-1**). Although this area has experienced limited drilling and most control points are on the shelf, some general statements can be made concerning resources. This province is dominated by Mesozoic carbonate rocks overlain by some Cenozoic clastic sediment. The hydrocarbon potential has been realized throughout the entire geologic interval from the very shallow, young portion of the Pleistocene (1,500-4,000 ft; 458-1,220 m) to the intermediate Cretaceous James Formation (14,000-16,000 ft; 4,270-4,880 m) and the deep, older Jurassic Norphlet Formation (15,000-24,000 ft; 4,575-7,320 m). Approximately two dozen fields in the Mesozoic Province produce gas from the shallow Cenozoic. In the area offshore of the Florida Panhandle (Pensacola and Destin Dome), a total of 34 wells have been drilled, with 18 of the wells penetrating the Norphlet. The depths at which the Norphlet is found in the Gulf Coast region varies from less than 5,000 ft (1,525 m) onshore to greater than 24,000 ft (7,320 m) subsea offshore Mississippi and 15,000 ft (4,575 m) subsea in the Apalachicola Embayment.

This province has several potential Mesozoic hydrocarbon plays that are downdip equivalents of onshore productive fields. Carbonate rocks often require favorable diagenesis (physical and chemical alterations to the sediments after deposition), faulting, fracturing, and stratigraphy to enhance what is typically the low porosity and permeability. The variability of the porosity and permeability within a carbonate rock increases the risk in the determination of potential drainage area, production rates, and resource volume when hydrocarbons are discovered.

Approximately 350 wells have been drilled in the Mesozoic Province of the Federal offshore, and less is known about the subsurface geology and its natural gas and oil resource potential. To date, the only discovered Mesozoic fields in the OCS are the Jurassic Norphlet (14 fields), the Cretaceous James (9 fields), and the Cretaceous Andrew (1 field). Most of these fields are located in the northeastern portion of the Central Planning Area (CPA). BOEM has identified 24 plays in the Mesozoic Province: 3 proven and 21 conceptual.

Cenozoic Plays

Plays of the Cenozoic Province extend from offshore Texas eastward across the north-central GOM to the edge of the Cretaceous Shelf Edge (commonly known as the Florida Escarpment) offshore Mississippi, Alabama, and Florida (**Figure A-1**). It incorporates all of the Western Planning Area (WPA), a large portion of the CPA, and the southwestern portion of the Eastern Planning Area (EPA). To date, hydrocarbon production on the OCS in the Cenozoic Province is from reservoir sands ranging in age from Oligocene to Pleistocene (approximately 34-0.2 Mya) (**Figure A-2**).

The hydrocarbon plays in the western and central GOM are typically influenced by salt piercement structures. Because salt is less dense than sand, silt, or clay, it tends to become mobilized as denser sediments are deposited over it. The loading of sediment on the continental shelf in the early Tertiary and the upward movement of salt during the later Tertiary have formed a vast canopy of mobilized salt that has essentially been extruded up and now lie over most of the OCS and slope sediments. The requirements for a good hydrocarbon province are met in the western and central GOM. First, the movement of salt upward pierces overlying sedimentary layers to form structures capable of trapping oil and gas. Piercement structures create pathways for migration of hydrocarbon from Upper Jurassic, Lower Cretaceous, and/or Lower Tertiary source beds to younger reservoir sands. Second, thick sands deposited by deltas or deep-sea fans have been deposited with good porosity (pore space between the sand grains where oil and gas can accumulate) and permeability (connections between the pore spaces through which oil and gas can flow) are good reservoir rocks. Third, impermeable shales, salt, and/or faults serve as seals for trapping oil and gas in reservoir rock pore spaces.

One prolific Cenozoic play is the Mississippi fan fold belt (Peel et al., 1995, Figure 12). The fold belt is formed by down dip compression caused by sediment loading from the Mississippi Delta up sedimentary dip. In the Mississippi Canyon and Atwater protraction areas lie some of the largest fields in the GOM that are part of this play, among them Thunder Horse, the largest single reservoir yet found in the Gulf of Mexico.

The ages of rock from where most hydrocarbon production occurs on the continental shelf and slope are mainly Miocene, Pliocene, and Pleistocene. BOEM has assessed 28 plays in the Cenozoic Province: 27 proven and 1 conceptual play. The Cenozoic productive intervals become thinner with less hydrocarbon potential eastward in the direction of the Cretaceous shelf edge (Mesozoic Province) (**Figure A-2**). The Mesozoic section has been penetrated by wells in the overlap area of the Cenozoic/ Mesozoic Provinces, with commercial hydrocarbons being identified in several fields.

Deep Gas (Continental Shelf)

The clastic sediments (sands and shales) of the GOM were deposited mostly in deltaic depositional systems that are influenced by the location of the sediment source, morphology of the seabed, and the edge of the shelf. Usually the most abundant reservoir rocks are deposited as channel or delta front sands on the shelf. Shifting of the delta complex and ocean currents tend to widely disperse these sands laterally along the shelf. On the shelf, in shallower water, early GOM exploration targeted these sands as potential hydrocarbon traps. In deeper water on the continental slope and abyssal plains, the sands were deposited by turbidite fans, are finer-grained, and gradually become thinner and less depositionally continuous farther from the continental shelf margin.

The present-day shelf was once the slope environment during the Oligocene and Miocene ages (approximately 34-5.3 Mya) (**Figure A-2**) when sea level was higher. The shelf area holds the potential for deepwater delta systems with channels, distributary bars, levees, overbank deposits, and large fan lobes that have been buried, sometimes deeply, by younger Pliocene and Pleistocene depositional systems. Subsequent faulting and salt movement created traps and supplied conduits for the migration of hydrocarbons. Pore pressure increases with depth because of the overburden of the sediments and the amount of water trapped within the sediments. Temperature also increases with depth and can be even higher in areas with less salt intrusions into the sediments. The presence of salt has a cooling effect on the surrounding sediments, causing areas with salt intrusions to have lower temperatures. It is anticipated that these older, deeper reservoirs will be more likely located adjacent to or under the present shelf fields. Deeply buried reservoirs would be subjected to high pressures (HP) and high temperatures (HT). The so-called HPHT environment is one challenging the limits for drilling and strength tolerances of steel.

The shelf off the western and central Louisiana coast is also prospective for the older and deeper Mesozoic age reservoir rocks. These rocks would also be under HPHT conditions because of their depth. The Mesozoic environment of deposition on the shelf is projected to be shallow-water carbonates and reefs.

Deep Water (Continental Slope and Abyssal Plain)

The continental slope in the GOM extends from the shelf edge to approximately 2,000 m (6,562 ft) water depth. The seafloor gradient on the slope varies from 3 to 6 degrees to in excess of 20 degrees in places along the escarpments. At the base of the Cenozoic Province slope is an apron of thick sediment accumulation referred to as the continental rise, inclining seaward from the Sigsbee Escarpment in transition to the abyssal plain.

Bathymetric maps of the continental slope in the northwestern GOM (Bryant et al., 1990; Bouma and Bryant, 1994) reveal the presence of over 105 intraslope basins with relief in excess of 150 m (492 ft), 28 mounds, and 5 major and 3 minor submarine canyons. These intraslope basins occupy much of the area of the continental slope. Hydrocarbon traps adjacent to minibasins and below the salt canopy are common plays on the continental slope.

The middle and lower portions of the Cenozoic Province continental slope contain a canopy of salt, which has moved down-slope in response to sediment loading on the shelf and upper slope. The Sigsbee Escarpment is the southern edge of the canopy within the GOM. Prominent submarine canyons occur along the lower continental slope and rise and the Sigsbee Escarpment (Alaminos, Keathley, Bryant, Cortez, Farnella, and Green Canyons), each evolving from, in part, the coalescing and migration of salt canopies, an unusual process for the formation of submarine canyons (Bouma and Bryant, 1994; Bryant et al., 1990; Bryant et al., 1991). Buried turbidite fans from the slope and rise spilling onto the abyssal plain have been play types in ultra-deepwater (≥5,000 ft; 1,525 m). Submarine fans of various sizes extend seaward of the edge of the Sigsbee Escarpment onto the continental rise. Although slopes in excess of 15 degrees are found, the majority of the slopes along the canyon walls and the escarpment range from 5 to 10 degrees.

Geologic Hazards

The Mississippi River Delta presents a unique set of geologic hazards because of high sedimentation rates that resulted in sediments with high-water-content and low-strength. Under these conditions, the sediments can be unstable, and slope failure or mass transport of sediments can result. These failures can be triggered by cyclic leading associated with hurricanes, overloading or oversteepening of the slope sediments, or uplift associated with movement of salt. These failures can form mudflow gullies, overlapping mudflow lobes, collapse depressions, slumps, and slides. Small, buried, river channels can result in differential sediment compaction and pose a hazard to jackup rigs.

Over-pressure conditions in a sedimentary section can result from loading by rapid deposition, sand collapse, in-leaking gas, or salt tectonics. Drilling through an over-pressured, shallow-gas pocket can cause loss of mud circulation or a blowout (a blowout occurs when improperly balanced well pressure results in sudden uncontrolled release of fluids from a wellbore or wellhead). A shallow-water flow can cause similar drilling problems. Over-pressured conditions can develop in deep water when “water sand” is trapped by a shale seal. Over-pressured formation water may escape around or through the wellbore to the seafloor and wash out the well foundation. No shallow-water flow event in the GOM has resulted in an oil spill. Over-pressured conditions may be found while penetrating naturally occurring gas hydrates below which lies free gas that can cause a loss of well control incident.

Deep drilling may encounter abnormally high geopressures. Deep drilling may also encounter hydrogen sulfide, which can occur near salt domes overlain by caprock and is the product of sulfate reducing microbes.

Potential Mitigation Measures

The best mitigation for most hazards is avoidance after detection by a geophysical survey. Leaseholders are required to run geophysical surveys before drilling in order to locate potential geologic or manmade hazards (30 CFR § 550.214). In deep water, most companies do a remotely operated vehicle (ROV) inspection of the seafloor before drilling begins. Companies are also required to take and analyze sediment borings for platform sites. Areas of hydrogen sulfide occurrences can be predicted and sensors installed on drilling rigs to warn operators. Certain leases also require archaeological surveys and live-bottom surveys to protect sensitive areas. Every application for permit to drill a well in the GOM is reviewed by BOEM geologists, geophysicists, and engineers to ensure compliance with standard drilling practices and BOEM regulations. All rigs and platforms are inspected by the Bureau of Safety Environmental Enforcement on a regular basis to ensure all equipment and procedures comply with Federal regulations for safety and environmental protection.

Geologic Condition	Hazard	Mitigations
Fault	Bend/shear casing Lost circulation Gas conduit	Stronger casing/heavier cement
Shallow Gas	Lost circulation Blowout Crater	Kill mud Pilot hole Circulate mud/drill slower Blowout preventer/diverter Pressure while drilling log
Buried Channel	Jack-up leg punch through	Pre-load rig Mat support All rig legs in same type of sediment
Slump	Bend/shear casing	Thicker casing Coil/flexible pipeline
Water Flow	Erosion/washout Lost circulation	Kill mud, foam cement Pilot hole Pressure while drilling

A.2. PHYSICAL OCEANOGRAPHY

Introduction

The Gulf of Mexico is a semienclosed, subtropical sea with an area of approximately 1.5 million square kilometers (km^2) (5.8×10^5 mi^2). The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits. The continental shelf width along the U.S. coastline is about 10 mi (16 km) off the Mississippi River, and 97 mi (156 km) off Galveston, Texas, decreasing to 55 mi (88 km) off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m (12,139 ft). The water volume of the entire Gulf, assuming a mean water depth of 1 mi (2 km), is 2 million km^3 (4.8×10^5 mi^3). The water volume of the continental shelf, assuming a mean water depth of 50 m (164 ft), is 25,000 km^3 (6,000 mi^3).

The origins of the principal watermasses in the GOM have been identified and include subtropical underwater, Sargasso Sea water, Tropical Atlantic Central Water, Antarctic Intermediate Water, and a deepwater mixture of watermasses **(Table A-1)**. This table excludes the highly variable surface waters observed in the eastern and western Gulf of Mexico (e.g., Nowlin and McLellan, 1967). Watermass property extremes are closely associated with specific density surfaces. All of these subsurface waters derive from outside the Gulf and enter from the Caribbean Sea through the Yucatan Channel. Below about 1,800 m (5,906 ft), horizontal distributions of temperature and salinity within the Gulf are essentially uniform (Nowlin, 1972; **Figure A-3** of this Appendix).

Shelf Circulation

Shelf water temperature and salinity varies seasonally based on changes in river inflow, surface solar heating, winds and related mixing, and downwelling and upwelling processes. Summer heating and stratification affect continental-shelf waters in the Gulf of Mexico and is one factor contributing to summertime hypoxia on the Louisiana-Texas shelf. Salinity is generally lower nearshore due to freshwater inputs from the Mississippi and other rivers. However, these fresh waters occasionally move into outer shelf waters and even out over deep waters of the Gulf, as when entrained by the Loop Current (LC) (Weisberg et al., 2005). Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes.

Continental shelf waves may propagate along the continental slopes of the Gulf of Mexico. These are long waves similar to topographic Rossby Waves (TRW's), but their energy is concentrated along a sloping bottom with shallow water to the right of the direction of propagation, and because of this constraint, they are effectively "trapped" by the sloping bottom topography (Hamilton, 1990).

A class of energetic surface currents was found over the Texas and Louisiana shelves during the Agency-sponsored Texas-Louisiana Shelf Circulation and Transport Process (LATEX) program of the early 1990's (Nowlin et al., 1998). July 1992 observations in 200-m (656-ft) water depth offshore of Louisiana were of maximum amplitudes of 40-60 cm/s (16-27 in/s) at a depth of 12 m (39 ft) during conditions of light winds. The period of diminished amplitudes followed an atmospheric frontal passage. These are near-circular, clockwise-rotating oscillations with a period near 24 hours. They seem to be an illustration of thermally induced cycling (DiMarco et al., 2000) in which high-amplitude rotary currents can exist in thin mixed layers typical of summer. Many examples of such currents, in phase at distinct locations, exist for the Texas-Louisiana shelf and, by implication, farther offshore. Currents at a depth of 1 m (3 ft) have been observed to reach 100 cm/s (40 in/s).

Inner-shelf currents on the Louisiana-Texas continental shelf flow in the downcoast (south or west) direction during nonsummer months, reversing to upcoast flow in the summer (Cochrane and Kelly, 1986; Nowlin et al., 2005). Modeling results show that the spring and fall reversals in alongshore flow can be accounted for by local wind stress alone (Current, 1996). Monthly averaged alongshore currents on the outer shelf are upcoast in the mean, but showed no coherent pattern in the annual signal and were not often in the same alongshore direction at different outer-shelf locations (Nowlin et al., 1998). Mean cross-shelf geostrophic transport observed at the Louisiana-Texas shelf break was offshore during the winter (particularly in the upper 70 m (230 ft) of the water column), and onshore during the summer (Current and Wiseman, 2000).

Circulation on the continental shelf in the northeastern GOM has been observed to follow a cyclonic pattern, with westward alongshore currents prevailing on the inner and middle shelf and opposing alongshore flow over the outer shelf and slope (Brooks, 1991). Inner shelf currents are primarily wind driven and are also influenced by river outflow and buoyancy forcing from water discharged by the Mississippi, Apalachicola, Tombigbee, Alabama, and other rivers in the region. Cold water from deeper off-shelf regions moves onto and off of the continental shelf by cross-shelf flow associated with upwelling and downwelling processes. Upwelling of nutrient rich, cold water onto the shelf in 1998 was correlated with hypoxia, anoxia, and mass mortalities of fishes and invertebrates in the region, although causation has not been established (Collard and Lugo-Fernandez, 1999).

Mean circulation on the West Florida inner shelf tends to be along the coast towards the southeast during the winter, and reverses to be along coast towards the northwest during the summer. These seasonal means in flow direction are because of the influence of seasonal local winds and heat flux forcing. Midshelf flow (around the 50-m ([164-ft] isobath) can be in the opposite direction from inner shelf flow on the broad, gently sloping West Florida shelf because of the partial closure imposed by the Florida Keys to the south. The outer shelf is an area of transition between deepwater currents over the continental slope and the shelf regime. The nearshore regions are influenced by freshwater outflow from rivers and estuaries. Mississippi River water is advected onto the West Florida shelf at times in spring and summer because of strong currents along the shelf break. Fresh water from the Mississippi River is sometimes entrained by the Loop Current as well (Weisberg et al., 2005).

Loop Current and Eddies

Observations and numerical studies have indicated that the Gulf of Mexico basin behaves as a basic two-layer ocean. The circulation in the upper layer upper (surface to depths of ~800-1,200 m [~2,600-3,900 ft]) is dominated by Loop Current and Loop Current Eddy, warm-core rings that episodically separate from the Loop. Strong Loop Current/Loop Current Eddy currents as high as 3 m/s (10 ft/s) have been observed. The lower layer is dominated by deep eddies and TRW's.

The Loop Current, the dominant circulation feature in the Gulf, enters through the Yucatan Channel and exits through the Florida Straits. The sill depth at the Florida Straits is about 700 m (2,300 ft); the effective sill depth at the Yucatan Channel is nearly 2,000 m (6,560 ft) (Badan et al., 2005). Watermasses in the Atlantic Ocean and Caribbean Sea that occur at greater depths cannot enter the Gulf of Mexico. The Loop Current is a part of the western boundary current system of the North Atlantic. This is the principal current and source of energy for the circulation in the Gulf. The Loop Current has a mean area of 142,000 km^2 (5.5 x 10^4 mi^2) (Hamilton et al., 2000). It may be confined to the southeastern GOM or it may extend well into the northeastern or north-central Gulf (**Figure A-3**), with intrusions of Loop Current water northward and on to the West Florida Shelf (Vukovich, 2005).

Closed rings of clockwise-rotating (anticyclonic) water, called Loop Current Eddies (LCE's), separate from the Loop Current at intervals of 5-19 months, with an average of 11 months (Vukovich, 2005). These LCE's are also called warm-core eddies since they surround a central core of warm Loop Current water. The LCE's have diameters of 200-400 km (124-248 mi), rotate with periods of 8-15 days, and travel on average at 4.4 km/day ± 2.9 km/day (2.7 mi/day ± 1.8 mi/day) into the western Gulf (Vukovich, 2007; **Figure A-3** of this Appendix). The Loop Current usually penetrates about as far north as 27°N. latitude just prior to shedding an LCE (Vukovich, 2005). A recent study of satellite-derived Loop Current metrics demonstrated a linear correlation between the retreat latitude of the Loop Current following eddy separation and the subsequent eddy separation period (Lugo-Fernández and Leben, 2010). This study provided a recommended forecasting tool for LCE separation in the Gulf of Mexico. Currents associated with the Loop Current and its eddies extend to at least depths of 700 m (2,300 ft), the sill depth of the Florida Straits, and geostrophic shear is observed to extend to the sill depth of the Yucatan Channel. Warm-core eddies can have life spans of 1 year or more (Elliot, 1982). Therefore, their effects can persist at one location for long periods—weeks or even months (e.g., Nowlin et al., 1998). Energetic, high-frequency currents have been observed when LCE's flow past structures, but they are not well documented. Such currents would be of concern to offshore operators because they could induce structural fatigue of materials. Loop Current eddies decay and generate secondary cyclones and anticyclones (SAIC, 1988) by interactions with boundaries, ring shedding, and ring-ring interactions. The net result is that, at almost any given time, the Gulf is populated with numerous eddies, which are interacting with one another and with the margins (SAIC, 1988; Hamilton and Lee, 2005).

Cold-core cyclonic (counterclockwise rotating) eddies have been observed in the study region as well. These cyclones are often called cold-core eddies, since they surround a central core of seawater that is cooler and fresher than adjacent waters. Cyclonic circulation is associated with upwelling, which brings cooler, deeper water towards the surface. Frontal or cold cyclonic waves form along the edge of the Loop Current, and similar cold cyclones have also been observed on the periphery of Loop Current eddies (Vukovich, 2007). Statistics of cold cyclones include spatial scales of 30-150 km (19-93 mi) in diameter and speeds of 4-26 km/day (~2-16 mi/day) (e.g., Walker et al., 2009). Small cyclonic eddies around 50-100 km (31-62 mi) in diameter have been observed over the continental slope off Louisiana (Hamilton, 1992). These eddies can persist for 6 months or longer and are relatively stationary.

Near the bottom of the Loop Current, velocities are low and fairly uniform in the vertical although with bottom intensification, a characteristic of TRW's. This indicates that the Loop Current is in fact a source of the TRW's, which are a major component of deep circulation below 1,000 m (3,281 ft) in this part of the Gulf (Sturges et al., 1993; SAIC, 1989; Hamilton, 1990). Exchange of surface and deep water occurs with descent of surface water beneath the Loop Current in the eastern GOM and with the ascent of deep water in the northwestern GOM where Loop Current eddies spin down (Welsh and Inoue, 2002). The Sturges et al. (1993) model suggests a surprisingly complex circulation pattern beneath LCE's, with vortex-like and wave-like features that interact with the bottom topography (Welsh and Inoue, 2000). These model findings are consistent with Hamilton's (1990) interpretation of observations. As well, moored current observations in the Loop Current have recently suggested formation of an anticyclone-cyclone pair in the lower layer, as predicted by models, as a response to an upper-layer anticyclone (Hamilton et al., 2011)

The major large-scale permanent circulation feature present in the western and central GOM is an anticyclonic (clockwise-rotating) feature oriented about ENE-WSW with its western extent near 24° N. latitude off Mexico. There has been debate regarding the mechanism for this anticyclonic circulation and the possible associated western boundary current along the coast of Mexico. Elliott (1982) attributed LCE's as the primary source of energy for the feature, but Sturges (1993) argued that wind stress curl over the western Gulf is adequate to drive an anticyclonic circulation with a western boundary current. Sturges (1993) found annual variability in the wind stress curl corresponding to the strongest observed boundary current in July and the weakest in October. Based on ship-drift data, Sturges (1993) showed the maximum northward surface speeds in the western boundary current were 25-30 cm/s (10-12 in/s) in July and about 5 cm/s (2 in/s) in October; the northward transport was estimated to vary from 2.5 to 7.5 m^3/s (88 to 265 ft^3/s). Sturges reasoned that the contribution of LCE's to driving this anticyclonic feature must be relatively small. Others have attributed the presence of a northward flow along the western Gulf boundary to ring-slope-ring interactions (Vidal et al., 1999).

Deepwater Currents

Mean deep (~2,000 m; ~6,562 ft) flow around the edges of the GOM circulates in a cyclonic (counterclockwise) direction (Sturges et al., 2004). A net counterclockwise circulation pattern was also observed at about the 900-m (2,953 ft) depth around the borders of the GOM (Weatherly, 2004).

Occasionally, currents have been directly measured at abyssal depths exceeding 3,000 m (9,843 ft) in the GOM. The major low-frequency fluctuations in velocity of these currents in the bottom 1,000-2,000 m (3,281-6,562 ft) of the water column have the characteristics of TRW's. These long waves have wavelengths of 150-250 km (93-155 mi), periods greater than 10 days, and group velocities estimated at 9 km/day (~6 mi/day). They are characterized by columnar motions that are intensified near the seafloor. They move westward at higher group velocities than the translation velocity of 3-6 km/day (2-4 mi/day) that is typical of anticyclonic eddies. The Loop Current and LCE's are thought to be major sources of these westward propagating TRW's (Hamilton, 1990; Oey et al., 2004). These TRW's transition from short to longer periods in going from east to west over the GOM basin, probably because of bottom slope and regional bathymetric conditions (Donohue et al., 2006).

In general, past observations of currents in the deepwater GOM have revealed decreases in current speed with depth. Bottom current measurements in the deep Gulf of Mexico were synthesized as part of the Agency-funded study *Deepwater Physical Oceanography Reanalysis and Synthesis of Historical Data: Synthesis Report*, which demonstrates mean near-bottom flows of 0.4-21 cm/sec (0.2-8.3 in/sec) (Nowlin, et al., 2001). During late 1999, a limited number of high-speed current events, at times approaching 100 cm/s (39 in/s), were observed at depths exceeding 1,500 m (4,921 m) in the northern GOM (Hamilton and Lugo-Fernandez, 2001; Hamilton et al., 2003). Furrows oriented nearly along depth contours were observed in the region of 90° W. longitude just off the Sigsbee Escarpment and near the Bryant Fan, south of Bryant Canyon, from 91° to 92.5° W. longitude. Depths in those regions range from 2,000 to 3,000 m (6,562-9,843 ft). Speculation based partly on laboratory experimentation is that near-bottom speeds of currents responsible for the furrows that are closest to shore might be 50 cm/s (20 in/s), and possibly in excess of 100 cm/s (39 in/s), and that these currents may be oriented along isobaths and increase in strength toward the escarpment. These currents might be sporadic or quasi-permanent.

In deep water, several oil and gas operators have observed very high-speed currents in the upper portions of the water column. These high-speed currents can last as long as a day. Such currents may have vertical extents of less than 100 m (328 ft), and they generally occur within the depth range of 100-300 m (328-984 ft) in total water depths of 700 m (2,297 ft) or less over the upper continental slope. Maximum speeds exceeding 150 cm/s (59 in/s) have been reported. The mechanisms by which these currents are generated may include motions derived from the Loop Current and associated eddies, motions due to eddy-eddy and/or slope-shelf/eddy interaction, internal/inertial wave motions, instabilities along eddy frontal boundaries, and biases in the data record related to instrument limitations (DiMarco et al., 2004).

Storm Events

Tropical conditions normally prevail over the Gulf from May or June until October or November. Hurricanes increase surface current speeds and cool the surface waters in much the same way as do cold fronts, but they may stir the mixed layer to an even greater depth. Wind events such as tropical cyclones (especially hurricanes), extra tropical cyclones, and cold-air outbreaks can result in extreme waves and cause currents with speeds of 100-150 cm/s (40-59 in/s) over the continental shelves. Examples for the Texas-Louisiana shelf and upper slope are given in Nowlin et al. (1998), and for the Alabama shelf during Hurricane Ivan, examples are given in Mitchell et al. (2005). Other researchers (e.g., Brooks, 1983 and 1984) have measured the effects of such phenomena down to depths of 700 m (2,297 ft) over the continental slope in the northwestern Gulf. Immediately after the passage of Hurricane Katrina, inertial oscillations were generated that caused enhanced surface currents, including maximum surface current speeds greater than 200 cm/s (~80 in/s) at Notice to Lessees Station 42868, located in deep waters (1,082 m, or ~3,550 ft) (USDOI, BOEMRE, 2011). Hurricanes can trigger a series of internal waves with near inertial period. Surface waves and sea state may limit normal oil and gas operations as well as oil-spill response activities (French et al., 2005; Fingas, 2001). Waves as high as 91 ft (28 m) were measured under Hurricane Ivan (Wang et al., 2005). Recently, a new mode was found to transport hurricane energy downward related to the sea-level rise near the storm eye (Welsh et al., 2009; Cole and DiMarco, 2010).

Cold fronts, as well as diurnal and seasonal cycles of heat flux at the air/sea interface, affect near-surface water temperatures, although water at depths greater than about 100 m (328 ft) remains unaffected by surface boundary heat flux. Water temperature is greater than air temperature at the air/sea interface during all seasons. Frontal passages over the region can cause changes in temperature and velocity structure in the upper layers, specifically increasing current speeds and variability. These fronts tend to occur with frequencies from 3 to 10 days (weatherband frequency). In the winter, the shelf water is nearly homogeneous due to wind stirring and cooling by fronts and winter storms.

A.3. METEOROLOGICAL CONDITIONS

The GOM is influenced by a maritime subtropical climate controlled mainly by the clockwise circulation around the semipermanent area of high barometric pressure commonly known as the Bermuda High. The GOM is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly southeasterly flow in the GOM region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months, December through March, cold fronts associated with cold continental air masses influence mainly the northern coastal areas of the GOM. Behind the fronts, strong north winds bring drier air into the region. Tropical cyclones may develop or migrate into the GOM during the warmer months. These storms may affect any area of the GOM and may substantially alter the local wind circulation around them. In coastal areas, the sea-breeze effect may become the primary circulation feature during the summer months of May through October. In general, however, the subtropical maritime climate is the dominant feature in driving all aspects of the weather in this region; as a result, the climate shows very little diurnal or seasonal variation.

Selected climatological data for a few selected Gulf coastal locations can be found in **Table A-2**. The western extension of the Bermuda High dominates the circulation throughout the year, weakening in the winter and strengthening in the summer. The average monthly pressure shows a west to east gradient along the northern Gulf during the summer. In the winter, the monthly pressure is more uniform along the northern Gulf. The minimum average monthly pressure occurs during the summer. The maximum pressure occurs during the winter as a result of the presence and influence of transitional continental cold air.

Average air temperatures at coastal locations vary with latitude and exposure. Air temperature ranges from highs in the summer of 24.7-28.0 ^{o}C (76.5-82.4 ^{o}F) to lows in the winter of 2.1-21.7 ^{o}C (35.8-71.1 ^{o}F). Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperatures over the open Gulf exhibit narrower limits of variations on a daily and seasonal basis due to the moderating effect of the large bodies of water. The average temperature over the center of the Gulf is about 29 ^{o}C (84 ^{o}F) in the summer and between 17 and 23 ^{o}C (63 and 73 ^{o}F) in the winter.

The relative humidity over the Gulf is high throughout the year. Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer when prevailing southerly winds bring in warm, moist air. The climate in the southwestern GOM is relative dry.

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the land and sea breeze regime. During the relatively constant summer conditions, the southerly position of the Bermuda High generates predominantly southeasterly winds, which become more southerly in the northern Gulf. Winter winds usually blow from easterly directions with fewer southerlies but more northerlies.

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. Stations along the entire coast record the highest precipitation values during the warmer months of the year. The warmer months usually have convective cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDOC, 1967; Brower et al., 1972). The month of maximum rainfall for most locations is July. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. Snowfalls are rare, and when frozen precipitation does occur, it usually melts on contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward, but visibility has been less than 800 m (2,625 ft) due to offshore fog. Coastal fogs generally last 3-4 hours, although particularly dense sea fogs may persist for several days. The poorest visibility conditions occur during winter and early spring. The period from November through April has the lowest visibility. Industrial pollution and agricultural burning also impact visibilities.

The mixing height is very important because it determines the volume available for dispersing pollutants. Because the mixing height is directly related to vertical mixing in the atmosphere, a mixed layer is expected to occur under neutral and unstable atmospheric conditions. The mixing height tends to be lower in winter, and daily changes are smaller than in summer.

The GOM is part of the Atlantic tropical cyclone basin. Tropical cyclones generally occur in summer and fall seasons; however, the Gulf also experiences winter storms or extratropical storms. These winter storms generally originate in middle and high latitudes and have winds that can attain speeds of 15-26 m/sec (11.2-58.2 miles per hour). The Gulf is an area of cyclone development during cooler months due to the contrast of the warm air over the Gulf and the cold continental air over North America. Cyclogenesis, or the formation of extratropical cyclones, in the GOM is associated with frontal overrunning (Hsu, 1992). The most severe extratropical storms in the Gulf originate when a cold front encounters the subtropical jetstream over the warm waters of the Gulf. Statistics of 100-year data of extratropical cyclones reveal that most activity occurs above 25° N. latitude in the western GOM. The mean number of these storms ranges from 0.9 near the southern tip of Florida to 4.2 over central Louisiana (Ford et al., 1988).

The frequency of cold fronts in the Gulf exhibits similar patterns during the 4-month period of December through March. During this time, the area of frontal influence reaches 10° N. latitude. Frontal frequency is about nine fronts per month (1 front every 3 days on the average) in February and about seven fronts per month in March (1 front every 4-5 days on the average). By May, the frequency decreases to about four fronts per month (1 front every 7-8 days) and the region of frontal influence retreats to about 15° N. latitude. During June-August, frontal activity decreases to almost zero and fronts seldom reach below 25° N. latitude (Ford et al., 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the GOM. Tropical cyclones occur most frequently between June and November. Based on 50 years of data, there are about 9.6 storms per year with about 5.9 of those becoming hurricanes in the Atlantic Ocean. Data from 1950 to 2000 show that 79 percent of these storms, or 4.7 storms per year, will affect the GOM (Klotzbach and Gray, 2005). The Yucatan Channel is the main entrance of Atlantic storms into the GOM, and a reduced translation speed over Gulf waters leads to longer residence times in this basin.

There is a high probability that tropical storms will cause damage to physical, economic, biological, and social systems in the Gulf. Tropical storms also affect OCS operations and activities; platform design needs to consider the storm surge, waves, and currents generated by tropical storms. Most of the damage is caused by storm surge, waves, and high winds. Storm surge depends on local factors, such as bottom topography and coastline configuration, and storm intensity. Water depth and storm intensity control wave height during hurricane conditions. Sustained winds for major hurricanes (Saffir-Simpson Category 3 and above) are higher than 49 m/sec (109.6 miles per hour). During the past few years, the Gulf Coast States have been impacted by several major hurricanes—Hurricanes Lili (2002), Ivan (2004), Katrina (2005), Rita (2005), Gustav (2008), and Ike (2008). Hurricane Isaac (2012) was a Category 1 hurricane; it only caused minor damage to offshore facilities in the Gulf of Mexico. The reduced hurricane activity in 2012 is mainly due to an anomalously cool tropical Atlantic.

A.4. ARTIFICIAL REEFS AND RIGS-TO-REEFS DEVELOPMENT

Artificial reefs have been used along the coastline of the U.S. since the early 19th century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

The long-standing debate as to whether artificial reefs contribute to biological production or merely attract the associated marine resources still continues within the scientific arena. The generally accepted conclusion is that artificial reefs both attract and produce fish. This conclusion depends on a variety of factors, such as associated species, limiting environmental factors, fishing pressure, and type of materials used. The degree to which any of the above factors can be controlled will dictate whether any particular artificial reef attracts fish or produce fish. In reality, many artificial reefs probably do both attract and produce fish at the same time.

The U.S. Congress passed the National Fishing Enhancement Act (NFEA) in 1984. The NFEA called for the development of a national plan to provide guidance to those individuals, organizations, and agencies interested in artificial reef development and management. The NFEA directed the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan (NARP) to promote and facilitate responsible and effective use of artificial reefs using the best scientific information available. In 1985, the National Oceanic and Atmospheric Administration’s (NOAA) National Marine Fisheries Service wrote and completed the NARP. The NARP states that properly designed, constructed, and located artificial reefs can enhance the habitat and diversity of fishery resources, enhance U.S. recreational and commercial fishing opportunities, increase the energy efficiency of recreational and commercial fisheries, and contribute to the U.S. coastal economies.

The NARP provides general criteria for the selection of materials for artificial reefs. These criteria include the following: (1) function, which is related to how well a material functions as reef habitat; (2) compatibility, which is related to how compatible a material is with the environment; (3) durability, which is related to how long a material will last in the environment; (4) stability, which is related to how stable a material will be when subject to storms, tides, currents, and other external forces; and (5) availability, which is related to how available a material is to an artificial reef program.

One of the most significant recommendations in the NARP was to encourage the development of State-specific artificial reef plans. The Gulf States Marine Fisheries Commission (GSMFC) and Atlantic States Marine Fisheries Commission (ASMFC) began to coordinate State artificial reef program activities for States along the coast of the Gulf of Mexico and Atlantic Ocean, respectively. Most of the States along the Gulf and Atlantic Coasts have taken a leadership role in artificial reef development and management, having developed state-specific plans, and established protocols for siting, deployment, and evaluation of materials for artificial reefs. Each commission formed working committees comprised of State artificial reef program personnel and representatives from the appropriate Federal agencies, including BOEM. Artificial Reef Working Committees of the GSMFC and ASMFC meet jointly to discuss artificial reef issues of a national scope and separately to discuss issues specific to the Gulf and Atlantic regions. As a result, these committees have been influential in shaping regional and national artificial reef policies and effecting future positive program changes within State and Federal agencies. The working committees have developed guidelines for marine artificial reef materials. The guidelines provide State and Federal agencies and the general public information related to the history, identification of the benefits, drawbacks, and limitations, and use of selected materials for use in the development of marine artificial reefs. In 2007, NOAA created the *National Artificial Reef Plan (as Amended): Guidelines for Siting, Construction, Development, and Assessment of Artificial Reefs*; this document reflects the working committee’s recommendations to NOAA Fisheries Service for revisions to the original National Artificial Reef Plan (USDOC, NOAA, 2007).

State Artificial Reef Programs

All of the five Gulf Coast States—Texas, Louisiana, Mississippi, Alabama, and Florida—have artificial reef programs and plans. The following are brief descriptions of each State’s artificial reef program. The States’ artificial reef planning areas, general permit areas, and permitted artificial reef sites within the area of influence considered in this EIS are shown in **Figure A-4**.

Texas

In 1989, the Texas State legislature passed the State's Artificial Reef Act. The Act provided guidance for planning and developing artificial reefs in a cost-effective manner to minimize conflicts and risk to the environment. The Act also directed the Texas Parks and Wildlife Department to promote, develop, maintain, monitor, and enhance the artificial reef potential in State waters and in Federal waters adjacent to Texas. The Act defined an artificial reef as a structure constructed, placed, or permitted in the navigable water of Texas or water of the Federal Exclusive Economic Zone adjacent to Texas for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities. To fulfill these purposes, the Department was directed to develop a State artificial reef plan in accordance with Chapter 89 of the Texas Parks and Wildlife code. Texas artificial reefs are mostly retired oil and gas platforms, liberty ships, and military hardware (battle tanks and armored vehicles).

Louisiana

In response to the NFEA, the Louisiana Artificial Reef Initiative combined the talents of university, State, Federal, and industry representatives to develop an artificial reef program for the State of Louisiana. As a result, the Louisiana Fishing Enhancement Act (Act 100) became law in 1986. Subsequently, the Louisiana Artificial Reef Plan was written and contains the rationale and guidelines for the implementation and maintenance of the State artificial reef program. The State plan is implemented under the leadership of the Louisiana Department of Wildlife and Fisheries.

The Louisiana Artificial Reef Initiative approved nine artificial reef planning areas where artificial reefs can be sited (Kasprzak and Perret, 1996). Artificial reef complexes are established within the planning areas on the basis of the best available information regarding bottom type, currents, bathymetry, and other factors affecting performance and productivity of the reefs. As of June 2012, Louisiana has 27 inshore artificial reef sites, and as of September 2012, Louisiana has 69 offshore artificial reef sites (Louisiana Dept. of Wildlife and Fisheries, 2012). Retired oil and gas platforms are the primary materials that have been use within the Louisiana artificial reef program. Military battle tanks have also been deployed offshore Louisiana for artificial reefs.

Mississippi

Mississippi's artificial reef efforts began in the 1960's. A group consisting primarily of charter boat operators and recreational fishermen obtained funding from their local coastal counties and constructed a car body reef site in the early 1960's. In 1972, the Mississippi Marine Conservation Commission, the organizational predecessor of the current Mississippi Department of Marine Resources, acquired five surplus liberty ships for artificial reefs. This liberty ship project was completed in 1978. The excess funds from the project and the reef permits were transferred to Mississippi Gulf Fishing Banks, Inc., a private reef-building organization made up of conservationists, charter boat operators, and recreational fishermen.

Presently, Mississippi has 67 nearshore reefs and 15 offshore reefs (Mississippi Dept. of Marine Resources, 2012). Most of the offshore sites are located within 16-23 km (10-14 mi) from shore. Artificial reef materials used on these sites include liberty ships, rig quarters, tugboats, barges, boxcars, buses, dumpsters, concrete modules, tires, and oil and gas platforms. All of Mississippi's reef sites have active reef permits, and suitable material can be deployed at these sites as they become available (Brainard, 1996).

Alabama

Alabama's artificial reef efforts began in 1953. The first reef project resulted in the placement of 250 automobile bodies in water depths of 20-30 m (66-98 ft) offshore Baldwin County. The Alabama Department of Conservation and Natural Resources is the responsible State agency for artificial reef development in State and Federal waters. Alabama's most impressive and lasting contribution to artificial reef activities is the acquisition and placement of five liberty ships in five locations in Alabama's offshore waters, which provide excellent offshore fishing opportunities for recreational fisherman. In 1986 and 1987, the Alabama Department of Conservation and Natural Resources was granted by the U.S. Army Corps of Engineers (COE) two artificial reef, general permit areas (Don Kelly North and Don Kelly

South) offshore Baldwin County. In 1991, a third artificial reef general permit area (Hugh Swingle) was granted by the COE offshore Mobile County. In 1997, a proposal for extension of the three general permit areas was requested by the Alabama Department of Conservation and Natural Resources and permits were issued that year by COE (Tatum, 1993). Alabama has used a large variety of materials (e.g., shell, concrete, automobile, vehicle tires, aircraft, railroad cars, steel and wooden vessels, oil and gas platforms, and military battle tanks) for reefs in its artificial reef program. Alabama has 21 inshore artificial reef sites and 5 offshore artificial reef general permitting areas that encompass 3,263 km^2 (1,260 mi^2) (Alabama Dept. of Conservation and Natural Resources, 2008).

Florida

Florida's first permitted artificial reef site was issued in 1918 (Pybas, 1991). A rapid proliferation of artificial reef sites began in 1980. In the past 25 years, over 300 reef sites have been established in State and Federal waters off 34 of Florida's 35 coastal counties on both the Gulf and Atlantic Coasts, and more than 2,000 documented artificial reefs have been placed off Florida's coastal counties. Artificial reefs were built at water depths ranging from less than 3 m (10 ft) to greater than 200 m (656 ft). For the past 25 years, Florida's artificial reef program has been a cooperative effort of local governments and State agencies with additional input provided by nongovernmental fishing and diving interests. The Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries, manages the State's artificial reef program. The primary objective of the State's program has been to provide grants-in-aid to local coastal governments to develop artificial fishing reefs in State and adjacent Federal waters to increase local sportfishing resources and enhance sportfishing opportunities (Dodrill and Horn, 1996; Maher, 1999). Florida has used a large variety of materials previously mentioned for reefs within their artificial reef program.

Rigs-to-Reefs Development

Rigs-to-Reefs (RTR) is a catchy term for converting obsolete, nonproductive, offshore oil and gas platforms to designated artificial reefs (Dauterive, 2000). Offshore oil and gas platforms began functioning as artificial reefs in 1947 when Kerr-McGee completed the world's first commercially successful oil well in 5.6 m (18 ft) of water, 70 km (44 mi) south of Morgan City, Louisiana. Approximately 3,000 offshore oil and gas platforms exist on the Gulf of Mexico OCS beyond State territorial waters, with most (>90%) occurring offshore the States of Louisiana and Texas. The distribution of offshore platforms across the Gulf of Mexico is shown in **Figure A-5**. Placed with the primary intent of producing oil and/or gas, offshore platforms also provide artificial substrate and marine habitat where natural hard-bottom habitat is at a minimum. These platforms form the largest artificial reef complex in the world (Stanley and Wilson, 2000).

BOEM and BSEE regulations require that platforms be removed within 1 year after termination of the lease and that the platform be disposed onshore. Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry, but it can be a loss of productive marine habitat (Kasprazak and Perret, 1996). The use of obsolete oil and gas platforms for reefs has proven to be highly successful. Their availability, design profile, durability, and stability provide a number of advantages over the use of traditional artificial reef materials. To capture this valuable fish habitat, the States of Florida, Louisiana, Alabama, Texas, and Mississippi in 1982, 1986, 1987, 1989, and 1999, respectively, passed enabling legislation and signed into law RTR plans for their respective States. Alabama and Florida have no RTR legislation; however, both States have oil and gas platforms in their programs. The distribution of RTR locations across the Gulf of Mexico is shown in **Figure A-6**.

The State laws set up a mechanism to transfer ownership and liability of the platform from oil and gas companies to the State when the platform ceases production and the lease is terminated. The company (donor) saves money by donating a platform to the State (recipient) for use as a reef rather than scrapping the platform onshore. The industry then donates 50 percent of the savings to the State to run the State's artificial reef program. Since the inception of the RTR plans, more than 420 retired platforms have been donated and used for reefs offshore of the Gulf Coast States. **Table A-3** shows the RTR donations by State.

A.5. CLIMATE CHANGE

Climate change is included as an impacting factor in the cumulative analysis of some resources. The resources that include climate change as a cumulative impact factor meet one or both of the following two criteria:

- the resource is already experiencing impacts from climate change, so the effects are observable and not speculative; and
- the resource will be directly or indirectly affected by warming temperatures that can be projected.

Warming of the Earth's climate system is occurring, and most of the measured increase in average global temperature since the mid-20th century is attributed to the measured increase in anthropogenic greenhouse gas concentrations (Intergovernmental Panel on Climate Change, 2007). The NOAA's *State of the Climate* reports 10 indicators for a warming climate (Blunden et al., 2011; Cook, 2010a). All of these indicators are moving in the direction of the 10 indicators (up or down) and show conditions on the Earth's surface consistent with that of a warming planet.

1. Sea ice: down
2. Snow cover: down
3. Glaciers: down
4. Humidity: up
5. Temperature over oceans: up
6. Sea-surface temperature: up
7. Ocean heat content: up
8. Sea level: up
9. Temperature over land: up
10. Air temperature near surface (troposphere): up

The full body of evidence in climate science shows a number of distinct and discernible human fingerprints on climate change (Cook, 2010b). Among these would be

- cooling and shrinking upper atmosphere (satellite measurements show warming lower atmosphere, less heat to warm upper atmosphere, symptom of greenhouse gas trapping);
- less oxygen in the air (ratio of O_2/CO_2 decreasing);
- less heat escaping to space and more heat returning to Earth (satellite measurement of infrared radiation, greenhouse gases returning infrared radiation to Earth);
- nights warming faster than days and winter warming faster than summer (greenhouse gases inhibit heat radiating out to space);
- more fossil-fuel carbon in the air and in sea coral (ratio of Carbon_{13} to Carbon_{12} decreasing); and
- pattern of ocean warming (world's oceans warming from surface downward).

Globally, many environmental effects have been documented, including widespread changes in snow melt and ice cap extent; spatial changes in precipitation patterns; changes in the frequency of extreme weather events; changes in stream flow and runoff patterns in snow-fed rivers; warming of lakes and rivers, with effects on thermal structure and water quality; changes in the timing of spring events such as bird migration and egg laying; and poleward or altitude shifts in ranges of plant and animal species (Intergovernmental Panel on Climate Change, 2007). Documented changes in marine and freshwater biological systems are associated with rising water temperatures, as well as changes in salinity, oxygen levels, and circulation. These changes include shifts in ranges and changes in algal, plankton, and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers (Intergovernmental Panel on Climate Change, 2007).

The U.S. Global Change Research Program (2009) has summarized regional climate changes for the southeastern U.S. (including the Gulf Coast States). Since 1970, average annual temperature has risen approximately 2 °F (1.1 °C) and the number of freezing days has declined by 4-7 days per year. Average autumn precipitation has increased 30 percent since 1901. There has been an increase in heavy downpours in many parts of the region, while the percentage of the region experiencing moderate to severe drought increased over the past three decades. The area of moderate to severe spring and summer drought has increased by 12 percent and 14 percent, respectively, since the mid-1970's. Texas, Louisiana, and Oklahoma experienced severe drought conditions in 2011 (Blunden et al., 2011). Continuing changes in precipitation could affect the water quality and marine ecology of the GOM by altering the quantity and quality of runoff into estuaries.

Over the next century, the Intergovernmental Panel on Climate Change (2007) projects that global temperature increases will cause significant global environmental changes, including the following: reductions in snow cover and sea ice; more frequent extreme heat waves and heavy precipitation events; an increase in the intensity of tropical cyclones (hurricanes); and numerous hydrological, ecological, social, and health effects. Regionally, the U.S. Global Change Research Program (2009) predicts similar long-term changes for the southeastern U.S., including increased shoreline erosion because of sea-level rise and increases in hurricane intensity; heat-related stresses for people, plants, and animals; and decreased water availability because of increased temperature and longer intervals between rainfall events. The resilience of many ecosystems is likely to be stressed because of major changes in ecosystem structure and function, species' ecological interactions, and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem function (Intergovernmental Panel on Climate Change, 2007).

Reasonably foreseeable marine environmental changes in the GOM that could result from climate change over the next century include changes in sea level and shoreline configuration; increased levels of beach restoration activity (and increased use of OCS sand sources); changes in estuaries and coastal habitats due to interactive effects of climate change, along with development and pollution; and impacts on calcification in plankton, corals, crustaceans, and other marine organisms because of ocean acidification (The Royal Society, 2005).

Over the next two decades, the Intergovernmental Panel on Climate Change (2007) projected a warming of about 0.2 °C (32.4 °F) per decade; environmental changes in the GOM that result from climate change are likely to be small, incremental, and difficult to discern from effects of other natural and anthropogenic factors. While continuing climate change could result in changing regional ecological and socioeconomic patterns and distributions in the GOM, the rates and direction of many of these changes are somewhat speculative. The effects of climate change tend to be more pronounced at higher latitudes. These effects can be more subtle in the GOM with its subtropical climatic regime.

A.5.1. Physical Resources

Physical resources include (1) water quality, (2) air quality, and (3) acoustic environment. Climate change predictions are based on models that simulate all relevant physical processes under a variety of projected greenhouse gas emission scenarios. Because the complexity of modeling global and regional climate systems is so great, uncertainty in climate projections can never be eliminated. The Intergovernmental Panel on Climate Change's (2007) projections relating generally to water and water quality include the following:

- sea level will rise by 0.18-0.59 m (0.59-1.94 ft) by the end of the 21st century;
- sea ice, glaciers, and ice sheets in polar regions will continue melting;
- ocean pH will decrease by 0.14 to 0.35 over the 21st century;
- tropical cyclones will become more intense (>66% likely);
- precipitation will increase at high latitudes (>90% likely); and

- annual river discharges (runoff) will increase by 10-40 percent at high latitudes and decrease by 10-30 percent in the dry regions at mid-latitudes.

The Gulf of Mexico region has already experienced increasing atmospheric temperatures since the 1960's. From 1900 to 1991, sea-surface temperatures increased in coastal areas and decreased in offshore areas. Sea-level rise along the northern coast is as high as 0.01 m/yr (0.03 ft/yr), and it has contributed to the loss of coastal wetland and mangroves and increased the rates of shoreline erosion. Future sea-level rise is expected to cause saltwater intrusion into coastal aquifers, potentially making some unsuitable as potable water supplies. Significant changes (increases or decreases) in precipitation and river discharges to the Gulf of Mexico would affect salinity and water circulation, which, in turn, affects water quality. Water quality impacts associated with increased river discharges result from increases in nutrients (nitrogen and phosphorous) and contaminants to estuaries, increases in harmful algal blooms, and an increase in stratification. Such changes could also affect dissolved oxygen content and the extent of the Gulf of Mexico hypoxic zone. Decreased discharge would diminish the flushing of estuaries and increase concentrations of pathogens.

Air quality and the acoustic environment will not be directly or indirectly affected by warming temperatures of climate change.

A.5.2. Coastal and Estuarine Habitats

Coastal and estuarine habitats include (1) barrier islands, beaches, and dunes; (2) wetlands; and (3) submerged seagrass communities.

Indirect effects from global climate change include changes in temperature, rainfall, alteration in stream flow and river discharge, sea-level rise, changes in hurricane frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and subsidence (Yanez-Arancibia and Day, 2004). Potential thermal expansion of ocean water and the melting of glaciers and ice caps could result in a global rise in mean sea level according to the Intergovernmental Panel on Climate Change's projections. Recent rates of sea-level rise have been approximately 3 mm/yr (0.12 in/yr), but this rate may increase to 4 mm/yr (0.16 in/yr) by 2100 (Blum and Roberts, 2009). Sea-level rise could result in increased inundation of barrier beaches and increases in losses of beach habitat. Effects of sea-level rise include damage from inundation, floods and storms, and erosion (Nicholls et al., 2007). Effects of increased storm intensity include increases in extreme water levels and wave heights and increases in episodic erosion, storm damage, risk of flooding, and defense failure (Nicholls et al., 2007). The small tidal range of the Gulf Coast increases the vulnerability of coastal habitats to the effects of climate change.

Patterns of erosion and accretion can also be altered along coastlines (Nicholls et al., 2007). Sea-level rise would result in greater inundation of coastal wetlands and likely result in an acceleration of coastal wetland losses, particularly in Louisiana, as wetlands are converted to open water. In addition, large changes in river flows into the Gulf could affect salinity and water circulation in estuaries, which, in turn, could impact estuarine wetland communities.

A study of coastal vulnerability along the entire U.S. Gulf Coast found that 42 percent of the mapped shoreline was classified as being at very high risk of coastal change due to factors associated with future sea-level rise (Thieler and Hammar-Klose, 2000). A revised coastal vulnerability index study of the coast from Galveston, Texas, to Panama City, Florida, indicated that 61 percent of that mapped coastline was classified as being at very high vulnerability, with coastal Louisiana being the most vulnerable area of this coastline (Pendleton et al., 2010).

A.5.3. Marine Benthic and Pelagic Habitats

Marine benthic and pelagic habitats include (1) topographic features and (2) chemosynthetic and nonchemosynthetic benthic communities.

In the benthic and pelagic habitats of the Gulf of Mexico, climate change may cause the temporal variability of key chemical and physical parameters—particularly hydrology, dissolved oxygen, salinity, and temperature—to change or increase, which could significantly alter the existing structure of the benthic and phytoplankton communities (Rabalais et al., 2010). For example, freshwater discharge into the Gulf of Mexico has been increasing, and it is expected to continue to increase as a result of the increased rainfall in the Mississippi River Basin (Dai et al., 2009). Such changes could result in severe long-term or short-term fluctuations in temperature and salinity that could reduce or eliminate sensitive species. Such changes are most likely to occur in the Mississippi Estuarine Ecoregion, where freshwater inputs are highest. In addition, greater rainfall may increase inputs of nutrients into the Gulf of Mexico, potentially resulting in more intense phytoplankton blooms that could promote benthic hypoxia (Rabalais et al., 2010). Hypoxic or anoxic conditions can reduce or eliminate the suitability of benthic habitat for marine organisms.

Climate change has the potential to profoundly affect coral communities in several ways including the following:

- increased frequency of bleaching as a stress response to warming water temperatures (Hoegh-Guldberg et al., 2007);
- excessive algal growth on reefs and an increase in bacterial, fungal, and viral agents (Boesch et al., 2000; Twilley et al., 2001);
- greater frequency of mechanical damage to corals from greater severity of tropical storms and hurricanes (Janetos et al., 2008);
- decreases in the oceanic pH and carbonate concentration are expected to reduce the reef formation rate, weaken the existing reef structure, and alter the composition of coral communities (Janetos et al., 2008); and
- platforms could accelerate the spread of invasive species that increase their range due to climate change.

As climate change has the potential to affect warm-water corals, it could affect cold-water *Lophelia* reefs. The saturation depth of aragonite (the primary carbonate formed used by hard corals) appears to be a primary determinant of deepwater coral distribution, with reefs forming in areas of high aragonite solubility (Orr et al., 2005). The depth at which the water is saturated with aragonite is projected to become shallower over the coming century, and most cold-water corals may be in undersaturated waters by 2100 (Orr et al., 2005). Consequently, the spatial extent, density, and growth of deepwater corals may decrease, diminishing their associated ecosystem functions (Orr et al., 2005).

Chemosynthetic and nonchemosynthetic benthic communities will not be directly or indirectly affected by warming temperatures of climate change.

A.5.4. Marine and Coastal Fauna

Marine and coastal fauna include (1) marine mammals, (2) beach mice, (3) sea turtles, (4) fish and essential fish habitat, (5) coastal and marine birds, and (6) *Sargassum*.

Marine mammal populations throughout the Gulf may be adversely affected by climate change and, to a lesser extent, by hurricane events. There is growing evidence that climate change is occurring, and potential effects in the Gulf may include a change (i.e., rise) in sea level or a change in water temperatures. Such changes could affect the distribution, availability, and quality of feeding habitats and the abundance of food resources. The U.S. Global Change Research Program (2009) predicts increased shoreline erosion because of sea-level rise and increases in hurricane intensity and a precipitous decline in wetland-dependent fish and shellfish populations as a result of coastal marsh landlosses. Changes in sea level and shoreline configuration could adversely affect sea turtle nesting beaches, along with attempts to restore beaches.

Potential impacts on pelagic and water column invertebrates resulting from climate change include the following:

- an increase in the range and temporal variability of a water column's oxygen, salinity, and temperature;
- a reduction in important estuarine habitats from sea-level rise;
- a range expansion of new species into the Gulf of Mexico;
- an increase in the extent and duration of Gulf of Mexico hypoxia that could kill or displace existing and suitable habitat areas; and

- reduced oceanic pH that could reduce the fitness of calcifying marine organisms such as echinoderms, zooplankton, and mollusks.

Beach mice populations may be affected by habitat fragmentation or inundation of the supratidal dunes where they live from rising sea levels. Fish and essential fish habitat, coastal and marine birds, and *Sargassum* will not be directly or indirectly affected by warming temperatures of climate change.

A.5.5. Social, Cultural, and Economic Resources

Social, cultural, and economic resources include (1) commercial and recreational fishing, (2) archaeological resources, (3) recreational resources, (4) human resources and land usage, and (5) environmental justice.

Rising relative sea levels and increased erosion have been observed all along the coast (Field et al., 2007). It is anticipated that climate change will result in increased temperatures and rising relative sea levels along the Gulf Coast, accompanied by an increase in severe storms in the coming decades. People who rely on commercial and recreational fishing are predicted to be most vulnerable to adverse effects resulting from these changes (Nicholls et al., 2007).

Archaeological resources, recreational resources, human resources and land usage, and environmental justice will not be directly or indirectly affected by warming temperatures of climate change.

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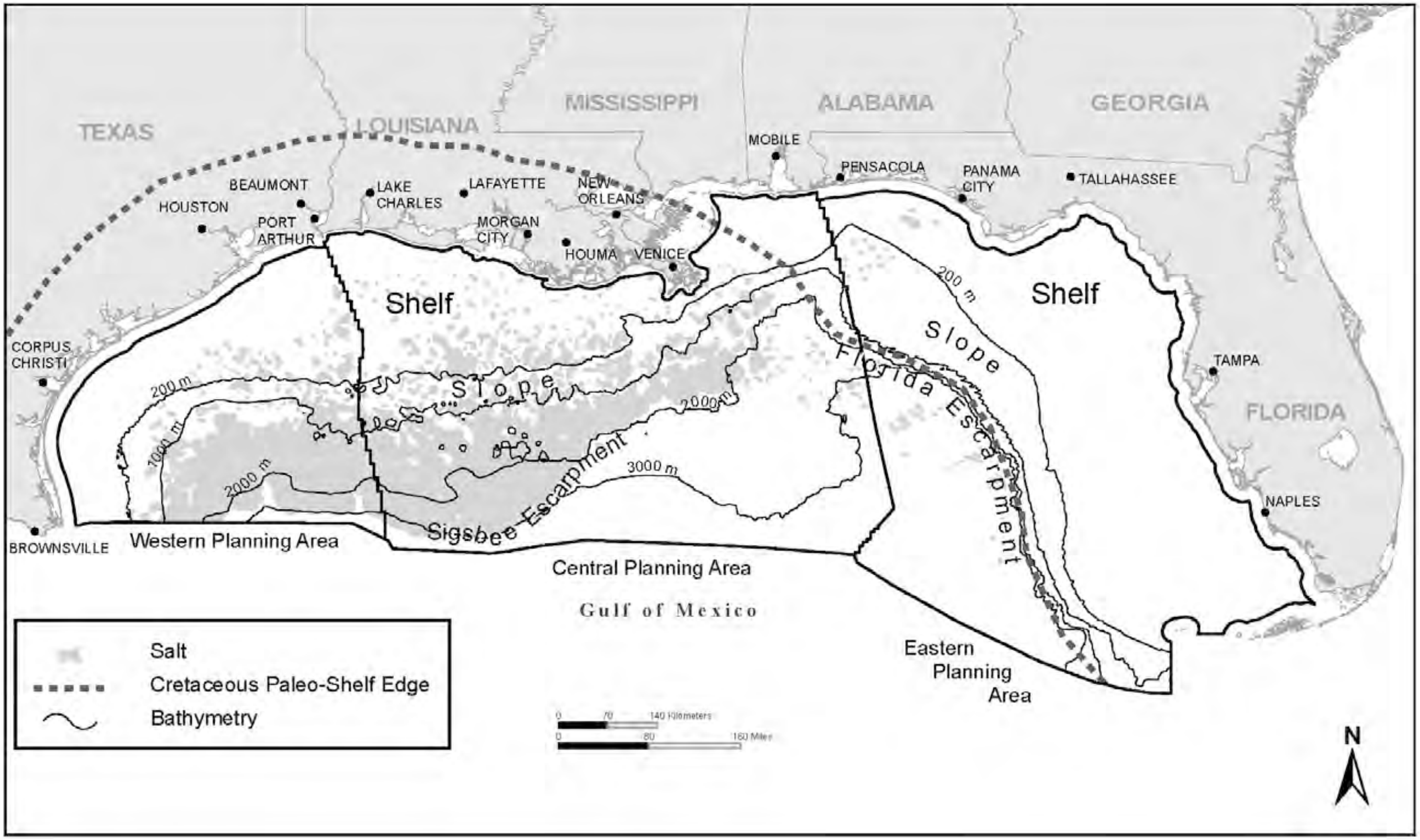
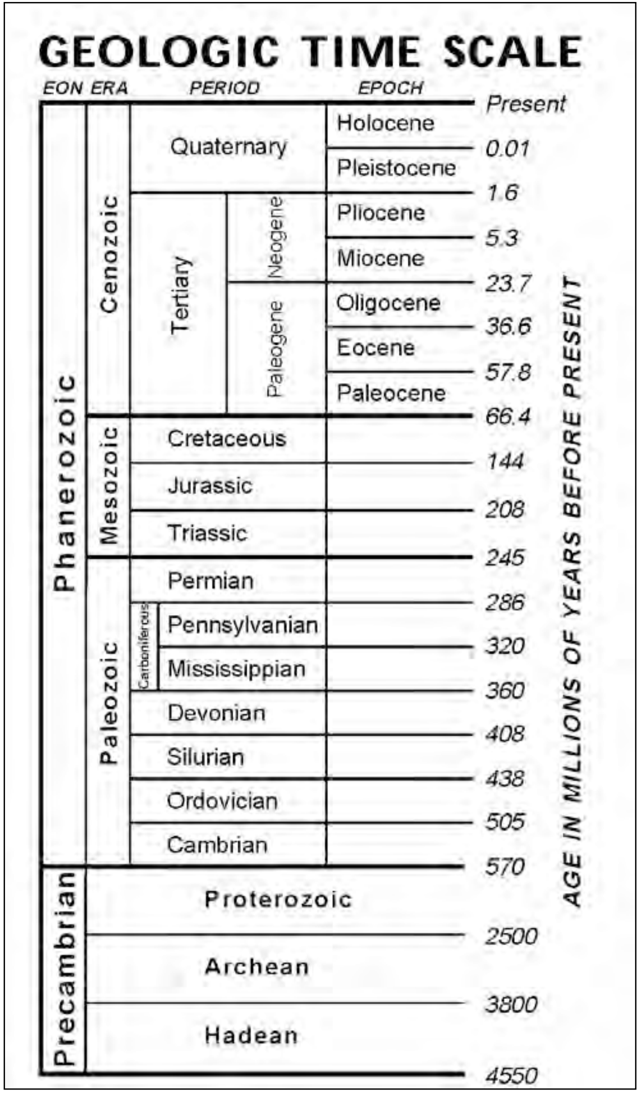


Figure A-1. Major Physiographic and Geologic Provinces of the Gulf of Mexico.



GEOLOGIC TIME SCALE

EON	ERA	PERIOD		EPOCH	AGE IN MILLIONS OF YEARS BEFORE PRESENT
					Present
Phanerozoic	Cenozoic	Quaternary		Holocene	0.01
				Pleistocene	1.6
		Tertiary	Neogene	Pliocene	5.3
				Miocene	23.7
			Paleogene	Oligocene	36.6
				Eocene	57.8
				Paleocene	66.4
	Mesozoic	Cretaceous			144
		Jurassic			208
		Triassic			245
	Paleozoic	Permian			286
		Carboniferous	Pennsylvanian		320
			Mississippian		360
		Devonian			408
		Silurian			438
		Ordovician			505
		Cambrian			570
Precambrian	Proterozoic				2500
	Archean				3800
	Hadean				4550

Figure A-2. Geologic Time Scale (Palmer, 1983).

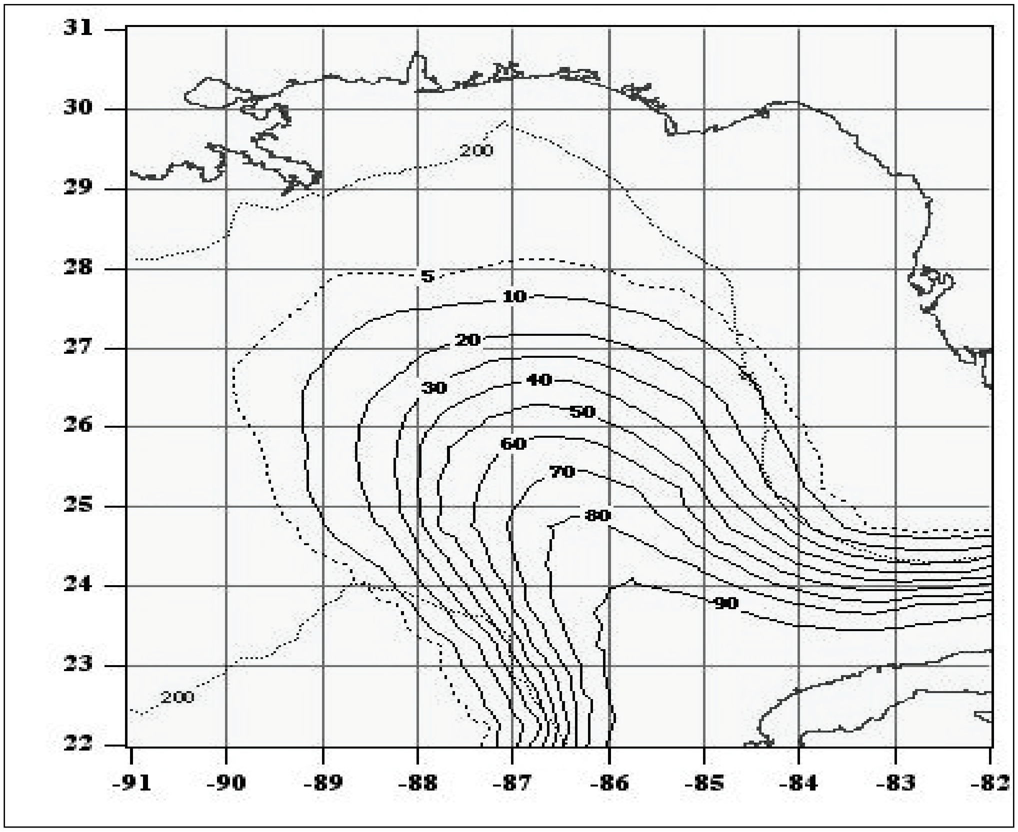


Figure A-3. Spatial Frequency (%) of the Watermass Associated with the Loop Current in the Eastern Gulf of Mexico based on Data for the Period 1976-2003 (Vukovich, 2005).

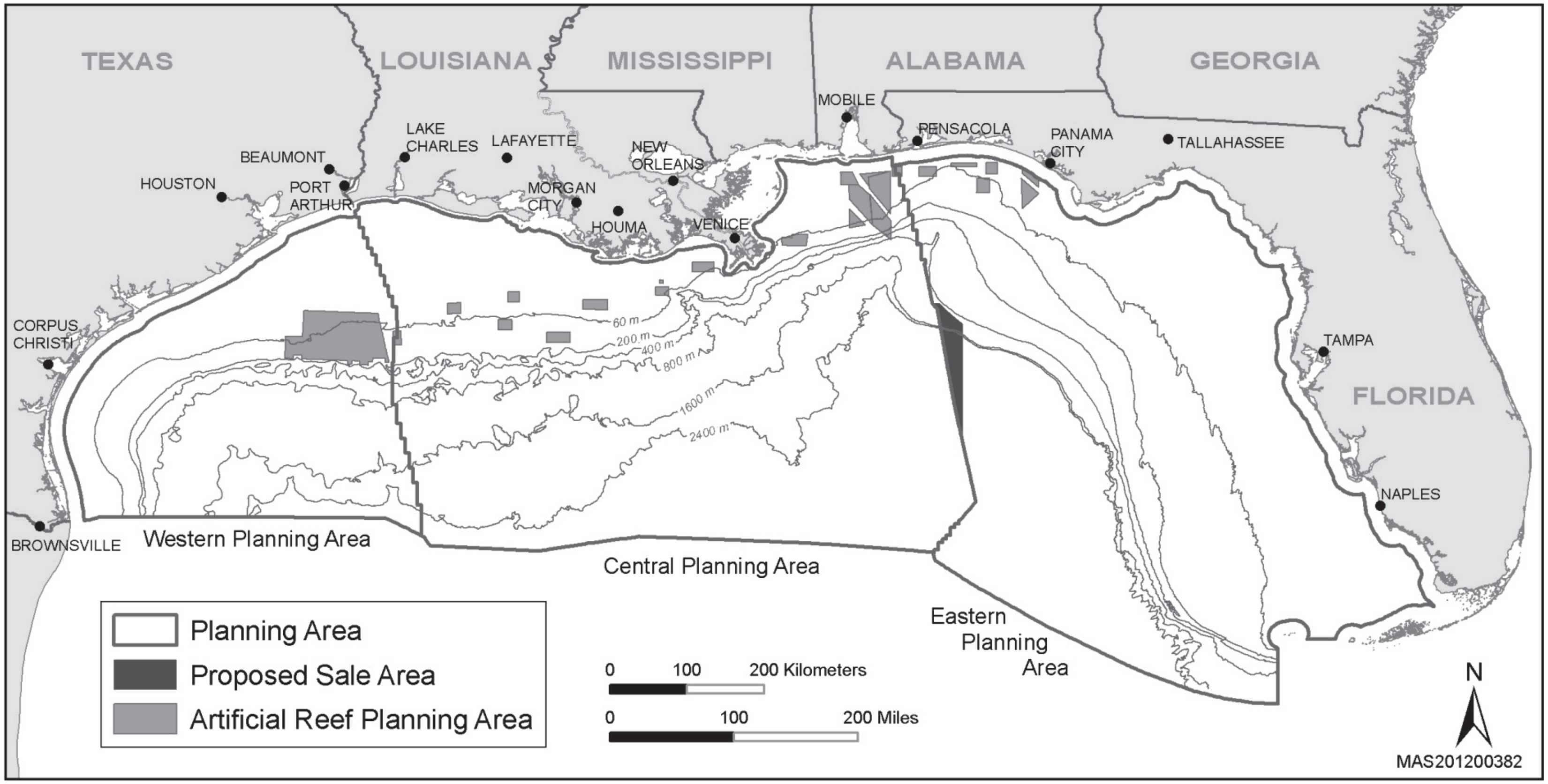


Figure A-4. Locations of Artificial Reef Planning Areas in the Gulf of Mexico.

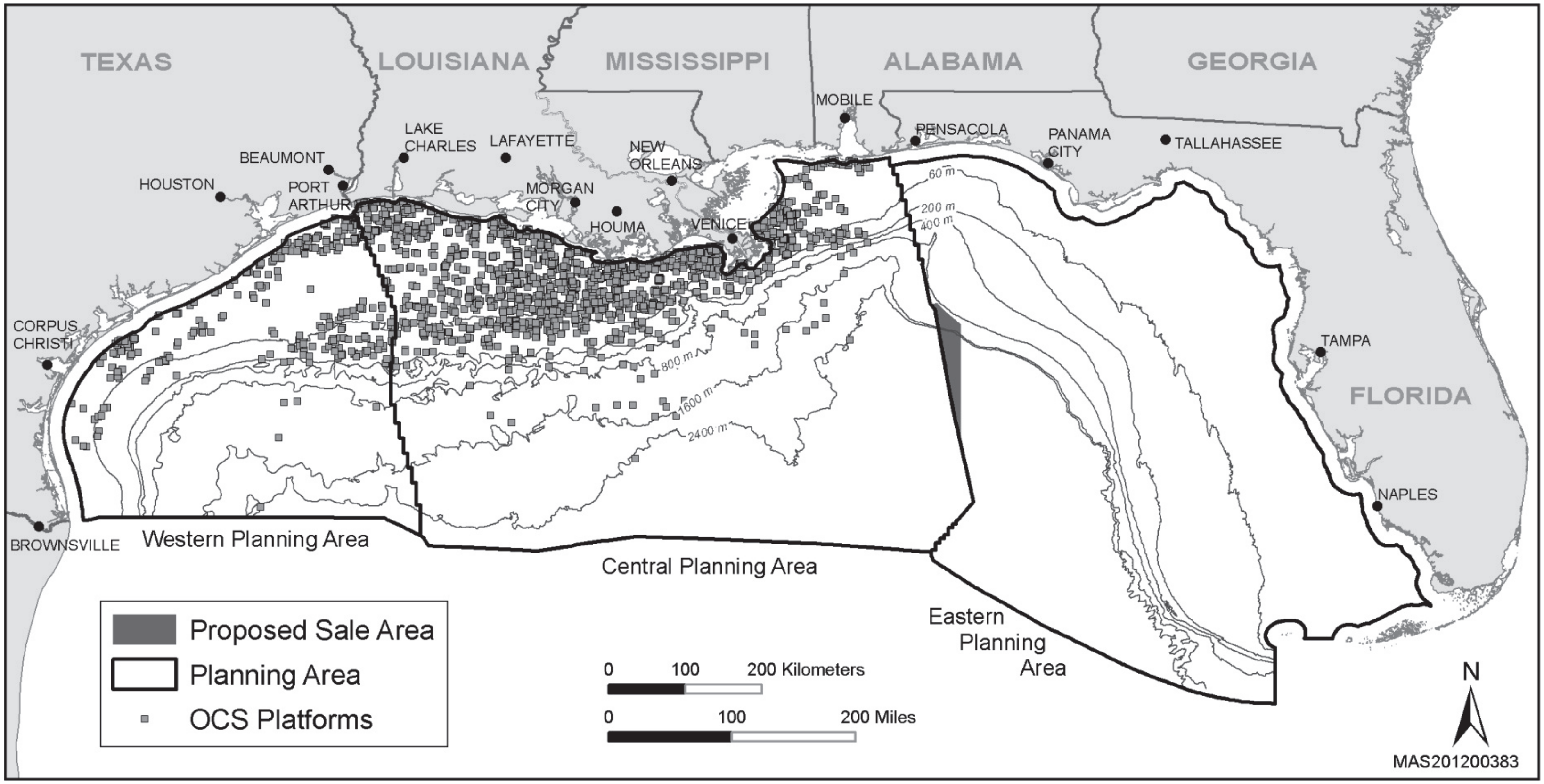


Figure A-5. OCS Platform Distribution across the Gulf of Mexico.

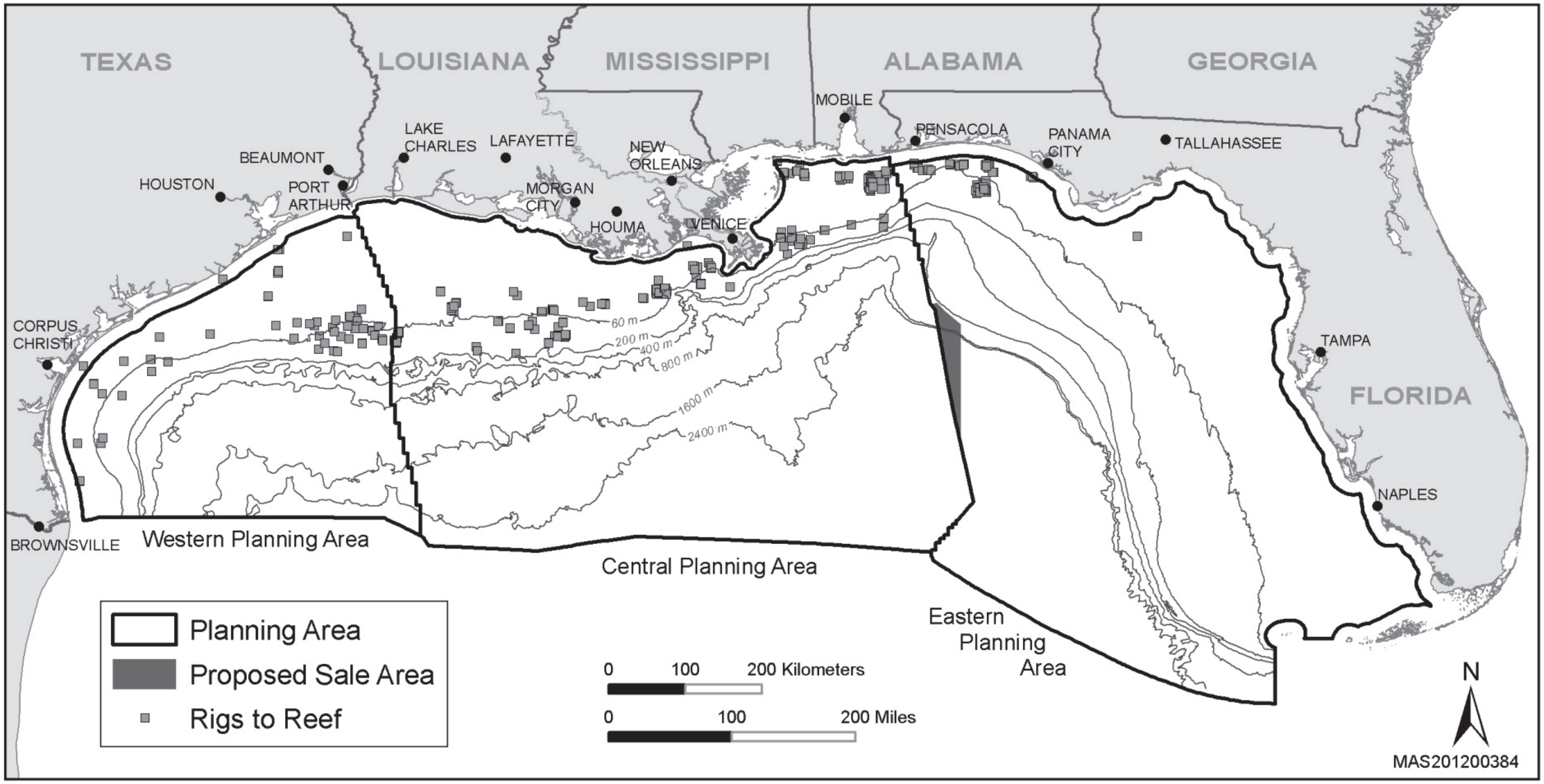


Figure A-6. Locations of Rigs-to-Reefs in the Gulf of Mexico.

Table A-1

Watermasses in the Gulf of Mexico

Watermass	Eastern Gulf of Mexico			Western Gulf of Mexico		
	Depth (m)	Feature(s)	Sigma-theta (m) (mg/cm^3)	Depth (m)	Feature(s)	Sigma-theta (m) (mg/cm^3)
SUW-LC	150-250	S_{max}	25.40	NA	NA	NA
SUW	150-250	S_{max}	25.40	0-250	S_{max}	25.40
18°C W	200-400	O_{2max}	26.50	NA	NA	NA
TACW	400-700	O_{2min}	27.15	250-400	O_{2min}	27.15
AAIW	NA	NA	NA	500-700	NO_{3max}	27.30
AAIW	700-900	PO_{4max}	27.40	600-800	PO_{4max}	27.40
AAIW	800-1,000	S_{min}	27.50	700-800	S_{min}	27.50
		SiO_{2max}	NA		SiO_{2max}	NA
UNADW	900-1,200	SiO_{2max}	27.70	1,000-1,100	SiO_{2max}	27.70

18^{o}C W = 18 degrees Centigrade Sargasso Sea Water.
AAIW = Antarctic intermediate water.
NA = information not available.
NO_{3max} = nitrate maximum.
O_{2max} = dissolved oxygen maximum.
O_{2min} = dissolved oxygen minimum.
PO_{4max} = phosphate maximum.
SiO_{2max} = silicate maximum.
S_{max} = salinity maximum.
S_{min} = salinity minimum.
SUW = subtropical underwater in the Gulf but outside the Loop Current.
SUW-LC = subtropical underwater in the Loop Current and new Loop Current eddies.
TACW = tropical Atlantic central water.
UNADW = mixture of upper North Atlantic deep water and high-silicate Caribbean mid-water.

Table A-2

Climatological Data for Selected Gulf Coast Locations

Location	Precipitation (annual average) (m)	Temperature (mean annual) (^{o}C)	Wind Speed (average annual mean) (m/sec)	Humidity (average percent)	Barometric Pressure (average annual) (millibars)	Stability Conditions (annual percent)		
						Unstable	Neutral	Stable
Corpus Christi, TX	0.82	21.9	5.4	66-89	1,014	11.0	61.0	28.0
Galveston, TX	1.11	21.8	4.9	72-83	1,015	16.0	61.4	22.6
Lake Charles, LA	1.45	19.9	3.7	67-91	1,016	23.0	44.0	33.0
Gulfport, MS	1.65	20.1	3.9	62-87	1,016	17.5	47.4	35.1
Pensacola, FL	1.63	20.1	3.7	62-84	1,013	18.0	22.0	60.0
Key West, FL	0.99	25.6	4.9	68-80	1,014	80.0	18.0	2.0

Source: USDOC, NOAA, 2011.

Table A-3

Rigs-to-Reefs Donations and Methods of Removal and Reefing by State as of October 2012

State	Rigs-to-Reefs Donations	Tow-and-Place Platforms	Topple-in-Place Platforms	Partial Removal Platforms
Louisiana	302	167	56	47
Texas	103	85	31	38
Florida	3	3	0	0
Alabama	4	6	0	0
Mississippi	8	3	5	0
Total	420	264	92	85

APPENDIX B

CATASTROPHIC SPILL EVENT ANALYSIS: HIGH-VOLUME, EXTENDED-DURATION OIL SPILL RESULTING FROM LOSS OF WELL CONTROL ON THE GULF OF MEXICO OUTER CONTINENTAL SHELF

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B. CATASTROPHIC SPILL EVENT ANALYSIS: HIGH-VOLUME, EXTENDED-DURATION OIL SPILL RESULTING FROM LOSS OF WELL CONTROL ON THE GULF OF MEXICO OUTER CONTINENTAL SHELF

B.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, 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 National Environmental Policy Act (NEPA) 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 National Five-Year Program, the Assistant Secretary of Land and Minerals Management for an oil and gas lease sale, and the Regional Supervisors of the Gulf of Mexico OCS Region's Office of Environment and Office of Leasing and Plans.

It should be noted that the analysis presented here is intended to be a general overview of the potential effects of a catastrophic spill in the Gulf of Mexico. As such, the *Catastrophic Spill Event Analysis* should be read with the understanding that further detail about accidental oil impacts on a particular resource may be found in the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2014 and 2016, Eastern Planning Area Lease Sales 225 and 226, Draft Environmental Impact Statement* (EPA 225/226 EIS) analysis or previous relevant NEPA analyses (e.g., the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247, Final Environmental Impact Statement* [2012-2017 WPA/CPA Multisale EIS]; USDOI, BOEM, 2012).

B.1.1. What is a Catastrophic Event?

As applicable to NEPA, Eccleston (2008) defines 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 (i.e., hurricane) or manmade (i.e., 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).

Each oil-spill event is unique; its outcome depends on several factors, including time of year and location of release relative to winds, currents, land, 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 of an oil spill cannot be predicted based on volume alone, although a minimum volume of oil must be spilled to reach catastrophic impacts.

Though large spills may result from a pipeline rupture, such events will not result in a catastrophic spill because the ability to detect leaks and shut off pipelines limits the amount of the spill to the contents of the pipeline. The largest, non-blowout-related 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, 2012); however, no significant environmental impacts were recorded as a result of this spill.

Although loss of well control is defined as the uncontrolled flow of reservoir fluid 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 losses of well control incidents may occur between formations penetrated in the wellbore or at the seafloor.

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 30,000 and 53,000 bbl of oil, respectively (USDOI, BSEE, 2012). 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, 2010c; USDOC, NOAA, Hazardous Materials Response and Assessment Division, 1992; ERCO, 1982). On April 20, 2010, the *Macondo* well blowout (*Deepwater Horizon* explosion, oil spill, and response) in deep water (4,992 ft; 1,522 m) 48 mi (77 km) offshore in Mississippi Canyon Block 252, released an estimated 4.9 MMbbl of oil until it was capped approximately 3 months later. 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.

B.1.2. Methodology

Two general approaches are utilized 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 circumstances 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. 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.

B.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.

B.1.2.2. Impact-Producing Factors and Scenario

A hypothetical, yet feasible, scenario (**Chapter B.2**) was developed to provide a framework for identifying the impacts of an extended oil spill from an uncontrolled blowout. Unless noted, this scenario is based on the large magnitude, blowout-related oil spills that have occurred in the Gulf of Mexico, i.e., *Ixtoc I* and *Macondo* well blowouts and spills (discussed in **Chapter B.1.1**). As noted above, because each spill event is unique, its outcome depends on many factors. Therefore, the specific impacts from future spills cannot be predicted based on this scenario.

B.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. 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. The OSRA was conducted for only the trajectories of oil spills from hypothetical spill locations to various onshore and offshore environmental resources. Though this Appendix is associated with all three planning areas, data from two hypothetical spill locations located in the Eastern Planning Area (EPA) (**Figure B-1**) were included and are intended for use as examples of this type of exercise. Information on previous catastrophic OSRA runs for the Western and Central Planning Areas (WPA and CPA) can be found in Appendix C of the 2012-2017 WPA/CPA Multisale EIS.

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, 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 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 spills might travel on the ocean's surface and what environmental resources might be contacted if and when another catastrophic spill occurs, but it does not provide input on the probability of another catastrophic spill occurring. Further detail on this catastrophic OSRA run is contained in **Appendix C**.

B.1.2.4. Environmental and Socioeconomic Impacts

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

Although the most recent EIS's prepared by this Agency 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, MMS, 2007 and 2008), 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.

B.1.3. How to Use This Analysis

The purpose of this technical analysis is to assist BOEM in meeting CEQ requirements that require a discussion of impacts from catastrophic events. 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 of time. The scenario and impacts discussed in **Chapters B.2 and B.3** should not be confused with the scenario and impacts anticipated to result from routine activities or the more reasonably foreseeable accidental events of an EPA proposed action.

Chapter B.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 B.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 the EPA 225/226 EIS.

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.

B.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 160-ft (50-m) water depth will be used as the basis for a shallow water spill and an event similar to the *Macondo* well blowout and spill that occurred in 2010 in the Mississippi Canyon area in 5,000-ft (1,524-m) water depth will be used to represent a deepwater spill.

B.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 B.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 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 B-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 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 (USDOC, NOAA, Office of Response and Restoration, 2010b). 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 search and rescue vessels and aircraft, such as United States Coast Guard (USCG) cutters, helicopters, and rescue planes.

B.2.2. Phase 2—Offshore Spill

Phase 2 of the analysis focuses on the spill and response in Federal and State offshore waters.

B.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 reentry 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 *Macondo* well blowout. In terms of persistence of spilled oil on surface waters, oil from the *Macondo* well blowout did not persist for more than 30 days (OSAT, 2010). However, based on BOEM's weathering modeling (refer to **Appendix C**), it is assumed that oil could persist on surface waters for as long as 1-2 months, depending on the season and year.

B.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 1-3 months. This estimate would include 1-3 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 resulting from a shallow water blowout is 2-5 months (approximately 1-3 months for active spillage and 1-2 months for oil persistence in the environment).

B.2.2.1.2. Deep Water

If a blowout occurs in 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 including drilling relief wells, if deemed necessary, could 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 2-6 months (approximately 1-4 months for active spillage and 1-2 months for oil persistence in the environment).

B.2.2.2. Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type and volume of oil that is spilled. However, a catastrophic spill would likely spread to 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.

Subsurface oil observed during both the *Ixtoc I* and *Macondo* well blowouts and 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.

B.2.2.3. Volume of Spill

After 50 years of oil and gas exploration and development activity on the continental shelf of the Gulf of Mexico in the CPA and WPA, most 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. Large undiscovered hydrocarbon reservoirs are still thought to exist in the shallow water areas of the CPA and WPA. However, results taken from BOEM’s most recent resource assessment study and a review of the more recent shallow-water drilling and leasing activity suggest that future discoveries of large reservoirs in the shallow-water areas of the GOM are likely to exist greater than 15,000 ft (4,572 m) below sea level where geologic conditions are more favorable for natural gas reservoirs to exist than 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, the results from BOEM’s resource assessment study pertaining to the deeper water areas of the GOM suggest that there is a high probability that many large oil and gas reservoirs have yet to be discovered in deep water. BOEM’s forecast for deep water has support from other public and private sector resource studies. 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 can 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 deep water oil development in the GOM.

B.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 spillage 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.

B.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 the assumption in **Chapter B.2.2.3.1** above, well test results, and the maximum flow rate estimated for the

The *Macondo* well blowout and 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.

B.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; page 89). 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 B-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 API gravity of 10.0 or less would sink and has not been encountered in the Gulf of Mexico OCS; therefore, it is not analyzed in this Appendix (USDOI, BOEMRE, 2010a).

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 *Macondo* well blowout and spill challenge that theory. While analyses are in their preliminary stages, it appears that measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the water column as subsurface “plumes” and on the seafloor in the vicinity of the release. While not all of these hydrocarbons have been definitively traced back to releases from the *Macondo* well, these early measurements and results warrant a reassessment of previous theories of the ultimate fate of hydrocarbons from unintended subsurface releases. 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.

B.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). Thus, if natural gas were to leak into the environment, methane may be released into the environment. Limited research is available for the biogeochemistry of hydrocarbon gases in the marine environment (Patin, 1999, page 233). Theoretically, methane could stay in the marine environment for long periods of time (Patin, 1999, page 237) 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, page 23). Methane is a carbon source and its introduction into the marine environment could result in diminished dissolved oxygen concentrations due to microbial degradation.

The *Macondo* well blowout and 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). 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 *Macondo* well blowout and 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 $\sim 3.0 \times 10^{10}$ 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 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 *Macondo* well blowout and spill was generally confined to the subsurface, with minimal amounts reaching the atmosphere (Kessler et al., 2011; Ryerson et al., 2011).

B.2.2.6. Deepwater Subsea Containment

To address the new improved containment systems’ expectations to rapidly contain a spill as a result of a loss of well control from a subsea well as addressed in Notice to Lessees and Operators (NTL) 2010-N10, the Marine Well Containment Company (MWCC) and Helix Well Containment Group (HWCG) initiated the development of new, rapid response systems. These systems are designed to fully contain oil flow in the event of a potential future underwater blowout and to address a variety of scenarios. The systems consist of specially designed equipment constructed, tested, and available for rapid response. Both the MWCC and the HWCG systems are anticipated to be fully operational within days to weeks after a spill event occurs. The availability of these systems can significantly reduce the length of time a blowout continues, thereby reducing the amount of oil potentially spilled during a catastrophic spill. However, this assumes that a particular blowout situation lends itself to the use of this subsea containment technology, whereas there are some situations that may delay or make its use improbable, such as the location of debris resulting from the blowout and the condition of the well.

The MWCC system is designed to operate in up to a 10,000-ft (3,048-m) water depth and adds containment capability of 60,000 bbl of oil per day. The HWCG system focuses on the utilization of the *Helix Producer I* and the *Q4000* vessels. Each of these vessels played a role in the *Macondo* well blowout and spill response, and each of these vessels are continually working in the Gulf. 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 55,000 bbl of oil per day (Helix Well Containment Group, 2010).

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 MWCC and HWCG.

The BSEE has indicated to BOEM that, it 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) (refer to NTL 2010-N10). The BSEE conducted a successful deployment drill of Helix's subsea containment capping stack in July 2012. A deployment drill of Helix's subsea containment capability is presently being planned by BSEE.

B.2.2.7. Offshore Cleanup Activities

As demonstrated by the *Ixtoc I* and *Macondo* well blowouts and 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 chemical dispersants. Even with the deployment of all of these spill-response technologies, it is likely that, with the operating limitations of today's spill-response technology, not all of the oil could be contained and removed offshore.

B.2.2.7.1. Shallow Water

The following are estimates for the deployment of equipment and personnel during a shallow-water spill response. Within the first week of an oil spill originating in shallow water, 25 vessels are estimated to respond, which would steadily increase to over 3,000 by the end of the spill. This includes about 25 skimmers in the vicinity of the well at any given time. In addition, recovered oil may be barged to shore from recovery vessels. Within the first week, over 500 responders are estimated to be deployed to a spill originating in shallow water, which would steadily increase up to 25,000 before the well is capped or killed within 2-4 months. Up to 25 planes and 50 helicopters are estimated to respond per day by the end of a shallow-water spill. Response to an oil spill in shallow water is expected to involve over 10,000 ft (3,048 m) of boom within the first week and would steadily increase up to 5 million feet (~950 mi; ~1,520 km) for use offshore and nearshore; the amount is dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed-upon protection strategies involving the local potentially impacted communities.

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 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, 2010). At this time, pursuant to a letter from the Florida Department of Environmental Protection dated May 5, 2011, to USCG, preapproval for dispersant use is not approved for any Florida State waters. However, USEPA is presently revisiting these RRT preapprovals in light of the dispersant issues, such as subsea application that arose during the *Macondo* well blowout and spill 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. 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. About 500 burns in all would remove 5-10 percent of the oil.

B.2.2.7.2. Deep Water

The following are estimates for the deployment of equipment and personnel during a deepwater spill response. Within the first week of an oil spill originating in deep water, 50 vessels are estimated to respond, which would steadily increase to over 7,000 by the end of the spill. This includes about 25 skimmers in the vicinity of the well at a time. In addition, recovered oil may be shuttle tankered to shore from recovery vessels. For an oil spill in deep water, over 1,000 responders are estimated to be deployed within the first week, which would steadily increase up to 50,000 before capping or killing the well within 4-5 months. Over 20,000 ft (6,096 m) of boom is estimated to be deployed within the first week of a deepwater spill, which would steadily increase up to 11 million feet (~2,100 mi; ~3,350 km) offshore and nearshore. The amount of boom would be dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. Up to 50 planes and 100 helicopters are estimated to respond per day by the end of a deepwater spill.

With the exception of special Federal management areas or designated exclusion areas, dispersants have been preapproved in the vicinity of a deepwater blowout (U.S. Dept. of Homeland Security, CG, 2010). However, USEPA is presently examining these preapprovals, and restrictions are anticipated regarding the future use of dispersants as a result. 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 discussed in **Table B-1**. 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 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 B.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, in addition to 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.

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. About 500 burns in all would remove 5-10 percent of the oil.

B.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, work boats 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 (Alabama State Port Authority, 2010; State of

Florida, Office of the Governor, 2010; Nodar, 2010; Unified Incident Command, 2010a-c; USDOC, NOAA, 2010a; USEPA, 2012).

B.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. In an average Atlantic season, there are 11 named storms, 6 hurricanes, and 2 Category 3 or higher storms (USDOC, NOAA, National Weather Service, 2010). 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 will 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 will not work effectively. Conventional booms will 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 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 will generate waves. Typically, waves greater than 3 ft (1 m) will prevent smaller vessels from skimming in offshore waters; waves greater than 5 ft (1.5 m) will 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 upon on the condition of the roads and bridges for traffic resumption and the amount of debris potentially blocking the roads.

B.2.3. Phase 3—Onshore Contact

B.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 *Macondo* well blowout and 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 *Macondo* well blowout and spill.

B.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 2-5 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.

B.2.3.1.2. Deep Water

Intervention is more difficult and would take longer in deeper water, in part, because at these water depths these 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 B.2.4** (Phase 4) below.

B.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 *Macondo* well blowout and spill, the "expected" scenario, developed by the Oil Budget Calculator Science and Engineering Team of The Federal Interagency Solutions Group, 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, USCG estimates that 5-30 percent of oil will reach shore in the event of an offshore spill (33 CFR part 154, Appendix C, Table 2). Using the USCG assumptions, a catastrophic spill could result in a large amount of oil reaching shore.

B.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
60 days	50-100 miles
90 days	100-1,000 miles
120 days	>1,000 miles[2]

[1] Not cumulative.

[2] Length was extrapolated.

Source: Operational Science Advisory Team, 2011.

B.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, as explained in **Chapter B.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.

B.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 B.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).

B.2.3.4. Severe Weather

The official Atlantic hurricane season runs from June 1st through November 30th, with a peak in hurricane probability in September. In an average Atlantic season, there are 11 named storms, 6 hurricanes, and 2 Category 3 or higher storms (USDOC, NOAA, National Weather Service, 2010). 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 if weathered oil is present. Weather that results in waves greater than 3 ft (1 m) prevents skimming in coastal waters so there is 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 upon 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 will 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 that are 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 and 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.

B.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 B.2.2.7**, the following response is also estimated to occur once the spill contacts the shore.

B.2.3.5.1. Shallow Water

- There would be 5-10 staging areas established.
- Weathering permitting, about 200-300 skimmers could be deployed near shore to protect coastlines.

B.2.3.5.2. Deep Water

- There would be 10-20 staging areas established.
- Weather permitting, about 500-600 skimmers could be deployed near shore to protect coastlines. As seen in Louisiana following the *Macondo* well blowout and spill, a few hundred coastal skimmers could still be in operation a few months after the well is capped or killed (The State of Louisiana, 2010).

B.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 (SRB's), also commonly known as tarballs, and surface residence patties (SRP's) are subject to smearing during the day; therefore, much of the beach cleanup can 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 will be universally applicable for cleaning sand beaches.
- Typically, sand sieving, shaking, and sifting beach cleaning machines will be utilized. 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 will be instructed that no disturbance will 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, 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

B.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 utilized.
- Bioremediation may be utilized but mostly as a secondary treatment after bulk removal.

B.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 utilized 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.

B.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 has been detected in sediment 30 years after a spill (USDOI, FWS, 2004). 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). As of this writing, residual oil can still be found in Louisiana marshes and oil still sporadically appears as tarballs and tar patties on Alabama and Florida beaches following the *Deepwater Horizon* explosion, oil spill, and response in 2010. In addition, oil may still reside in deeper waters in sediments within close proximity of the wellhead, where response cleanup activities may not be pursued (OSAT, 2010).

If a shoreline is oiled, the selection of the type of shoreline remediation to be used will 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 will 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) (National Response Team, 2010).

B.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 will become more extensive and continue for some time (**Chapters B.2.3.5.3, B.2.3.5.4, and B.2.3.5.5**). Spill response post-*Macondo* well blowout and spill is still ongoing in some of the more heavily oiled areas in Louisiana and in other areas, such as Florida and Alabama, that experience 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 have been 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. Additional information regarding shoreline response considerations can be found in **Chapter 3.2.1.8.3** of this EIS.

B.3. DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

B.3.1. Long Duration—Large Volume 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 B.2** and summarized in **Table B-4**).

B.3.1.1. Air Quality

Phase 1—Initial Event

A catastrophic blowout close to the water surface would initially emit large amounts of methane and other 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 (VOC's), particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$). The fire could also produce polycyclic aromatic hydrocarbons (PAH's), 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. Organic aerosols formed downwind from the *Macondo* well blowout and spill (de Gouw et al., 2011), during which the lightest compounds, the VOC's, in the oil from the *Macondo* well blowout and spill evaporated within hours and during which the heavier compounds took longer to evaporate, contributing to the formation of air pollution particles downwind.

Phase 2—Offshore Spill

In the Gulf of Mexico, evaporation from the oil spill would result in concentrations of VOC's in the atmosphere, including chemicals that are classified as being hazardous. The VOC concentrations would occur anywhere where there is an oil slick, but they would be highest at the source of the spill because the rate of evaporation depends on the volume of oil present at the surface. The VOC concentrations would decrease with distance as the layer of oil gets thinner. The lighter compounds of VOC's would be most abundant in the immediate vicinity of the spill site. The heavier compounds would be emitted over a longer period of time and over a larger area. Some of the compounds emitted could be hazardous to workers in close vicinity of the spill site. 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. 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 out of high exposure areas, and pointing vessels into the wind. During the *Macondo* well blowout and spill, 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 ACGIH (American Conference of Governmental Industrial Hygienists) 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. In addition, VOC's 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, because of the distance of the proposed EPA lease sale area from shore, the oil slick would not likely have any effects on onshore ozone concentrations; 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.

It is assumed that response efforts would include hundreds of in-situ or controlled burns, which would remove an estimated 5-10 percent of the volume of oil spilled. This could be as much as 720,000 bbl of oil for a spill of 60,000 bbl per day for 90 days. In-situ burning would result in ambient concentrations of CO, NO_x, SO_2, PM_{10}, and $PM_{2.5}$ very near the site of the burn and would generate a plume of black smoke. The levels of $PM_{2.5}$ could be a hazard to personnel working in the area, but this could be effectively mitigated through monitoring and relocating vessels to avoid areas of highest concentrations. In an experiment of an in-situ burn off Newfoundland, it was found that CO, SO_2, and 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, the residues, and the air indicated that the PAH in the crude oil are largely destroyed during combustion (Fingas et al., 1995).

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. For example, in the *Macondo* well blowout and spill, gas was flared at the rate of 100-200 million cubic feet per day and oil burned at the rate of 10,000-15,000 bbl per day. 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, there would be 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, 2010b). However, responders could be exposed to levels higher than OSHA occupational permissible exposure levels (U.S. Department of Labor, OSHA, 2010b). During the *Deepwater Horizon* explosion, oil spill, and response, 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 Human and Health 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. Department 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. The air pollutants include criteria NAAQS pollutants, volatile and semi-volatile organic compounds, H_2S, and methane. If a fire was associated with the event, it would produce a broad array of pollutants, including all NAAQS-regulated primary pollutants, including NO_2, CO, SO_x, VOC, PM_{10}, and $PM_{2.5}$. 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 applied from aircraft. Measurements taken during an in-situ burning show that a major portion of compounds was consumed in the burn; therefore, pollutant concentrations would be expected to be within the NAAQS. In a recent analysis of air in coastal communities, low levels of dispersant components, which are also used in everyday household products, were identified. These response activities are temporary in nature and occur offshore; therefore, there are little expected impacts from these actions to onshore air quality. Catastrophic events involving high concentrations of H_2S could result in deaths as well as environmental damage. Regulations and NTL's mandate safeguards and protective measures, which are in place, to protect workers from H_2S releases. 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. To date, air monitoring conducted following the *Macondo* well blowout and spill, has not found any pollutants at levels expected to cause long-term harm (USEPA, 2010a).

B.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 chapter 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 B-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. In the deep Gulf of Mexico, 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 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.

A subsea release also has the potential to destabilize the sediments and create slumping or larger scale sediment movements along depth gradients. These types of events would have the potential to move and/or damage any infrastructure in the affected area.

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), suspended sediments, or may be mixed with drilling mud and deposited near the source. Mitigation efforts such as 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 *Macondo* well blowout and 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 *Macondo* well blowout and 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, some subsurface oil was also 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 put into offshore water may alter the chemistry of the sea with unforeseeable results. The properties and persistence of oil, including oil in the Gulf of Mexico, is further discussed in **Chapter B.2.2.4**. The VOC’s, including benzene, toluene, ethylbenzene, and xylenes (also referred to as BTEX), are highly soluble and can have acutely toxic effects; however, VOC’s are light-weight oil components and tend to evaporate rather than persist in the environment (Michel, 1992). Middle-weight organic components tend to pose the greatest risk in the environment because they are more persistent in the environment, are more bioavailable, and include polycyclic aromatic hydrocarbons (PAH’s), which have high toxicities (Michel, 1992). To determine the overall toxicity of PAH’s in water or sediment, the contributions of every individual PAH compound in the petroleum mixture must be included (USEPA, 2011). This approach was used during the *Macondo* well blowout, spill and cleanup in determining the potential risk of PAH’s 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 *Macondo* well blowout and 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 this oil is lower in PAH's than many other crude oils. Studies indicate that the oil contained approximately 3.9 percent PAH's by weight, which results in an estimated release of 2.1×10^{10} grams of PAH's (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, page 237), 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, page 23). 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. Unfortunately, little is known about methane toxicity in the marine environment, but there is concern as to how methane in the water column might affect fish. Further discussion of natural gas released during the *Macondo* well blowout and spill is given in **Chapter B.2.2.5**.

Phase 2—Offshore Spill

Offshore Water Quality

The water offshore of the Gulf's coasts can be divided into two regions: the continental shelf and slope (<1,000 ft; 305 m) and deep water (>1,000 ft; 305 m). 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 55 percent of the continental U.S. (Murray, 1998). 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, page 524), 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 B-2**). 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 will 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 assumed that large quantities of subsea dispersants would be used. 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 *Macondo* well blowout and spill. 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 *Macondo* well blowout and spill 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, 2010b; USDOC, NOAA, 2010d). The drop in oxygen, which did not continue over time, has been attributed to 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 *Macondo* well blowout and spill 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 the sediment quality and the coastal habitat index affect 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 from 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 tax 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 of the water 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, 2010b). 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 leak (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 foodwebs 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 will depend on many factors, including the effectiveness of the dispersion, temperature, salinity, the degree of weathering, type of dispersant, and the 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 occurs seasonally 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 2010 hypoxic zone could not be linked to the

Macondo well blowout and spill 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). Urban runoff increases with population growth, and the Gulf Coast region has experienced a 109 percent population growth since 1970, with an additional expected 15 percent increase expected by 2020 (USDOC, NOAA, 2011). 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, Table I-4, page 237) 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, Table I-9, page 242) into the waters of the Gulf. Hydrocarbons also enter the Gulf of Mexico through natural seeps in the Gulf at a rate of approximately 980,392 bbl per year (a range of approximately 560,224-1,400,560 bbl per year) (NRC, 2003, page 191). Produced water (formation water) is, by volume, the largest waste stream from the oil and gas industry that enters Gulf waters (e.g., **Table B-3**). The NRC has estimated the quantity of oil in produced water entering the Gulf per year to be 473,000 bbl (NRC, 2003, page 200, Table D-8).[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 B.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 will include degradation of offshore water quality, disturbance and degradation of sediments, and the release and suspension of oil and natural gas into 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 to impact 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 will be significantly impacted during this phase despite response efforts. Response efforts may even tax 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 Gulf will depend on the properties and persistence of the oil as noted in **Chapter B.2.2.4**. Though the spill will increase the amount of oil entering the Gulf of Mexico, oil regularly enters the Gulf through sources such as oil refineries, the Mississippi River, produced water, and natural seeps. However, oil from a spill will be more concentrated than the oil input from these other sources.

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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.

B.3.1.3. 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

Barrier islands make up more than two-thirds of the northern Gulf of Mexico shore. Each of the barrier islands is either high profile or low profile, depending on the elevations and morphology of the island (Morton et al., 2004). The distinguishing characteristics of the high- and low-profile barriers relate to the width of the islands along with the continuity of the frontal dunes. Low-profile barriers are narrow with discontinuous frontal dunes easily overtopped by storm surge, which makes the island susceptible to over wash and erosion. This over wash can create channels to bring sand onto the island or into lagoons formed on these islands. High-profile barrier islands are generally wider than the low-profile islands and have continuous, vegetated, frontal dunes with elevations high enough to prevent over wash from major storm surge and, therefore, are less susceptible to erosion. The sand stored in these high-profile dunes allows the island to withstand prolonged erosion and therefore prevents breaching, which could result in damaging the island core.

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. This is due to the distance from shore, the weather, the time oil remains offshore, and microbial degradation. To assess probabilities of spilled oil contacting shorelines, two OSRA catastrophic model runs were performed using two different launch points (LP 6 and LP 7) in the EPA, as described in **Chapter B.1.2.3**. A greater than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from LP 7. Texas has a greater than 5 percent estimated conditional probability of oil contacting its coastline from both LP 6 and LP 7 after 60 days in winter, summer, and fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days for winter, summer, and fall and from LP 7 after 30 days for spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in all seasons from LP 6 and in winter, spring, and summer from LP 7. Mississippi and Alabama has a less than 5 percent conditional probability of oil contacting their coastlines from both LP 6 and LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in spring and after 60 days in winter, spring, and summer and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for a catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) after 60 days.

As a result of a catastrophic spill, many of the barrier islands and beaches would receive varying degrees of oiling. Oil disposal on sand and vegetated sand dunes was shown in experiments by Webb (1988) to have little deleterious effects on the existing vegetation or on the recolonization of the oiled sands by plants. However, other studies have documented toxic effects of oil on barrier beach vegetation (Ko and Day, 2004). 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. However, most areas of oiling are expected to be light, and sand removal during cleanup activities should be minimized. The severity of oiling dictates the appropriate cleanup method to be utilized (refer to **Table B-4**).

In areas designated as natural wilderness areas (e.g., Breton National Wildlife Refuge and Gulf Islands National Seashore), land managers may require little to no disruption of the natural system. In these environments it is preferred to let the oil degrade naturally without aggressive and intrusive cleanup procedures. Manual rather than mechanized removal techniques would be used in these areas and only if heavy oiling has 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. During wave events when the islands and beaches erode, the oil can become remobilized and transported. Thus, the fate of oil is not as simple as either reaching land, becoming sequestered, or being treated; but, 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 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.

Bik et al. (2012) found that, despite the disappearance of visible surface oil on heavily oiled Gulf beaches impacted by the *Macondo* well blowout and spill, microbial communities showed significant changes in community structure, with a decrease in diversity and a shift toward dominance by fungal taxa, particularly known hydrocarbon-degrading genera. Likewise, nematode communities showed decreased diversity and increased dominance by predatory and scavenger taxa alongside an increased abundance of juveniles.

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.

Vessel traffic in close proximity to barrier islands has been shown to move considerably more bottom sediment than tidal currents, thus increasing coastal and barrier island erosion rates. If staging areas for cleanup of a catastrophic spill are in close proximity to these islands, recovery time of the barrier islands could be greatly extended because of the large number of response vessels.

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 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. For example on sandy beaches, oil can sink deep into the sediments. As stranded oil weathers, some oil may become buried through natural beach processes and appear as surface residual balls (SRB's; <10 cm [4 in]) or as surface residual patties (SRP's; 10 cm to 1 m [4 in to 3 ft]) **(Table B-4)**. Such balls continue to provide a source of contamination with accompanying toxic effects.

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 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)

As a result of a catastrophic spill, many of the barrier islands and beaches would receive varying degrees of oiling. However, most areas of oiling are expected to be lightly oiled, and sand removal during cleanup activities should be minimal. 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.

B.3.1.4. 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

Coastal wetland habitats in the Gulf of Mexico occur as 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. Offshore oil spills would have a low probability of contacting and damaging any wetlands along the Gulf Coast, except in the case of a catastrophic event. This is because of 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 because wetlands are generally protected by barrier islands, peninsulas, sand spits, and offshore currents.

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 impacted coastal resources. A spill from a catastrophic blowout could oil a few to several hundred acres of wetlands depending on the depth of inland penetration (Burdeau and Collins, 2010). This would vary from moderate to heavy oiling.

To assess the probabilities of spilled oil contacting shorelines, two OSRA catastrophic model runs were performed using two different launch points (LP 6 and LP 7) in the EPA, as described in **Chapter B.1.2.3**. A greater than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from LP 7. Texas has a greater than 5 percent estimated conditional probability of oil contacting its coastline from both LP 6 and LP 7 after 60 days in winter, summer, and fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days for winter, summer, and fall and from LP 7 after 30 days for spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in all seasons from LP 6 and in winter, spring, and summer from LP 7. Mississippi and Alabama has a less than 5 percent conditional probability of oil contacting their coastlines for both LP 6 and LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in the spring and after 60 days in winter, spring, and summer and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for a catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) after 60 days.

The NOAA Environmental Sensitivity Index (ESI) ranks shorelines according to their sensitivity to oil, the natural persistence of oil, and the expected ease of cleanup after an oil spill. These factors cause oil to persist in coastal and estuarine areas (USDOI, MMS, 2010). According to the ESI, the most sensitive shoreline types (i.e., sheltered tidal flats, vegetated low banks, salt/brackish-water marshes, freshwater marshes/swamps, and scrub-shrub wetlands) tend to accumulate oil and are difficult to clean, thus causing oil to persist in these coastal and estuarine areas (USDOI, MMS, 2010).

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 assure that these systems are installed and functioning properly and that they are not damaging the wetlands they are trying to protect. In most cases, the beach face would take the most oil; however, in areas where the marsh is immediately adjacent to the beach face or embayments, or in the case of small to severe storms, marshes would be oiled. For example, in Alabama, Mississippi, and Florida, severe weather could push oil into the tidal pools and back beach areas that support tidal marsh vegetation.

The primary factors that affect vegetation responses to oil are toxicity of the oil and extent of plant coverage, amount of contact with and penetration of the soil, plant species affected, oiling frequency, season, and cleanup activities (Mendelssohn et al., 2012). Previous studies of other large spills have shown that, when oil has a short residence time in the marsh and it 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). 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 the utilization 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 area wetlands. For wetlands along the central Louisiana coast, the critical oil concentration is assumed 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 loss of land.

Due to the distance of deep water from shore, the possibility of a spill from a deepwater blowout reaching coastal wetlands with the toxicity to significantly impact the coastal wetlands is low because of the response procedures implemented during a catastrophic spill. (It is assumed that oil would reach shore within 2-4 weeks.) Therefore, a spill from a shallow-water blowout is more likely to contribute to wetland damage. However, for the few deepwater areas that are located closer to shore, such as in the Mississippi Canyon Area, the amount of time before shoreline contact could occur could be estimated to be the same as the estimate given for the shallow-water scenario, i.e., 1-3 weeks.

Offshore skimming, burning, and dispersal treatments for the oil near the spill site would result in capture, detoxification, and dilution of the majority of oil spilled. The utilization of nearshore booming protection for beaches and wetlands could also help to reduce oiling of these resources, if done correctly. Booms deployed adjacent to marsh shorelines can be lifted by wave action onto marsh vegetation, resulting in plant mortality under the displaced booms. 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 utilized. The severity of oiling is the main factor that dictates the appropriate marsh cleanup method to be utilized (refer to **Table B-4**).

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

Wetlands serve a number of important ecological functions. For example, Louisiana's coastal wetlands support more than two-thirds of the wintering waterfowl population of the Mississippi Flyway (Louisiana Department of Wildlife and Fisheries, 2012). 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.

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 *Macondo* well blowout and 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 platform loss that is likely to be permanent. Eighteen months after the *Macondo* well blowout and spill, in previously oiled, noneroded areas, marsh grasses had largely recovered, and the elevated shoreline retreat rates observed at oiled sites had decreased to levels at reference marsh sites. 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. It was estimated in 2000 that coastal Louisiana would continue to lose land at a rate of approximately 2,672 hectares/year (10 mi^2/year) over the next 50 years. Further, it was estimated that an additional net loss of 132,794 hectares (512 mi^2) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands (Barras et al., 2003). Barras (2006) indicated an additional 562 km^2 (217 mi^2) of land lost during the 2005 hurricane season. A catastrophic spill occurring nearshore would contribute further to this landloss. 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 made landfall as a Category 2 storm near Cocodrie, Louisiana, pushing large surges of saline water into the fresh marshes and coastal swamps of Louisiana from Grand Isle westward. While Hurricane Gustav did not impact the quantity of wetlands that Hurricanes Katrina and Rita impacted, it did have a severe and continuing effect on the coastal barrier islands and the wetlands associated with backshore (back of the island) and foreshore (front of the island). While Hurricane Gustav affected the eastern portion of the Louisiana coast closer to Grand Isle and Houma, Hurricane Ike concentrated on Louisiana's western coast. The Texas coast received the brunt of Hurricane Ike where it made landfall slightly east of Galveston. The storm surge heavily eroded the dune systems and significantly lowered the beach elevations along the eastern portion of the Texas coast near Galveston and the Bolivar Peninsula. The erosion and wash-over associated with Hurricane Ike's tidal surge breeched beach ridges and opened the inland freshwater ponds and their associated wetlands to the sea. As a result of the four successive storms, the Louisiana and Texas coasts have lost protective elevations, barrier islands, and wetlands, and they now have the potential for transitioning to a less productive salt-marsh system in areas where fresh-marsh systems once existed. In addition, the loss of these protective 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. Boat traffic in marsh areas from the thousands of response vessels associated with a catastrophic spill would 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)

A spill from a catastrophic blowout could oil a few to several hundred acres of wetlands depending on the depth of inland penetration (Burdeau and Collins, 2010). This would vary from moderate to heavy oiling. Impacts to wetlands would vary according to the severity of the oiling. The duration and magnitude of the spill could result in severe oiling of wetlands in some areas, causing long-term effects to wetland vegetation, including some plant mortality and loss of land.

B.3.1.5. Seagrass Communities

Phase 1—Initial Event

There would likely be no adverse impacts to submerged vegetation 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 submerged vegetation beds.

Phase 2—Offshore Spill

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

Phase 3—Onshore Contact

According to the most recent and comprehensive data available, approximately 500,000 hectares (1.25 million acres; 505,857 hectares) of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters and embayments of the northern Gulf of Mexico, and over 80 percent of this area is in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). Submerged vegetation 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 submerged aquatic vegetation (SAV) species occur in the low-salinity waters of coastal estuaries (Castellanos and Rozas, 2001). Seagrasses and freshwater SAV's 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).

It is estimated that shoreline oiling would last 1-5 months from a shallow-water catastrophic spill event and 3-4 months from a deepwater catastrophic event. It is estimated that there would be contact to the shoreline within 30 days of the spill for both shallow-water and deepwater spill locations. Though response methods would be monitored, there would also be some impact from these efforts on contacted submerged vegetation beds. Two catastrophic OSRA model runs were used to estimate conditional probabilities of contact to resources from two different launch points (LP 6 and LP 7) as described in **Chapter B.1.2.3**, the condition being that a spill is assumed to have occurred at a given location. The results are given in **Tables B-5 and B-6**. The conditional probability of oil contacting any submerged vegetation beds were estimated by using the probabilities of contact to State waters (Texas, Louisiana, Mississippi, Alabama, and Florida). A greater than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from LP 7. Texas has a greater than 5 percent conditional probability of oil contacting its coastline from both LP 6 and LP 7 after 60 days in winter, summer, and fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days for winter, summer, and fall and from LP 7 after 30 days for spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in all seasons from LP 6 and in winter, spring, and summer from LP 7. Mississippi and Alabama had a less than 5 percent conditional probability of oil contacting their coastlines for both LP 6 and LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in the spring and after 60 days in winter, spring, and summer and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for a catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) and after 60 days.

If oil comes into areas with submerged 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 plat 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). However, 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. With a greater distance from shore, there is a greater chance of the oil being weathered by natural and mechanical processes by the time it reaches the nearshore habitat.

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 a spill; however, communities residing within the beds could accrue greater negative outcomes (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 submerged vegetation 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 submerged vegetation because they are tolerant to specific salinities and light levels (Zieman et al., 1984; Kenworthy and Fonesca, 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

According to the most recent and comprehensive data available, approximately 500,000 hectares (1.25 million acres; 505,857 hectares) of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters and embayments of the northern Gulf of Mexico, and over 80 percent of this area is in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). Submerged vegetation 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). Seagrasses and freshwater SAV's 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).

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-term 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; Taylor et al., 2007).

If bays and estuaries accrue oil, there is an assumption that there would be a decrease in seagrass cover and negative community impacts. Submerged vegetation serves important ecological functions. For example, seagrasses and freshwater SAV's 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 submerged vegetation would adversely impact these species with a loss of valuable habitat and food.

Overall Summary and Conclusion (Phases 1-4)

Because of the likely distance of an initial catastrophic spill event to submerged vegetation communities, there would be no adverse impacts to submerged vegetation resulting from the initial event (Phase 1). Also, with regards to an offshore spill event, there would likely be no adverse impacts to submerged vegetation before the spill reaches shore (Phase 2). Texas, Louisiana, and Florida had a greater than 5 percent estimated probability of oil contacting its coastline from the EPA example OSRA run (Phase 3). It is assumed when these coastlines are contacted with oil, all associated habitat are considered oiled. If oil comes into areas with submerged beds, 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 is the possibility of buried or sequestered oil becoming resuspended after a disturbance, which would have similar effects as the original oiling event (Phase 4). While there are impacts on submerged vegetation 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 (den Hartog and Jacobs, 1980; Kenworthy et al., 1993; Taylor et al., 2006 and 2007).

B.3.1.6. Live Bottoms (Pinnacle Trend and Low Relief)

The Gulf of Mexico has hard-bottom features upon which encrusting and epibenthic organisms attach on the continental shelf in water depths less than 300 m (984 ft). Live bottom features occur in the northeastern portion of the CPA and in the EPA. The Pinnacle Trend is located in the northeastern portion of the central Gulf of Mexico at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. 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.” Fish are attracted to outcrops that provide hard substrate for sessile invertebrates to attach. The BOEM does not allow bottom-disturbing activities to occur within 30 m (98 ft) of any hard bottoms/pinnacles in 74 lease blocks in the CPA (each block is typically 3 mi x 3 mi).

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 the reef communities like those found on the Florida Escarpment. BOEM has stipulations to protect these features from impacts, including bottom-disturbing activity. This chapter discusses the hard substrate, as seagrasses are covered in **Chapter B.3.1.5**.

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill 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 surface almost directly over the source location. However, if the 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). 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. Subsea plumes or sinking oil on particulates may contact live bottom 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 many organisms within a few hundred meters of the wellhead. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. If a blowout were to occur close enough to a live bottom feature, suspended sediment 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 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 Live Bottom Features

Impacts that occur to benthic organisms on live bottom 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 distancing of bottom-disturbing activities from Pinnacle and live bottom, low-relief features helps to prevent blowouts in the immediate vicinity of a live bottom 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 areas that have live bottom features. Although these small oil droplets will 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 or other epibenthic cover, as a result of impaired recruitment, are discussed in Phase 4 ("Post-Spill, Long-Term Recovery and Response"). Also, if the blowout were to occur beneath the seabed, suspension and subsequent deposition of disturbed sediment may smother localized areas of live bottom communities.

Following a catastrophic, subsurface blowout, benthic communities on a live bottoms exposed to large amounts of resuspended and then deposited sediments could be subject to sediment suffocation, exposure to resuspended toxic contaminants and to reduced light availability. Impacts to fauna found on hard bottoms as a result of sedimentation 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 clear the sediment. Impacts may range from sublethal effects (such as reduced or slower growth, alteration in form, and reduced recruitment and productivity) to suffocation and death (Rogers, 1990; Fucik et al., 1980).

The initial blowout impact would be greatest to communities located in clear waters that experience heavy sedimentation. The most sensitive organisms are typically elevated above soft sediments, making them less likely to be buried, and it is unlikely that corals would experience heavy sedimentation because they are located within Live Bottom (Low Relief) Stipulation blocks that distance bottom-disturbing activity from the features. None of the Live Bottom Stipulation blocks were included in the current proposed lease sale, farther distancing oil and gas activity from live bottoms. In addition, BOEM conducts case-by-case reviews of plans submitted by operators to ensure that the proposed activity will not impact sensitive seafloor features. It is possible, however, for some live bottoms to experience some turbidity or sedimentation impacts from a blowout if they are downstream of a current transporting sediment. Corals may experience discoloration or bleaching as a result of sediment exposure, although recovery from such exposure may occur within 1 month (Wesseling et al., 1999).

Initial impacts would be much less extreme in a turbid environment (Rogers, 1990). For example, the Pinnacle Trend community exists in a relatively turbid environment, starting just 65 km (37 mi) east of the mouth of the Mississippi River and trending to the northeast, and many low-relief live bottoms are frequently covered with a thin sand veneer that moves with waves and bottom currents, exposing and covering up areas with movement (Phillips et al., 1990; Gittings et al., 1992). 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 predominate in 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). Those organisms that have a lesser relief could experience sedimentation, abrasion, and suffocation. However, many organisms present in the lower relief, live bottom habitat are motile, can burrow in the sediment, or have mechanisms for dealing with turbidity and can be tolerant 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; for example, crabs and shrimp spend a portion of their lives in estuaries and nearshore waters that are turbid (Wilber et al., 2005). These organisms are also able to move away from turbid areas that have sediment concentrations that become too high (Clarke and Wilber, 2000; Wilber et al., 2005). Oysters, on the other hand, are not able to move away from turbidity, but they are tolerant of this environmental factor as they tend to live near the mouths of rivers that deposit sediment into their habitat

(Wilber et al., 2005). Many of these organisms can also rapidly repopulate an area affected by sedimentation (Fucik et al., 1980).

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 live bottom feature. 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; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration if the hard substrate upon which they live was not physically destroyed. Destruction of a live bottom community by a sinking rig is highly unlikely because BOEM requires infrastructure to be distanced from live bottoms.

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 B-4**) for a catastrophic spill on the continental shelf is assumed to last 2-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which will float (API° >10). 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 B-4**) for a catastrophic spill in deep water is assumed to last 4-6 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 will be released, which will float (API° >10). 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 will also occur as it travels from its release point. 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 to 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 to Live Bottom 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 at which Pinnacles and most live bottom, low-relief features flourish 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 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 the amount 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). Low-relief, live bottom habitats located in shallow coastal water may be at greater risk of surface oil mixing to the depth where their active growth occurs; however, because oil and gas activities currently take place far from the coastlines where nearshore live bottoms are located, the surface oil will be well dispersed and diluted by the time it reaches waters above the shallow live bottoms.

Depending on the location of the release point for a catastrophic spill, the time of year may also affect the probability of oil reaching the surface water above live bottom habitats. For example, the conditional probability of surface water oiling occurring as a result of a catastrophic spill at two launch points (LP 6 and LP 7) in the EPA was estimated by the Bureau of Ocean Energy Management's OSRA model, the condition being that a spill is assumed to have occurred at the given location. The greatest probabilities of oil moving toward the Pinnacle Trend and live bottom, low-relief habitats in the EPA and northeast corner of the CPA would occur in the spring, while a lesser probability of such occurrence would occur in the fall, summer, and winter. In the OSRA model example for LP 6, 60 days after oil was released, there is a 14 percent conditional probability that oil may reach surface waters over the Pinnacle Trend in the spring, and up to a 10 percent chance in the fall, up to a 9 percent chance in the winter, and up to an 8 percent chance in the summer (**Figures B-3 through B-6 and Tables B-5 and B-6**). The live bottoms of the Florida Keys National Marine Sanctuary have the greatest chance of receiving oil in the surface waters after 60 days of a spill, followed by Pulley Ridge, with the conditional probability of surface water oiling greater in winter and spring for both sites (**Figures B-3 through B-6 and Tables B-5 and B-6**). This oil, however, is only modeled for surface waters, and it is not expected to mix to the depth of the benthic organisms on the Pinnacle Trend or most live bottoms, as discussed above. Therefore, based on measurements and modeling, surface oil is not anticipated to impact live bottoms. The one exception would be for shallow live bottom habitats in which surface oil could mix to the depth of the feature, but the regulated distance of oil and gas activity from these shallow features would allow for dispersion and dilution before the oil reached the features.

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 live bottom 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, thus not impacting sensitive benthic communities. 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). 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 live bottom habitats. A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column will 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.

Live bottom, low-relief features have a greater chance of being impacted by subsea plumes than some Pinnacle 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 in the Pinnacle Trend) may fall in the path of the plume because the feature is 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, feeding activity or reproductive ability may be reduced when coral is exposed to low levels of oil; however, impacts may be temporary or unable to be measured over time. Experiments indicated that oil exposure reduced the normal feeding activity of coral, and oiled reefs produced smaller gonads than unoiled reefs, resulting in 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 (Cook and Knap, 1983; Dodge et al., 1984; Burns and Knap, 1989; Knap et al., 1982; Kennedy et al., 1992). Sublethal responses of other marine invertebrates on live bottoms may 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. 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. 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 not travel onto the continental shelf, but a plume formed on the continental shelf could impact live bottom 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 more dispersed and present 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 (6 ft) (McAuliffe et al., 1981). 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). There is very little information on the mixing and dispersion of subsea dispersants.

Dispersed oil reaching live bottoms in the Gulf of Mexico would be expected to occur at very low concentrations (<1 part per million [ppm]) (McAuliffe et al., 1981). Such concentrations would not be life threatening to larval or adult stages at this depth below the sea surface based on experiments conducted with benthic organisms. 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 dispersant used, length of exposure, and the physical barriers the organism has to protect itself from the dispersant. Organisms with shells appear to be more tolerant of dispersants than those with only a tissue barrier (Scarlett et al., 2005). In addition, organisms that produce mucus, such as coral, have an elevated tolerance for oil exposure (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Concentrations of 100 ppm and 1,000 ppm oil plus dispersant in a ratio of 4:1 were necessary for oyster and mussel fertilization and development to become reduced when the larvae was exposed to the mixture (Renzoni, 1973). After 48 hours of exposure to dispersants, the blue mussel (*Mytilus edulis*) died at dispersant concentrations of 250 ppm, although reduced feeding rates were observed at 50 ppm (Scarlett et al., 2005). The snakelocks anemone (*Anemonia viridis*), which does not have a protective shell, was much more sensitive to dispersants. It retracted its tentacles and failed to respond to stimuli after 48 hours of exposure to 40 ppm dispersant (Scarlett et al., 2005). Corals exposed to dispersed oil showed 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 does not appear to be reversible; however, if the exposure is short enough, nervous system damage may be reversed and organisms may recover (Scarlett et al., 2005). Experiments using both anemones and corals showed recovery after exposure to dispersants (Scarlett et al., 2005; Wyers et al., 1986)

Concentrations used in historical experiments are generally much higher than the exposure that would occur in the field (Renzoni, 1973; George-Ares and Clark, 2000). Although historical experiments seem to indicate that the toxicity of oil increases with the addition of the 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 the dispersed oil is more easily diluted with the surrounding water and biodegraded by bacteria (George-Ares and Clark, 2000). Therefore, concentrated dispersants are not anticipated to reach live bottoms, and any 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, however, some oil could be carried to live bottoms 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 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 sedimented oil, however, are anticipated to experience low-level concentrations because as oiled sediments settle to the seafloor they become widely dispersed. Many organisms on live bottoms will be able to protect themselves from low levels of oiled sediment that may settle out of the water column. Organisms with shells will not experience direct contact with the oil, and mobile organisms will be able to move away from areas where oiled sediment has accumulated. Coral may also be able to protect itself from low concentrations of sedimented oil that settles from the water column through mucus that will not only act as a barrier to protect coral from the oil in the water column but which 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 turbidity and sedimentation, slight addition of sediment to the area should not impact survival.

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 booms are moved around by waves (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill live bottoms that have unmapped locations 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 failed recovery. Effort should be made to keep vessel anchorage areas as far from sensitive benthic features as possible to minimize impact.

Drilling muds comprised primarily of barite 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 stipulations as described in NTL 2009-G39, a well should be far enough away from a Pinnacle 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

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

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

Live bottoms 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, such as the live bottoms off Florida. 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, would be greatly reduced, as the species are tolerant of suspended sediments, and recovery would occur quicker. Recovery time from sediment exposure would depend on the amount of sediment an organism was exposed to, if an entire population was demolished, and the extent of the loss.

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 such as reduced recruitment success, reduced growth, and reduced organism cover as a result of impaired recruitment may occur. Recovery may be fairly rapid from brief, low-level exposures, but it could be much longer if acute concentrations of oil contact organisms. 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 (if it ever reaches them), and it would be unlikely, except in shallow coastal waters, that it would mix to the depth of the live bottoms in concentrations that could cause toxicity. Subsea plumes formed in deep water would not travel onto the continental shelf because deep-sea currents do not travel up a slope.

A catastrophic blowout and spill on the continental shelf has a greater chance to impact live bottom features. If a blowout on the continental shelf occurs close enough to sensitive features, the organisms may be smothered by settling sediment that is 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 oil and gas activity from live bottom features helps to prevent heavy sedimentation, as well as features being crushed by a sinking rig.

In most cases, the impacts from oil would be sublethal. Surface oil is not expected to mix to the zone of active growth, and any oil components that do reach that depth would 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 features should be protected from subsea plumes, while lower relief live bottoms may be impacted. The current oil and gas activity in the GOM, however, is distanced from low-relief live bottoms because no live bottom, low-relief blocks have been leased with the current proposed lease sales. Overall impacts of dispersed oil would be similar to subsea plumes. Spill response activity may impact low-relief, live bottom features if they are unmarked on nautical charts and vessels anchor on the features, but it is doubtful that a vessel would anchor on a marked Pinnacle feature.

Overall, a catastrophic spill would have a fairly low probability of impacting live bottom features because the bottom-disturbing activities of oil and gas activities are distanced from live bottom features within the Live Bottom Stipulation blocks, as described in NTL 2009-G39, and because BOEM conducts a case-by-case review of all plans to ensure that activities do not impact these seafloor features. In addition, the Live Bottom Stipulation blocks have not been leased as part of these proposed lease sales, creating farther distance between oil and gas activities and live bottoms. Also, live bottom features are protected by the limited mixing depth of surface oil compared with the depth of the live bottom features, currents sweeping around larger features, and the weathering and dispersion of oil that would occur with distance from the source as it travels toward the features. Low-relief features could have impacts from a blowout as their relief would not divert currents. In addition, the locations of these features are not all known so accidental anchor impacts may result in breakage of the features and possibly destruction. These low-relief features, however, would be protected by the regulated distance of current oil and gas activities, which increases the chance of oil becoming well dispersed before it reaches the features.

B.3.1.7. Topographic Features

The Gulf of Mexico has a series of topographic features (banks or seamounts) on the continental shelf in 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 37 named topographic features in the Gulf of Mexico with specific BOEM protections, including the Flower Garden Banks. BOEM has created “No Activity Zones” around topographic features in order to protect these habitats from disruption by oil and gas 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. NTL 2009-G39 recommends that drilling should not occur within 152 m (500 ft) of a “No Activity Zone” of a topographic feature.

Potentially sensitive biological features (PSBF's) are features that have moderate to high relief (8 ft [2 m] or higher), provide hard surface for sessile invertebrates, and attract fish, but they are not located within the "No Activity Zone" of topographic features. These features are frequently located near topographic features. No bottom-disturbing activities that may cause impact to these features are permitted.

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill 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 surface almost directly over the source location. However, if the 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). 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 oil on 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 many organisms within a few hundred meters of the wellhead. Fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. 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 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 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 recommends 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 PSBF's. Although these small oil droplets will 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 (Post-Spill, Long-Term Recovery and Response). 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 PSBF's.

Benthic communities on a topographic feature or PSBF 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.

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 may occur within 1 month (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 PSBF's, 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 adapted to frequent sedimentation.

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 predominate in 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; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration if the hard substrate upon which they live was not physically destroyed.

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 B-4**) for a catastrophic spill on the continental shelf is assumed to last 2-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which will float (API° >10). 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 B-4**) for a catastrophic spill in deep water is assumed to last 4-6 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 will be released, which will float (API° >10). 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 will also occur as it travels from its release point. 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 to Topographic Features

Impacts from Surface Oil

Sensitive reef communities flourish on topographic features and PSBF's 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 PSBF's in the GOM are shallower than 10 m (33 ft), and only the Flower Garden Banks are shallower than 20 m (66 ft).

Depending on the location of the launch point for a catastrophic spill, the time of year may also affect the probability of oil reaching the surface water above the topographic features. For example, the conditional probability of surface water oiling occurring as a result of a catastrophic spill at two launch points in the EPA was estimated by the Bureau of Ocean Energy Management's OSRA model; the condition of these probabilities is that a spill is assumed to have occurred at the given location. The greatest probability of oil moving to the west of the launch points toward the topographic features would generally occur in the fall, while the least probability of such occurrence would generally occur in the spring. In the spring, there is only a 1 percent conditional probability that one bank (Ewing Bank) could have the surface waters above the bank oiled after 60 days (for LP 7) (**Figure B-4 and Tables B-5 and B-6**). Most of the waters above the topographic features could experience a 1-2 percent conditional probability of oiling after 60 days in the summer, winter, and fall (**Figures B-3, B-5, and B-6, and Tables B-5 and B-6**). This oil, however, is only modeled for surface waters, and it is not expected to mix to the depth of the benthic organisms on topographic features and PSBF's, as discussed above. Therefore, based on measurements and modeling, surface oil is not anticipated to impact topographic features or PSBF's.

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 PSBF's. 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 PSBF's. A sustained spill would continuously create surface slicks and possibly subsurface spill plumes. Some of the oil in the water column will 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 higher the exposure concentration may be.

The PSBF's have a greater chance of being impacted by subsea plumes than topographic features because currents tend to sweep around topographic features (Rezak et al., 1983; McGrail, 1982). The lower relief PSBF's may fall in the path of the plume because the feature is 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; however, impacts may be temporary or unable to be measured over time. Experimental simulations of exposure indicated that normal feeding activity of *Porites porites* and *Madracis asperula* were reduced when exposed to 50 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 be necessary to measure reduced photosynthesis or growth in corals. Photosynthesis of the zooxanthellae in *Diplora 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 *Montastrea 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 PSBF's. 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 (6 ft) (McAuliffe et al., 1981). 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). There is very little information on the behavior of subsea dispersants.

Dispersed oil reaching the topographic features and PSBF's in the Gulf of Mexico would 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 does 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 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 PSBF's 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, however, are anticipated to experience low-level concentrations because as the oiled sediments settle to the seafloor 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 (Tokotch, 2010). Vessel anchorage and decontamination stations set up during response efforts may also break or kill PSBF's 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). Effort should be made to keep vessel anchorage areas as far from sensitive benthic features as possible to minimize impact.

Drilling muds comprised primarily of barite 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 stipulations as 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 fluid would 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 PSBF's 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 PSBF's are located offshore.

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

Topographic features and PSBF's 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 quicker.

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 PSBF's 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 PSBF's (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 deepwater would not travel onto the continental shelf because deep-sea currents do not travel up a slope.

A catastrophic blowout and spill on the continental shelf has a greater chance to impact topographic features and PSBF's. If the blowout occurs close enough to sensitive features, the organisms may be smothered by settling sediment that was displaced by the blowout. 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 oil and gas activities from topographic features prevents the settlement of a sinking rig on top of a topographic feature, although it may destroy a PSBF.

In most cases, impacts from oil would be sublethal. Surface oil is not 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 protected from subsea plumes, while lower relief PSBF's may be impacted. Overall impacts of dispersed oil would be similar to subsea plumes. 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 PSBF's.

Overall, a catastrophic spill would have a low probability of impacting topographic features because of the distancing requirements included in leases, as described in NTL 2009-G39, of oil and gas activities from topographic features, 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 PSBF's could have greater impacts from a blowout as oil and gas activities are not as far distanced from them as 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 breakage of the features and possibly destruction. The PSBF's would, however, have similar protection as for topographic features from surface oil.

B.3.1.8. Sargassum *Communities*

Pelagic *Sargassum* algae is a floating brown algae that occurs in all parts of the GOM throughout the year. It has a seasonal cycle so that its abundance greatly increases spring through fall, when it is carried by water currents around the south of Florida and then up the east coast (Gower and King, 2011). It 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.

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 chapter 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, 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 utilizes the habitat of the *Sargassum*. Impacts 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).

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 comes 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 chapter deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

Since *Sargassum* is a floating pelagic (open ocean) 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. For example, *Macondo* well oil spill covered up to one-third of the northern GOM (McCrea and Pauly, 2011; USDOC, NMFS, 2011a) and may have affected about one-third of the *Sargassum* algae in the northern GOM at the time.

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. Two catastrophic OSRA model runs were used to estimate the conditional probabilities of contact to resources from two different launch points (LP 6 and LP 7) as described in **Chapter B.1.2.3**, the condition being that a spill is assumed to have occurred at a given location. The conditional probabilities (expressed as percent chance) of a spill contacting *Sargassum* beds within 60 days are given for various locations in **Tables B-7 and B-8**. The highest conditional probability of contact with *Sargassum* beds from a catastrophic spill starting at both LP 6 and LP 7 is in summer (66%). The conditional probability of oil contacting *Sargassum* beds during any other season is less than or equal to 2 percent for either launch point. This is primarily due to the naturally seasonal cycle of summer growth and winter reduction within *Sargassum* communities.

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 increase the exposure of *Sargassum* to oil by promoting mixing of oil into the upper few meters of the water column. This also promotes the dispersion of oil, speeding its decline toward low concentrations that would be less toxic. 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. Heavy oiling of *Sargassum* near the source of the spill would destroy the affected algae. Very light exposure far from the oil source may have little effect.

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. There are no published studies of the effects of oil on *Sargassum* or its associates, but numerous studies of similar organisms in benthic habitats can suggest expected results. 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 re-activated, producing renewed impacts.

Sargassum algae has a yearly seasonal cycle of growth and a yearly cycle of migration from the GOM to the western Atlantic. A catastrophic spill could affect a large portion of the annual crop of the algae. A large event, such as the *Macondo* well blowout and spill, could reduce the standing crop of *Sargassum* in the GOM and subsequently in the western Atlantic. This could have a cascading effect down current (in the Atlantic) that would stress the cycles of other organisms that depend on the *Sargassum* habitat. However, the effect can be expected to diminish with remoteness from the direct impacts of the spill, i.e., the algae community itself would be most affected, with lesser effects on organisms that utilize the habitat as a nursery, for feeding, as shelter, or 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 quickly regain its typically very high water quality. The pelagic habitat far from shore is also far from land-based sources of pollution. 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. Relatively small populations survive each winter, subsequently repopulating the habitat each year. With this pattern, recovery from the effects of a catastrophic event is expected within 1-2 growing seasons.

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 within 1-2 years because the algae has a yearly cycle of subsidence and re-growth. The pelagic habitat would quickly regain its high level of water quality after the cessation of a spill. 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.

B.3.1.9. Chemosynthetic Deepwater Benthic Communities

Deepwater benthic communities of the Gulf of Mexico include soft bottom, chemosynthetic, and coral habitats. Deep water, for ecology in the GOM, is defined as water depths over 300 m (984 ft) because chemosynthetic communities and *Lophelia* coral habitats have not been found in waters shallower than these depths. The possible impacts to these benthic communities from a catastrophic blowout depend on the location and the nature of the event.

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 chapter 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 many organisms within a few hundred meters of the wellhead. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. If a blowout were to occur close enough to a chemosynthetic community, suspended sediment may impact the organisms. Restrictions described in NTL 2009-G40 require drilling to be removed at least 610 m (2,000 ft) from possible chemosynthetic communities. During a blowout, sediment may become contaminated with oil and subsequently deposit that oil down-current from the source. The highest concentrations of contamination 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 sediment.

Destruction of the oil drilling rig and associated equipment could have an acute effect on any chemosynthetic communities caught under the direct impact of the equipment when it falls to the seafloor. However, the restrictions described in NTL 2009-G40 require drilling locations to be 610 m (2,000 ft) from any possible indications of chemosynthetic communities, reducing the possibility that a rig would settle 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 3.2.1.2** of this EIS; 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 affecting chemosynthetic communities on the seafloor. Even oil treated with chemical dispersants on the sea surface would not 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 in the top 2 m (6 ft) (McAuliffe et al., 1981a; Lewis and Aurand, 1997). Lubchenco et al. (2010) reports that chemically dispersed surface oil from the *Macondo* well blowout and oil spill remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. However, if the 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, 2010a). It is unlikely that any chemosynthetic community would be affected by the initial stage of a catastrophic event due to the required separation of drilling activities from sensitive habitats, because released oil would rise rapidly to a level above the habitat, and because surface oil would not mix to the depths of the 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 chapter deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

A spill resulting from a catastrophic blowout in deep water has the potential to impact offshore benthic communities; however, it is not likely that deepwater benthic communities would be affected by a spill from a shallow-water blowout. Although subsurface plumes can be generated when oil is ejected under high pressure or 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 *Macondo* well blowout and spill 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 by adhering to other particles, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil would also reach the seafloor through planktonic consumption and associated excretion, which is distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). 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).

A sustained spill may result in elevated exposure concentrations to chemosynthetic features 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-G39) prevents wells from being placed immediately adjacent to sensitive communities; however, in the event of a seafloor blowout, some oil could be carried to chemosynthetic communities by subsea plumes. Impacts may include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment. 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 at this time. In general, 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 patch habitats may be affected, the Gulfwide ecosystem of chemosynthetic communities would be expected to suffer no significant effects.

Drilling muds comprised primarily of barite 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 stipulations as described in NTL 2009-G40, a well should be far enough away from a chemosynthetic community to prevent extruded drilling muds from smothering sensitive benthic communities.

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 chemosynthetic 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 the chemosynthetic communities are located offshore in deep water (>300 m, 610 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 located at more 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 be diluted with distance from the well. 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 from a blowout. 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. 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, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil would also reach the seafloor through planktonic consumption and associated excretion, which is distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). 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 since the oil would be deposited in a widely scattered and decayed state, little 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) are not likely to reach chemosynthetic communities in heavy amounts because of requirements described in NTL 2009-G40. Fine sediment from a blowout may 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 if the structure travels more than 610 m (2,000 ft) from the well site.

The ongoing spill event (Phase 2) would have the most effect on chemosynthetic communities. Chemosynthetic 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, 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 may be affected, the Gulfwide ecosystem of chemosynthetic communities would be expected to suffer no significant effects.

As oil approaches shore (Phase 3), there would be no additional adverse impacts to chemosynthetic communities because the chemosynthetic communities are located offshore in deep water (>300 m; 610 ft).

The recovery of chemosynthetic 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 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. 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. However, most chemosynthetic community habitats 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.

B.3.1.10. Nonchemosynthetic Deepwater Benthic Communities

Deepwater benthic communities of the Gulf of Mexico include soft bottom, chemosynthetic, and live bottom communities (mostly deepwater coral communities). Deep water, for ecology in the GOM, is defined as water depths over 300 m (984 ft) because nonchemosynthetic communities and *Lophelia* coral habitats have not been found in waters shallower than these depths. The possible impacts to nonchemosynthetic deepwater benthic communities from a catastrophic blowout depend on the location and the nature of the event.

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 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 many organisms within a few hundred meters of the wellhead. A blowout that occurs outside the well casing can rapidly deposit 30 cm (12 in) or more of sediment within a few hundred meters and may smother much of the soft bottom community in a localized area. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. Many of the organisms on soft bottoms live within the sediment and have the ability to migrate upward in response to burial by sedimentation. In situations where soft bottom infaunal communities are negatively impacted, recolonization by populations from neighboring soft bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than 1 year for most macrofauna and megafauna species. Recolonization could take longer for areas affected by direct contact of concentrated oil.

If a blowout were to occur close enough to a sensitive deepwater live bottom community, suspended sediment may impact the organisms. Restrictions described in NTL 2009-G40 require drilling to be removed at least 610 m (2,000 ft) from possible live bottom communities. During a blowout, suspended sediment may become contaminated with oil and subsequently deposit that oil down-current from the source. The highest concentrations of contamination 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 sediment.

Destruction of the oil drilling rig and associated equipment could have an acute effect on any nonchemosynthetic communities caught under the direct impact of the equipment when it falls to the seafloor. However, the restrictions described in NTL 2009-G40 require drilling locations to be 610 m (2,000 ft) from any possible indications of sensitive live bottom communities, reducing the possibility that a rig would settle 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 3.2.1.2** of this EIS; 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 affecting nonchemosynthetic communities on the seafloor. Even oil treated with chemical dispersants on the sea surface would not 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 in the top 2 m (6 ft) (McAuliffe et al., 1981; Lewis and Aurand, 1997). Lubchenco et al. (2010) report that chemically dispersed surface oil from the *Macondo* well blowout and oil spill remained in the top 6 m (20 ft) of the water column where it mixed with surrounding waters and biodegraded. However, if the 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 unlikely that any deepwater live bottom community would be affected by the initial stage of a catastrophic event due to the required separation of drilling activities from sensitive habitats, because released oil would rapidly rise to a level above the habitat, and because surface oil would not 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 chapter deals with the growing effects of a blowout that releases oil and methane into the offshore environment.

A spill resulting from a catastrophic blowout in deep water has the potential to impact offshore benthic communities; however, it is not likely that deepwater benthic communities would be affected by a spill from a shallow-water blowout. 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. Oil and chemical spills that originate at the sea surface are not considered to be a potential source of measurable impacts on deepwater, live bottom 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. Surface oil also could not physically mix to depths of deepwater communities under natural conditions (Lange, 1985; McAuliffe et al., 1975; McAuliffe et al., 1981a; Tkalich and Chan, 2002).

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. One deepwater coral site at a depth of 1,370 m (4,495 ft) has been reported as severely damaged following the *Macondo* well blowout and oil spill. 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) (White et al., 2012). The published results document damage to the coral community. Forty-three coral colonies were analyzed via close-up imagery: 86 percent exhibited signs of impact; 46 percent exhibited impact to at least 50 percent 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. This appears to be an exceptional case, since the numerous other communities investigated since the spill remained healthy (White et al., 2012). 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 *Macondo* well blowout and spill 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 the oil occurs in the water, rendering the oil less toxic when it contacts the seafloor (Hazen et al., 2010). However, as evidenced by the report of White et al. (2012), subsea plumes can still retain toxic concentrations over a distance of at least 11 km (7 mi). Oil in a plume can adhere to other particles and precipitate to the seafloor, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil also would reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). 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).

A sustained spill may result in elevated exposure concentrations to live bottom features 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 biological degradation pathways. BOEM's policy (refer to NTL 2009-G39) prevents wells from being placed immediately adjacent to sensitive communities; however, in the event of a seafloor blowout, some oil could be carried to live bottom communities by subsea plumes. Impacts may include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment. Concentrated oil plumes reaching live bottom 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 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 at this time. In general, the potential impacts to deepwater live bottom 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 patch habitats may be affected, the Gulfwide ecosystem of deepwater live bottom communities would be expected to suffer no significant effects.

Drilling muds comprised primarily of barite 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 stipulations as described in NTL 2009-G40, a well should be far enough away from sensitive live bottom communities to prevent extruded drilling muds from smothering them.

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 nonchemosynthetic benthic 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 the communities are located offshore in deep water (>300 m; 610 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 re-activated, producing renewed impacts.

Although deepwater coral and other live bottom communities often live in close association with hydrocarbon seeps (since the carbonate substrate is precipitated by chemosynthetic communities), this does not mean they are necessarily tolerant to the effects of oil contamination. Natural seepage is very constant and at very low rates as compared with the potential volume of oil released from a catastrophic event (blowout or pipeline rupture). In addition, live bottom organisms, such as *Lophelia pertusa*, inhabit areas around the perimeter of seeps and sites where hydrocarbon seepage has reduced its flow or stopped. 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 live bottom communities are found near oil seeps, they are not typically exposed to concentrated oil.

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 live bottom community habitat in its path. The farther the dispersed oil travels, the more diluted it would become as it mixes with surrounding water. Sensitive live bottom communities located at more 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 be diluted with distance from the well.

There have been no experiments showing the response of deepwater corals to oil exposure. Experiments with shallow tropical corals indicate that 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. 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 scarcity of deepwater hard bottoms, their comparatively low surface area, 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 devastating effects on 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, much like rainfall (Kingston et al., 1995; International Tanker Owners Pollution Federation Limited, 2007). Oil also would reach the seafloor through consumption by plankton with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2007). 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 since the oil would be deposited in a widely scattered and decayed state, little effect is anticipated.

Overall Summary and Conclusion (Phases 1-4)

Nonchemosynthetic communities would potentially be subject to detrimental effects from a catastrophic seafloor blowout. Sediment and oiled sediment from the initial event (Phase 1) are not likely to reach sensitive live bottom communities in heavy amounts because of requirements described in NTL 2009-G40. Fine sediment from a blowout may 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 if the structure travels more than 610 m (2,000 ft) from the well site.

The ongoing spill event (Phase 2) would have the most effect on nonchemosynthetic communities. Deepwater live bottom communities are at risk from subsea oil plumes that could directly contact localized patches of sensitive habitat. Oil plumes reaching live bottom 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 may be affected, the gulf-wide ecosystem of live bottom communities would be expected to suffer no significant effects.

As oil approaches shore (Phase 3), there would be no adverse impacts to nonchemosynthetic communities because the communities are located offshore in deep water (>300 m; 610 ft).

The recovery of nonchemosynthetic 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. 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. However, most live bottom community habitats 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.

B.3.1.11. Soft Bottom Benthic Communities

The seafloor on the continental shelf in the Gulf of Mexico consists primarily of muddy to sandy sediments. Benthic organisms found on the seafloor include infauna (animals that live in the substrate, including mostly burrowing worms, crustaceans, and mollusks) and epifauna (animals that live on or are attached to the substrate; mostly crustaceans, as well as echinoderms, mollusks, hydroids, sponges, soft and hard corals, and demersal fishes). Infauna is comprised of meiofauna, small organisms (63-500 μm) that live among the grains of sediment; and macroinfauna, slightly larger organisms (>0.5 mm; 0.02 in) that live in the sediment (Dames and Moore, Inc., 1979). Shrimp and demersal fish are closely associated with the benthic community. The most abundant organisms on the continental shelf are the deposit-feeding polychaetes. The slope and deep sea consist of vast areas of primarily fine sediments that support benthic communities with lower densities and biomass but higher diversity than the continental shelf (Rowe and Kennicutt, 2001).

Phase 1—Initial Event

A blowout from an oil well could result in a catastrophic spill 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 surface almost directly over the source location. However, if the 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). 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. Subsea plumes or sinking oil on particulates may contact portions of the seafloor.

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 many organisms within a few hundred meters of the wellhead. Some fine sediment could travel up to a few thousand meters before redeposition, negatively impacting a localized area of benthic communities. The localized seafloor habitat around which a seafloor blowout occurs would be impacted by suspended and redeposited sediment.

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 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 Soft Bottom Benthic Communities

Impacts that occur to benthic organisms as a result of a blowout would depend on the type of blowout and their distance from the blowout. Also, if the blowout were to occur beneath the seabed, soft sediment habitat would be destroyed by the formation of a crater, and the suspension and subsequent deposition of disturbed sediment would smother localized areas of benthic communities. A blowout that occurs outside the well casing can rapidly deposit 30 cm (12 in) or more of sediment within a few hundred meters and may smother much of the soft bottom community in a localized area. Benthic communities exposed to large amounts of resuspended and deposited sediments following a catastrophic, subsurface blowout could be subject to smothering, sediment suffocation, and exposure to resuspended toxic contaminants. Impacts to organisms as a result of sedimentation would vary based on species tolerance, degree of sedimentation, length of exposure, burial depth, and vertical migration ability through sediment.

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. A settling rig may suspend sediments, which may smother nearby benthic communities. The habitats beneath the rig may be permanently lost; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration if the hard substrate upon which they live was not physically destroyed.

Phase 2—Offshore Spill

A spill from a shallow-water blowout could impact benthic communities on the continental shelf. The scenario (**Table B-4**) for a catastrophic spill on the continental shelf is assumed to last 2-5 months and to release 30,000 bbl per day. A total volume of 0.9-3.0 MMbbl of South Louisiana midrange paraffinic sweet crude oil could be released, which would float (API° >10). 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 and deepwater communities. The scenario (**Table B-4**) for a catastrophic spill in deep water is assumed to last 4-6 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 could be released, which would float (API° >10). 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 launch point. 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 to Soft Bottom Benthic Communities

Impacts from Surface Oil

Surface oil slicks can spread over a large area; however, the majority of the slick is comprised of a very thin surface layer of oil moved by winds and currents (Lewis and Aurand, 1997). The potential of surface oil slicks to affect benthic habitats is limited by its ability to mix into the water column. Soft bottom benthic communities below 10-m (33-ft) water depth are protected from surface oil because of its lack of ability to mix with water (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Benthic organisms would not become physically coated or smothered by surface oil. However, if this surface oil makes its way into the water column through physical mixing, the use of dispersants, or the sedimenting to particles in the water column, benthic communities may be impacted. These scenarios are discussed in later sections.

Disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10-20 m (33-66 ft) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002). Therefore, soft bottom benthic communities located in shallow water have the potential to be fouled by oil that is floating on shallow water and mixes to the depth of the seafloor. Nearshore oil deposits that occur in sheltered areas, such as bays, may remain in the sediment and impact organisms for long periods. Oil in nearshore sediments was found in high concentrations 8 years following the *Exxon Valdez* spill (Dean and Jewett, 2001). Benthic communities located in deeper water would not be impacted by oil physically mixed into the water column. However, if dispersants are used, they would enable oil to mix into the water column and possibly impact organisms in deeper water. Dispersants are discussed later in this chapter.

Depending on the location of the launch point for a catastrophic spill, the time of year may also affect where the surface slick travels, and subsequently is deposited on the seafloor. For example, the conditional probability of surface water oiling occurring as a result of a catastrophic spill at two launch points in the EPA was estimated by the Bureau of Ocean Energy Management's OSRA model; the condition of these probabilities is that a spill is assumed to have occurred at the given location. The greatest probability of oil moving to the west of the launch points is generally in the fall, while the greatest probability of oil moving to the east is generally in the spring. Oil is more evenly distributed in both directions in the summer and winter (**Figures B-3 and B-5, and Tables B-5 and B-6**). The heaviest surface oiling is concentrated near the launch points and it becomes more dispersed with distance from the source (**Figures B-3 and B-5, and Tables B-5 and B-6**). This oil, however, is only modeled for surface waters, and it is unlikely that it will mix to the depth of the benthic organisms on the seafloor. It can, however, make its way to the seafloor through flocculation, by adhering to sediment and other particles in the water column, and by being consumed and deposited by organisms.

Impacts from Subsurface Oil

The presence of a subsurface oil plume on the continental shelf from a shallow-water blowout may affect soft bottom benthic communities. A majority of the oil released is expected to rise rapidly to the sea surface above the launch point because of the specific gravity characteristics of the oil reserves in the GOM, thus not directly sinking to the seafloor and smothering 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 (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 portions of the seafloor as it travels from the source. A sustained spill would continuously create surface slicks and possibly subsurface plumes. Some of the oil in the water column will 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 higher the exposure concentration may be.

Soft bottom infaunal communities that come into direct contact with oil may experience sublethal and/or lethal effects. The greatest effects of oil exposure would occur close to the well and impacts would decrease with distance. A subsurface plume that contacts the seafloor may result in acute toxicity. The water accommodated fraction (WAF) or water soluble fraction (WSF) of oil that dissolves in water may be the most toxic to organisms, especially larvae and embryos in the water column or at the water sediment interface. Lethal effects for marine invertebrates have been reported at exposures between 0.10 ppm to 100 ppm WSF of oil (Suchanek, 1993). The WSF of petroleum hydrocarbons was reportedly highly toxic to the embryos of oysters and sea urchins, while sediment containing weathered fuel was not toxic to the same species (Beiras and Saco-Álvarez, 2006). Quahog clam embryos and larvae also experienced toxicity and deformation of several different crude oils at WSF concentrations between 0.10 ppm and 10 ppm (Byrne and Calder, 1977). An experiment indicated that the WSF of No. 2 fuel oil at a concentration of 5 ppm disrupted the cellular development of 270 out of 300 test organisms within 3 hours of exposure (Byrne, 1989). After 48 hours exposure, all of the test organisms died and the 48-hour LC_{50} (lethal concentration for 50% of the test population) was calculated to be 0.59 ppm (Byrne, 1989). Another experiment indicated that a WSF of 0.6 ppm and greater of No. 2 fuel oil depressed respiration, reduced mobility of sperm, interfered with cell fertilization and embryonic cleavage, and retarded larval development of sand dollar eggs (Nicol et al., 1977). Experiments that exposed sea urchin embryos to 10-30 ppm WSF of diesel oil for 15-45 days resulted in defective embryonic development and nonviable offspring (Vashchenko, 1980). Therefore, any dissolved petroleum hydrocarbon constituents that reach larval benthic organisms may cause acute toxicity and other developmental effects to this life stage. The WAF and WSF, however, should be considered "worst-case scenario" values as they are based on a closed system at equilibrium with the contaminant and, due to its size and complexity, the GOM will not reach equilibrium with released oil.

Oil in the water column may impact pelagic eggs and larvae of invertebrates. Toxicity tests indicated that eggs of many species were killed by diesel oil in seawater, and in general, the smaller eggs died earlier (Chia, 1973). Bivalve fertilization and sperm fertility were depressed with exposure to crude oil (Renzoni, 1975). The WSF of crude oil was also highly toxic to gametes, embryos, and larvae of bivalves (Renzoni, 1975). Oil concentrations of 0.1 and 1 ppm caused a decrease in fertilization, development of embryos, survival or larvae, and larval growth in the bivalves *Crassostrea virginica* and *Mulinia lateralis* (Renzoni, 1975). Another experiment, however, calculated the LC_{50} for a 6-hour exposure of the gametes, eggs, and larvae of three bivalves (*Crassostrea angulata*, *Crassostrea gigas*, and *Mytilus galloprovincialis*) to be 1,000 ppm oil and 1,000 ppm oil plus dispersant (Renzoni, 1973). Toxicity varies widely among species and oil types.

Sublethal responses of marine invertebrates may result in population level changes (Suchanek, 1993). Such sublethal responses may occur at concentrations as low as 1-10 ppb (Hyland and Schneider, 1976). Sublethal impacts may include reduced feeding rates, reduced ability to detect food, ciliary inhibition, reduced movement, decreased aggression, and altered respiration (Suchanek, 1993).

The farther a subsea plume travels, the more physical and biological changes occur to the oil before it reaches benthic organisms. Oil would become diluted as it physically mixes with the surrounding water, and significant evaporation occurs from surface slicks. The most toxic compounds of oil are lost within the first 24 hours of a spill, leaving the heavier, less toxic compounds in the system (Ganning et al., 1984). An even greater component of the lighter fuel oils dissipates through evaporation. Water currents could carry a plume to contact the seafloor directly, but a likely scenario would be for the oil to adhere to other particles and precipitate to the seafloor, much like rainfall (International Tanker Owners Pollution Federation Limited, 2002; Kingston et al., 1995). Oil also would reach the seafloor through consumption by plankton, with excretion distributed over the seafloor (International Tanker Owners Pollution Federation Limited, 2002). The longer and farther a subsea plume travels in the sea, the more dilute the oil would be (Vandermeulen, 1982; Tkalich and Chan, 2002). In addition, microbial degradation of the oil occurs in the water column, reducing toxicity (Hazen et al., 2010; McAuliffe et al., 1981b). The oil would move in the direction of prevailing currents (S.L. Ross Environmental Research Ltd., 1997) and, although the oil would weather with the distance it travels, low levels of oil transported in subsea plumes would impact benthic communities. These mechanisms would result in a wide distribution of small amounts of oil. 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).

Localized areas of lethal effects would be recolonized by populations from neighboring soft bottom substrate once the oil in the sediment has been sufficiently reduced to a level able to support marine life (Sanders et al., 1980; Lu and Wu, 2006; Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000; Dean and Jewett, 2001). This initial recolonization process may be fairly rapid, but full recovery may take up to 10 years depending on the species present, substrate in the area, toxicity of oil spilled, concentration and dispersion of oil spilled, and other localized environmental factors that may affect recruitment (Kingston et al., 1995; Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). Opportunistic species would take advantage of the barren sediment, repopulating impacted areas first. These species may occur within the first recruitment cycle of the surrounding populations or from species immigration from surrounding stocks and may maintain a stronghold in the area until community succession begins (Rhodes and Germano, 1982; Sanders et al., 1980).

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). However, the impacts to deepwater soft bottom benthic communities as a result of a blowout would similar to those on the continental shelf.

Impacts from Dispersed Oil

If dispersants are used at the sea surface, oil may mix into the water column, and if they are applied subsea, dispersed oil can travel with currents and contact the seafloor. Chemically dispersed oil from a surface slick is not anticipated to result in lethal exposures to organisms on the seafloor. The chemical dispersion of oil may increase the weathering process and allow surface oil to be diluted by greater amounts of water. Reports on dispersant usage on surface plumes 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 (6 ft) (McAuliffe et al., 1981a). Dispersant usage also reduces the oil's ability to stick to particles in the water column, minimizing oiled sediments from traveling to the seafloor (McAuliffe et al., 1981a). If applied, subsea benthic communities near the source could be exposed to dispersed oil that is concentrated enough to harm the benthic community. If the oil remains suspended for a longer period of time, it would be more dispersed and less concentrated. There is very little information on the behavior of subsea dispersants.

Dispersed oil used at the sea surface reaching the benthic communities in the Gulf of Mexico would be expected to be at very low concentrations (<1 ppm) (McAuliffe et al., 1981a). Such concentrations would not be life threatening to larval or adult stages on the seafloor based on experiments conducted with benthic and pelagic species (Scarlett et al., 2005; Hemmer et al., 2010; George-Ares and Clark, 2000). Any dispersed oil in the water column that comes in contact with benthic communities may evoke short-term negative responses by the organisms (Scarlett et al., 2005). Sublethal responses may include reduced feeding rate, erratic movement, and tentacle retraction (Scarlett et al., 2005). In addition, although dispersants were detected in waters off Louisiana after the *Macondo* well blowout and spill, they were below USEPA benchmarks of chronic toxicity (OSAT, 2010). The rapid dilution of dispersants in the water column and lack of transport to the seafloor was also reported by OSAT (2010) where no dispersants were detected in sediment on the Gulf floor following the *Macondo* well blowout and spill.

Impacts from Oil Adhering to Sediments

Oiled sediment that settles to the seafloor may affect organisms upon which it settles. The greatest impacts would be closest to the well where organisms may become smothered by particles and exposed to hydrocarbons. High concentrations of suspended sediment in the water column may lend to large quantities of oiled sediment (Moore, 1976). Deposition of oiled sediment is anticipated to begin occurring within days or weeks of the spill and may be fairly deep near the source (Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000). Oily sand layers were reported to be 10 cm (4 in) deep on the seafloor near the *Amoco Cadiz* spill (Gómez Gesteira and Dauvin, 2000). Acute toxicity may occur near the spill, eliminating benthic communities.

Much of the oil released from a blowout would rise to the sea surface, therefore dispersing the released oil before it makes its way back to the seafloor through flocculation, by deposition from organisms that pass it through their systems with food, and by adhering to sinking particles in the water column. In addition, small droplets of oil that are entrained in the water column for extended periods of time may migrate a great distance from their point of release and may attach to suspended particles in the water column and later be deposited on the seafloor (McAuliffe et al., 1975). The majority of organisms exposed to oiled sediment are anticipated to experience low-level concentrations because as the oiled sediments settle to the seafloor they are widely dispersed. Impacts may include reduced recruitment success, reduced growth, and altered community composition as a result of impaired recruitment.

Impacts from Oil-Spill-Response Activity

Continued localized disturbance of soft bottom communities may occur during oil-spill response efforts. Anchors used to set booms to contain oil or vessel anchors in decontamination zones may affect infaunal communities in the response activity zone. Infaunal communities may be altered in the anchor scar, and deposition of suspended sediment may result from the setting and resetting of anchors. The disturbed benthic community should begin to repopulate from the surrounding communities during their next recruitment event and through immigration of organisms from surrounding stocks. Any decontamination activities, such as cleaning vessel hulls of oil, may also contaminate the sediments of the decontamination zone, as some oil may settle to the seabed, impacting the underlying benthic community.

If a blowout occurs at the seafloor, drilling muds (primarily barite) may be pumped into a well in order to "kill" it. 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 heavy layers of the extruded drilling mud would be buried. Base fluids of drilling muds are designed to be low in toxicity and biodegradable in offshore marine sediments (Neff et al., 2000). However, as bacteria and fungi break down the drilling fluids, the sediments may temporarily become anoxic (Neff et al., 2000). Benthic macrofaunal recovery would occur when drilling mud concentrations are reduced to levels that enable the sediment to become re-oxygenated (Neff et al., 2000). Complete community recovery from drilling mud exposure may take 3-5 years, although microbial degradation of drilling fluids, followed by an influx of tolerant opportunistic species, is anticipated to begin almost immediately (Neff et al., 2000). In addition, the extruded mud may bury hydrocarbons from the well, making them a hazard to the infaunal species and difficult to remove.

Phase 3—Onshore Contact

There would likely be no additional adverse impacts to soft bottom benthic communities as a result of events and the potential impact producing factors that could occur throughout Phase 3 of a catastrophic spill because these soft bottom benthic communities are located below the water line.

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

Benthic Habitats

In situations where soft bottom infaunal communities are negatively impacted, recolonization by populations from neighboring soft bottom substrate would be expected over a relatively short period. Recolonization would begin with recruitment and immigration of opportunistic species from surrounding stocks. More complex communities would follow with time. Repopulation could take longer for areas affected by direct oil contact in higher concentrations.

Many of the organisms on soft bottoms live within the sediment and have the ability to migrate upward in response to burial by sedimentation. A blowout that occurs outside the well casing can rapidly deposit 30 cm (12 in) or more of sediment within a few hundred meters and may smother much of the soft bottom community in a localized area. In situations where soft bottom infaunal communities are negatively impacted, recolonization by populations from neighboring soft bottom substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria, and probably less than 1 year for most macrofauna and megafauna species. Recolonization could take longer for areas affected by direct contact of concentrated oil. Initial repopulation from nearby stocks of pioneering species, such as tube-dwelling polychaetes or oligochaetes, may begin with the next recruitment event (Rhodes and Germano, 1982). Full recovery would follow as later stages of successional communities overtake the pioneering species (Rhodes and Germano, 1982). The time it takes to reach a climax community may vary depending on the species and degree of impact. Full benthic community recovery may take years to decades if the benthic habitat is heavily oiled (Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). A slow recovery rate would result in a community with reduced biological diversity and possibly a lesser food value for predatory species.

Localized areas of lethal effects would be recolonized by populations from neighboring soft bottom substrate once the oil in the sediment has been sufficiently reduced to a level able to support marine life (Sanders et al., 1980; Lu and Wu, 2006; Ganning et al., 1984; Gómez Gesteira and Dauvin, 2000; Dean and Jewett, 2001). This initial recolonization process may be fairly rapid, but full recovery may take up to 10 years depending on the species present, substrate in the area, toxicity of oil spilled, concentration and dispersion of oil spilled, and other localized environmental factors that may affect recruitment (Kingston et al., 1995; Gómez Gesteira and Dauvin, 2000; Sanders et al., 1980; Conan, 1982). Opportunistic species would take advantage of the barren sediment, repopulating impacted areas first. These species may occur within the first recruitment cycle of the surrounding populations or from species immigration from surrounding stocks and may maintain a stronghold in the area until community succession begins (Rhodes and Germano, 1982; Sanders et al., 1980).

Overall Summary and Conclusion (Phases 1-4)

A catastrophic blowout and spill would have the greatest impact on the soft bottom benthic communities in the immediate vicinity of the spill. Turbidity, sedimentation, and oiling would be heaviest closest to the source, and decrease with distance from the source. Complete loss of benthic populations may occur with heavy sedimentation and oil deposition. Farther from the well, a less thick layer of sediment would be deposited and oil would be dispersed from the source, resulting in sublethal impacts. The recovery of benthic populations would begin with recruitment from surrounding areas fairly rapidly.

B.3.1.12. 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. 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 B-4**.

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. 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.

An oil spill and related spill-response activities can impact marine mammals that come into contact with oil and remediation efforts. The marine mammals' exposure to hydrocarbons persisting in the sea may result in sublethal impacts (e.g., decreased health, reproductive fitness, longevity, and increased vulnerability to disease), 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. More detail on the potential range of effects to marine mammals from contact with spilled oil can be found in Geraci and St. Aubin (1990). The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities on marine mammals. For example, it is expected that the large amount of chemical dispersants being used on the oil may act as an irritant on the marine mammals' tissues and sensitive membranes.

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 potential biological removal (PBR) level is defined by the Marine Mammal Protection Act 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. However, in the Gulf of Mexico, many marine mammal species have unknown PBR's or PBR's with outdated abundance estimates, which are considered undetermined. The biological significance of any injury or mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and size of the marine mammals affected.

The *Deepwater Horizon* explosion, oil spill, and response in Mississippi Canyon Block 252 (including use of dispersants) have impacted marine mammals that have come into contact with oil and remediation efforts. According to the "Dolphins and Whales of the Gulf of Mexico Oil Spill" website, within the designated *Deepwater Horizon* explosion, oil spill, and response area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011b). All marine mammals collected either alive or dead were found east of the Louisiana/Texas border through Apalachicola, Florida. The highest concentration of strandings has occurred off eastern Louisiana, Mississippi, and Alabama, with a significantly lesser number off western Louisiana and western Florida (USDOC, NMFS, 2011b). Due to known low-detection rates of carcasses, it is possible that the number of deaths of marine mammals is underestimated (Williams et al., 2011). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses collected were related to the *Deepwater Horizon* explosion, oil spill, and response. These stranding numbers are significantly greater than reported in past years; though it should be further noted that stranding coverage (i.e., effort in collecting strategies) has increased considerably due to the *Deepwater Horizon* explosion, oil spill, and response.

The OSRA model's catastrophic runs indicate that the environmental resources closest to the spill offshore typically had the greatest risk of contact. The model provides estimated conditional probabilities (expressed as percent chance) of a spill contacting an environmental resource, the condition being that a spill is assumed to have occurred at a given location. This analysis modeled a spill that continued for 90 consecutive days by launching a spill trajectory every day for 90 days, with each trajectory tracked for up to 60 days. The OSRA for this analysis was conducted for only the trajectories of oil spills from two hypothetical spill locations (LP 6 and LP 7) in the EPA 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 potential contact probabilities of greater than 0.5 percent (refer to **Appendix C**). For 60-day OSRA trajectories, conditional probabilities for State waters varied depending on season and location, with the highest probability occurring for west Florida State waters in spring (24% for LP 6). 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 will remain at sea for 60 days or more.

Based on these data, it is reasonable to assume that a catastrophic oil spill lasting up to 90 days could have population-level effects on many species of marine mammals (e.g., sperm whales, Bryde's whales, etc.).

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response and 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. 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.

A high-volume oil spill lasting 90 days could directly impact over 22 species of marine mammals. As a spill enters coastal waters, manatees and coastal and estuarine dolphins would be the most likely to be affected.

Manatees 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). Manatees from the Northwest Unit are more likely to be seen in the northern GOM, and they can be found as far west as Texas; however, most sightings are in the eastern GOM (Fertl et al., 2005).

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. 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 reached the Florida coast when manatees were in or near coastal waters, the spill could have population-level effects.

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. Vessel strikes are the primary cause of death of manatees.

The best available count of Florida manatees is 4,834 animals, based on a January 2011 aerial survey of warm water refuges (Florida Fish and Wildlife Conservation Commission, 2011). By November 2012, there were 306 manatee carcasses collected in Florida, 80 of these animals died of human causes (Florida Fish and Wildlife Conservation Commission, 2012). Human causes included water control structures, entanglement in and ingestion of marine debris, entrapment in pipes/culverts, and collisions with watercraft. Eight-six percent of the manatees that died of human causes were killed by watercraft (Florida Fish and Wildlife Conservation Commission, 2012). 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.

There have been no experimental studies and only a few observations suggesting that oil impacts have harmed any manatees (St. Aubin and Lounsbury, 1990). Types of impacts to manatees and dugongs from contact with oil 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 tissues, (4) nutritional stress through damage to food sources, and (5) inflammation or infection and difficulty eating because of oil sticking to the sensory hairs around their mouths (Preen, 1989, in Sadiq and McCain, 1993; Australian Maritime Safety Authority, 2003). For a population whose environment is already under great pressure, even a localized incident could be significant (St. Aubin and Lounsbury, 1990). Spilled oil might affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

Bottlenose dolphins were the most affected species of marine mammals from the *Deepwater Horizon* explosion, oil spill, and response. According to the “Dolphins and Whales of the Gulf of Mexico Oil Spill” website, within the designated *Deepwater Horizon* explosion, oil spill, and response area, 171 marine mammals (89% of which were deceased) were reported. This includes 155 bottlenose dolphins, 2 Kogia spp., 2 melon-headed whales, 6 spinner dolphins, 2 sperm whales, and 4 unknown species (USDOC, NMFS, 2011b). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses collected were related to the *Deepwater Horizon* explosion, oil spill, and response. Bottlenose dolphins can be found throughout coastal waters in the Gulf of Mexico. Like manatees, dolphins could be affected, possibly to population level, by a catastrophic oil spill if it reaches the coast (as well as affecting them in the open ocean), through direct contact, inhalation, ingestion, and stress, as well as through collisions with cleanup vessels.

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. Potential impacts reflect long term persistence of oil in the environment and residual and long term clean-up 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, 2010a).

On December 13, 2010, NMFS declared an unusual mortality event (UME) for cetaceans (whales and dolphins) in the Gulf of Mexico. An UME is defined under the Marine Mammal Protect Act as a "stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response." Evidence of the UME was first noted by NMFS as early as February 1, 2010, before the *Macondo* well blowout and spill. As of July 29, 2012, a total of 759 cetaceans (5% stranded alive and 95% stranded dead) have stranded since the start of the UME, with a vast majority of these strandings between Franklin County, Florida, and the Louisiana/Texas border. The 759 cetaceans include 6 dolphins killed during a fish-related scientific study and 1 dolphin killed incidental to trawl relocation for a dredging project. More detail on the UME can be found on NMFS's website (USDOC, NMFS, 2012a). In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have played in the UME, and this continues today.

On May 9, 2012, NOAA declared an UME for bottlenose dolphins in five Texas counties. The UME lasted from November 2011-March 2012, when 123 bottlenose dolphins stranded in Aransas, Calhoun, Kleberg, Galveston, and Brazoria Counties in Texas. The investigation is ongoing (USDOC, NMFS, 2012b).

Overall Summary and Conclusion (Phases 1-4)

Accidental events related to an EPA proposed action have the potential to have adverse, but not significant impacts to marine mammal populations in the GOM. Accidental blowouts, oil spills, and spill-response activities may impact 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.

B.3.1.13. 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. 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, leatherback, hawksbill, Kemp's ridley, and loggerhead. All species are protected under the Endangered Species Act (ESA), and all are listed as endangered except the loggerhead turtle, which is listed as threatened. 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 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 B-4**.

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. 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.

The *Deepwater Horizon* explosion, oil spill, and response in Mississippi Canyon Block (including use of dispersants) have impacted sea turtles that have come into contact with oil and remediation efforts. For the latest available information on oiled or affected sea turtles documented in the area, refer to NMFS's "Sea Turtles and the Gulf of Mexico Oil Spill" website (USDOC, NMFS, 2011c).

According to this NMFS website, 1,146 sea turtles have been collected (537 alive, 609 deceased) as of February 15, 2011). Of these, 201 were greens, 16 Hawksbills, 809 Kemp's ridleys, 88 loggerheads, and the remaining 32 unknown (USDOC, NMFS, 2011c). Individuals were documented either through strandings or directed offshore captures. Due to low detection rates of carcasses in prior events, it is possible that the number of deaths of sea turtles is underestimated (Epperly et al., 1996). It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that not all carcasses were related to the *Deepwater Horizon* explosion, oil spill, and response. Over the last 2 years, NOAA has documented increased numbers of sea turtle strandings in the northern GOM. Many of the stranded turtles were reported from Mississippi and Alabama waters, and very few showed signs of external oiling (believed to be related to the *Deepwater Horizon* explosion, oil spill, and response). Necropsy results from many of the stranded turtles indicate mortality due to forced submergence, which is commonly associated with fishery interactions. In May 2012, NMFS published the Draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (*Federal Register*, 2012).

The OSRA model catastrophic runs indicate that the environmental resources closest to the spill offshore typically had the greatest risk of contact. The model provides estimated conditional probabilities (expressed as percent chance) of a spill contacting an environmental resource, the condition being that a spill is assumed to have occurred at a given location. This analysis modeled a spill that continued for 90 consecutive days by launching a spill trajectory every day for 90 days, with each trajectory tracked for up to 60 days. The OSRA for this analysis was conducted for only the trajectories of oil spills from two hypothetical spill locations (LP 6 and LP 7) in the EPA 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 of greater than 0.5 percent (refer to **Appendix C**). For 30-day OSRA trajectories, offshore waters including State waters often had higher conditional probabilities during spring (April, May, June) from both launch points (LP 6 and LP 7). 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 will remain at sea for 60 days or more.

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). According to the ERCO study, "Whether or not hypoxic conditions could, in fact, be responsible for areawide reductions in [invertebrate] faunal abundance is unclear, however." 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). Therefore, the effects of the *Ixtoc I* well blowout and spill on sea turtles in waters off Texas are still unknown.

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. 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, loggerhead, and green sea turtles are therefore most likely to be affected by a 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, 2010b). 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 (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.

As a preventative measure during the *Deepwater Horizon* explosion, oil spill, and response, NMFS and FWS translocated a number of sea turtle nests and eggs that were located on beaches affected or potentially affected by spilled oil. According to the latest information on the NMFS stranding network website (USDOC, NMFS, 2011c), a total of 274 nests were translocated from GOM beaches to the east coast of Florida. These nests were mainly for hatchlings that would enter waters off Alabama and Florida's northwest Gulf Coast. Of these, 4 were from green turtles, 5 from Kemp's ridley, and 265 were loggerheads. The translocation effort ended August 19, 2010, at the time when biologists determined that risks to hatchlings emerging from beaches and entering waters off Alabama and Florida's northwest Gulf Coast had diminished significantly and that the risks of translocating nests during late incubation to the east coast of Florida outweighed the risks of letting hatchlings emerge into the Gulf of Mexico. The hatchlings resulting from the translocations were all released as of September 9, 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.

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. 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, 2010a). Declines in the food supply for sea turtles, which include invertebrates and sponge populations, could also affect sea turtle populations. 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. 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 also drastically reduce the population.

Since January 1, 2011, a notable increase in sea turtle strandings has occurred in the northern GOM, primarily in Mississippi. While turtle strandings in this region typically increase in the spring, the recent increase is a cause for concern. The Sea Turtle Stranding and Salvage Network is monitoring and investigating this increase. The network encompasses the coastal areas of the 18 states from Maine through Texas and includes portions of the U.S. Caribbean. There are many possible reasons for the increase in strandings in the northern GOM, both natural and human caused (USDOC, NMFS, 2012c). One sea turtle had a small amount of tar from the *Deepwater Horizon* explosion, oil spill, and response on its shell. No visible external or internal oil was observed in any other animals. These sea turtle species include loggerhead, green, Kemp's ridley, leatherback, hawksbill, and unidentified. An EPA proposed action also covers these same areas. As of July 29, 2012, NMFS has identified 81 strandings in Texas (upper Texas coast – Zone 18).

Over the last 2 years, NOAA has documented necropsy results from many of the stranded turtles, indicating mortality due to forced submergence, which is commonly associated with fishery interactions, and acute toxicosis. On May 10, 2012, NMFS published the Draft EIS to reduce incidental bycatch and mortality of sea turtles in the southeastern U.S. shrimp fishery (77 FR 27411) (*Federal Register*, 2012).

Overall Summary and Conclusion (Phases 1-4)

Accidental blowouts, oil spills, and spill-response activities resulting from an EPA proposed action 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 date of accidents, and various meteorological and hydrological factors. Impacts on sea turtles from smaller accidental events are likely to affect individual sea turtles in the spill area, but they are unlikely to rise to the level of population effects (or significance) given the size and scope of such spills.

Unavailable information on the effects to sea turtles from the *Deepwater Horizon* explosion, oil spill, and response and increased stranding events (and thus changes to the sea turtle baseline in the affected environment) makes an understanding of the effects less clear.

For low-probability catastrophic spills, this analysis concludes that there is a potential for a low-probability catastrophic event to result in significant, population-level effects on affected sea turtle species.

B.3.1.14. Diamondback Terrapins

Phase1—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 1-2 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. 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.

The scenarios for each phase, including cleanup methods, can be found in **Table B-4**.

There would likely be no adverse impacts to diamondback terrapins 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 species exclusively inhabit estuarine waters and salt marshes.

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. 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.

There would likely be no adverse impacts to diamondback terrapins 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 species exclusively inhabit estuarine waters and salt marshes.

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. 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.

The major impact-producing factors resulting from the low-probability catastrophic event at may affect the five terrapin subspecies that occur in the EPA and CPA include offshore and coastal oil spills and spill-response activities.

Terrapins inhabit brackish waters including coastal marshes, tidal flats, creeks, and lagoons behind barrier beaches (Hogan, 2003). Their diet consists of fish, snails, worms, clams, crabs, and marsh plants (Cagle, 1952). Courtship and mating occur in March and April, and the nesting season extends through July, with possibly multiple clutches (U.S. Dept. of the Army, COE, 2002; Butler et al., 2006). Terrapins nest on dunes, beaches, sandy edges of marshes, islands, and dike roads (Roosenburg, 1994). The common factor for proper egg development is sandy soil, which does not clog eggshell pores, thus allowing sufficient gas exchange between the developing embryo and the environment (Roosenburg, 1994). Nesting occurs primarily in the daytime during high tide on high sand dunes with gentle slopes and minimal vegetation (Burger, 1977). Clutch size ranges from 4 to 22 eggs, and incubation time ranges from 61 to 104 days (Butler et al., 2006; Burger, 1977). Female terrapins may nest 2-3 times in the same nesting season. Gender determination is temperature dependent. Hatching occurs from July through October in northeastern Florida (Butler et al., 2004).

Spending most of their lives at the aquatic-terrestrial boundary in estuaries, terrapins are susceptible to habitat destruction from oil-spill cleanup efforts as well as direct contact with oil. However, most impacts cannot be quantified at this time. Even after oil is no longer visible, terrapins may still be exposed while they forage in the salt marshes lining the edges of estuaries, where oil may have accumulated under the sediments and within the food chain. Terrapin nests can also be disturbed or destroyed by cleanup efforts. The range of the possible chronic effects from contact with oil and dispersants include lethal or sublethal oil-related injuries that may include skin irritation from the oil or dispersants, respiratory problems from the inhalation of volatile petroleum compounds or dispersants, gastrointestinal problems caused by the ingestion of oil or dispersants, and damage to other organs because of the ingestion or inhalation of these chemicals.

Accidental blowouts, oil spills, and spill-response activities resulting from an EPA proposed action have the potential to impact small to large numbers of terrapins within their habitat, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of terrapins in the Gulf may be exposed to residuals of oils spilled as a result of an EPA proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to terrapins occurring in the GOM. In the most likely scenarios, exposure to hydrocarbons persisting within the wetlands following the dispersal of an oil slick could result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease). Terrapin hatchling exposure to, fouling by, or consumption of tarballs persisting inland following the dispersal of an oil slick could likely be fatal but unlikely. Impacts from the dispersants are unknown, but they may have similar irritants to tissues and sensitive membranes as are known to occur in seabirds and sea turtles (NRC, 2005). The impacts to diamondback terrapins from chemical dispersants could include nonlethal injury (e.g., tissue irritation and inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats.

Burger (1994) described the behavior of 11 female diamondback terrapins that were oiled during the January 1990 spill of No. 2 fuel oil in Arthur Kill, New York. The terrapins were hibernating at the time of the spill, and when they emerged from hibernation, they were found to be oiled. The terrapins voided oil from their digestive tracks for 2 weeks in rehabilitation. At 3 weeks, the terrapins scored low on strength tests and were slow to right themselves when placed on their backs. At 4 weeks, they developed edema and appetite suppression. Eight of the 11 died; these animals had traces of oil in their tissues and exhibited lesions in their digestive tract consistent with oil exposure (Burger, 1994).

The OSRA catastrophic model runs indicate environmental resources closest to a spill offshore typically had the greatest risk of contact. The model provides estimated conditional probabilities (expressed as percent chance of contact) of a spill, the condition being that a spill is assumed to have occurred at the given location. As the model run duration increased (3, 10, 30 and 60 days), more resources including onshore potential contact had meaningful probabilities of greater than 0.5 percent (refer to **Appendix C**). From LP 6, Plaquemines Parish in Louisiana typically had amongst the highest 30- to 60-day conditional probabilities all year (winter, spring, summer and fall), compared with other parishes or counties. From LP 7, Plaquemines Parish in Louisiana and Dade and Monroe Counties in Florida had amongst the highest 30- to 60-day conditional probabilities. The remaining counties and parishes typically had higher 30-day conditional probabilities during spring (April, May, June) from both launch points, which is during the terrapin courtship, mating, and nesting times. For some launch points and 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 will remain at sea for 60 days or more.

The *Deepwater Horizon* explosion, oil spill, and response may have potentially impacted the terrapin community. Impacts from a catastrophic spill may impact terrapin communities. Impacts can be either direct (mortality or injury) or indirect (e.g., reduced prey availability); however, most impacts cannot be quantified at this time. The best available information does not provide a complete understanding of the effects of the spilled oil and active response/cleanup activities on the potentially affected terrapin environment. Current available information includes photographic evidence of one terrapin found oiled on Grand Terre Island, Louisiana, on June 8, 2010 (State of Louisiana, Coastal Protection and Restoration, 2012).

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. Potential impacts reflect long term persistence of oil in the environment and residual and long-term cleanup efforts.

The *Deepwater Horizon* explosion, oil spill, and response and associated oil spill may have impacted the terrapin community and associated brackish habitats. According to OSAT-2 (2011), possible environmental effects from the *Deepwater Horizon* explosion, oil spill, and response could occur within terrapin marsh habitat via food or to nesting habitat since no active intervention (natural remediation) is the preferred protocol.

Habitat destruction, road construction, drowning in crab traps, and nest predation are the most recent threats to diamondback terrapins. Tropical storms, hurricanes, and beach erosion threaten their preferred nesting habitats. Destruction of the remaining habitat because of a catastrophic spill and response efforts could drastically affect future population levels and reproduction.

Overall Summary and Conclusion (Phases 1-4)

Impacts on diamondback terrapins from smaller accidental events are likely to affect individual diamondback terrapins in the spill area, as described above, but are unlikely to rise to the level of population effects (or significance) given the probable size and scope of such spills. Possible catastrophic environmental effects from an oil spill and cleanup could occur within terrapin marsh habitat via food or to the nesting habitat. Since terrapins do not move far from where they are hatched, it is possible that entire subpopulations could incur high mortality rates and community disruptions, though this would be highly localized depending on the time, place, and size of the spill.

The OSRA analyses in this EIS conclude that there is a low probability for catastrophic spills and that there is a potential for a low-probability catastrophic event to result in significant, population-level effects on affected diamondback terrapin species.

For those terrapin populations that may not have been impacted by the *Deepwater Horizon* explosion, oil spill, and response, it is unlikely that a future accidental event related to an EPA proposed action would result in significant impacts due to the distance of most terrapin habitat from offshore OCS energy-related activities.

B.3.1.15. 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 away from beach mouse habitat.

Phase 3—Onshore Contact

Five subspecies of the field mouse, collectively known as beach mice, live along the Gulf Coast, and two beach mouse subspecies live on the Atlantic Coast of Florida. Five subspecies of beach mice (Alabama, Perdido Key, Choctawhatchee, St. Andrew, and Anastasia Island) are listed as State and federally endangered; also, the southeastern beach mouse is listed as federally threatened. Beach mice are restricted to the coastal barrier sand dunes along the Gulf Coasts of Alabama and Florida. Erosion caused by the loss of vegetation because of oiling would likely cause more damage than the direct oiling of beach mice because of the degradation or loss of habitat. In addition, vehicular traffic and activity associated with cleanup can trample or bury beach mice nests and burrows or cause displacement from 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 habitat.

The Alabama, Choctawhatchee, St. Andrew, Perdido Key, Anastasia Island, and southeastern 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, MMS, 2007). Some of the subspecies have coastal habitat that is designated as their critical habitat. For example, the endangered Alabama beach mouse's (*Peromyscus polionotus ammobates*) designated critical habitat is 1,211 acres (450 hectares) of frontal dunes covering just 10 mi (16 km) of shoreline (USDOI, FWS, 2007). Critical habitat is 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 occurs within a close proximity to the critical habitat, there is the potential for the entire critical habitat for a subspecies of beach mice to be completely oiled. 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 would increase the threat of extinction of several subspecies of beach mice. The catastrophic OSRA provides the following estimated conditional probabilities (expressed as percent chance) of a hypothetical spill occurring at LP 6 or LP 7 and then contacting the Alabama, Perdido Key, Santa Rosa, Choctawhatchee, St. Andrew, and southeastern beach mouse critical habitat, respectively, in winter (W), spring (Sp), summer (Su), and fall (F). 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 are much lower and are not available.

For a spill from LP 6 after 30 days, the data are as follows (note that probabilities are always low [<0.5%] for summer and fall):

- <0.5% (W), 2% (Sp), <0.5% (Su), and <0.5% (F) for Alabama beach mouse critical habitat;
- 1% (W), 3% (Sp), <0.5% (Su), and <0.5% (F) for Perdido Key beach mouse critical habitat;
- 1% (W), 1% (Sp), <0.5% (Su), and <0.5% (F) for Santa Rosa beach mouse critical habitat;
- 2% (W), 6% (Sp), <0.5% (Su), and <0.5% (F) for Choctawhatchee beach mouse critical habitat;
- <0.5% (W), 5% (Sp), <0.5% (Su), and <0.5% (F) for St. Andrew beach mouse critical habitat; and
- 1% (W), <0.5% (Sp), <0.5% (Su), and <0.5% (F) for southeastern beach mouse critical habitat.

For a spill from LP 6 after 60 days, the data are as follows:

- 1% (W), 2% (Sp), <0.5% (Su), and 1% (F) for Alabama beach mouse critical habitat;
- 4% (W), 5% (Sp), 1% (Su), and 1% (F) for Perdido Key beach mouse critical habitat;
- 2% (W), 2% (Sp), <0.5% (Su), and <0.5% (F) for Santa Rosa beach mouse critical habitat;
- 2% (W), 10% (Sp), 1% (Su), and <0.5% (F) for Choctawhatchee beach mouse critical habitat;
- 1% (W), 8% (Sp), 1% (Su), and <0.5% (F) for St. Andrew beach mouse critical habitat; and
- 3% (W), 1% (Sp), 2% (Su), and 1% (F) for southeastern beach mouse critical habitat.

For a spill from LP 7 after 30 days, the data are as follows (note that, except for the southeastern beach mouse, probabilities are always low [<0.5%] for summer and fall):

- <0.5% (W), 1% (Sp), <0.5% (Su), and <0.5% (F) for Alabama beach mouse critical habitat;
- <0.5% (W), 2% (Sp), <0.5% (Su), and <0.5% (F) for Perdido Key beach mouse critical habitat;
- <0.5% (W), <0.5% (Sp), <0.5% (Su), and <0.5% (F) for Santa Rosa beach mouse critical habitat;
- <0.5% (W), 1% (Sp), <0.5% (Su), and <0.5% (F) for Choctawhatchee beach mouse critical habitat;
- 1% (W), 1% (Sp), <0.5% (Su), and <0.5% (F) for St. Andrew beach mouse critical habitat; and

- 2% (W), 1% (Sp), 1% (Su), and 1% (F) for southeastern beach mouse critical habitat.

For a spill from launch point 7 after 60 days, the data are as follows (note that, except for the southeastern beach mouse, probabilities are always low [<0.5%] for summer and fall):

- <0.5% (W), 2% (Sp), <0.5% (Su), and <0.5% (F) for Alabama beach mouse critical habitat;
- 1% (W), 3% (Sp), <0.5% (Su), and <0.5% (F) for Perdido Key beach mouse critical habitat;
- <0.5% (W), 1% (Sp), <0.5% (Su), and <0.5% (F) for Santa Rosa beach mouse critical habitat;
- 1% (W), 3% (Sp), <0.5% (Su), and <0.5% (F) for Choctawhatchee beach mouse critical habitat;
- 1% (W), 3% (Sp), <0.5% (Su), and <0.5% (F) for St. Andrew beach mouse critical habitat; and
- 4% (W), 3% (Sp), 2% (Su), and 2% (F) for southeastern beach mouse critical habitat.

The usually low conditional probabilities (<0.5%) for a summer and fall catastrophic spill contacting beach mice noted above occur 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 will be generally diminished.

This same seasonal period of low oil-spill probabilities (<0.5%; summer and fall) 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 will 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.

The probabilities for the Anastasia Island beach mouse after all time periods, for both launch points (LP 6 and LP 7), and for all seasons are always low (<0.5%) and are not listed. Similarly, the probabilities after 3 and 10 days for all subspecies, for all seasons, and for both launch points are always low (<0.5%) and are not listed.

The probabilities vary greatly depending on duration (3, 10, 30, or 60 days), season (winter, spring, summer, and fall), and subspecies. 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.

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

Within the last 20-30 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 erosion of sand by wave action. Oil may therefore persist near beach mouse habitat for the long term. The destruction of the remaining habitat because of 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. The OSRA conditional probabilities vary greatly depending on duration (3, 10, 30, or 60 days), season (winter, spring, summer, and fall), and subspecies. Percent probabilities vary from less than 0.5 percent to 10 percent. Due to seasonal variation, 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 will be generally diminished. The potential is present for synergistic impacts on beach mice from (1) a catastrophic spill and (2) a hurricane or two or more successive hurricanes.

B.3.1.16. Coastal, Marine, and Migratory Birds

Phase 1—Initial Event

Some migratory birds use offshore platforms or rigs as potential stopover sites during their long-distance migrations across the GOM during the spring and fall (Russell, 2005). In addition, it has been well documented that seabirds are attracted to offshore platforms and rigs for a myriad of reasons; i.e., concentrations of baitfish, roost sites, etc. (Tasker et al., 1986; Wiese et al., 2001; Burke et al., 2012). The numbers of birds present at a platform or rig tend to be greater on platforms or rigs closer to shore, particularly during drilling operations (Baird, 1990). Birds resting on the drilling rig or platform during a catastrophic blowout at the surface (similar to the *Deepwater Horizon* explosion, oil spill, and response) are more likely to be killed by the explosion. While it is assumed that most birds in trans-Gulf migration would likely avoid the fire and smoke plume during the day, it is possible that the light from the fire could interfere with nocturnal migration, especially during poor visibility conditions, i.e., fog or low clouds. It has been documented that seabirds are attracted to natural gas flares at rigs and platforms (Russell, 2005; Wiese et al., 2001); therefore, additional bird fatalities could result from the fire following the blowout. Though different species migrate differentially throughout the year, the largest number of species migrates through the proposed area from mid-April through mid-May (spring migration back north) and from mid-August through early November (fall migration south) (Russell, 2005, Table 6.12; Farnsworth and Russell, 2007). A blowout during this time would potentially result in a greater number of bird fatalities (see below).

Of the four phases considered herein, avian mortality associated with this Phase is certainly expected to be much lower than avian 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 event. The only scenario considered is the case where a blowout and explosion occurred at the surface (**Table B-4**). If the catastrophic event, in this case a blowout and explosion at the surface (refer to **Table B-4**), occurs more proximal to the coast during the breeding season or during a peak migration period (late March to late May and mid-August to early November), then the level of avian mortality is expected to be higher. In comparison, a blowout and explosion at the surface on a platform more distant from the coast (greater than or equal to the distance of the *Macondo* well from the coast) would result in much lower avian mortality, particularly if the event did not overlap temporally with either the breeding season or either of the trans-Gulf migrations.

While the species composition and species-specific mortality estimates are unknown and would be dependent on the blowout location and time of year, the initial mortalities would almost certainly not result in population-level impacts for species present at the time of the blowout and resulting fire (Arnold and Zink, 2011; also refer to Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS). 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, whereas if the event occurred during either the spring or fall migration, species of passerines would most likely have the greatest potential to be affected due to the diversity and sheer numbers of individuals in this avian species group (Rappole and Ramos, 1994; Lincoln et al., 1998; Russell, 2005; also refer to Chapter 4.1.1.14.1 of the 2012-2017 WPA/CPA Multisale EIS).

Phase 2—Offshore Spill

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.) and species that feed by plunge-diving into the water to catch small fish (e.g., pelicans, gannets, terns, gulls, and pelagic birds) and those that use 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 also to ingesting oil (**Table B-9** of this EIS; also refer to Table 4-13 and Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS). Seabirds, in particular, tend to feed and concentrate in convergence zones, eddies, upwellings, and near *Sargassum* mats (Haney, 1986a-c; 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 compromises the insulative characteristics of down and contour feathers, making it difficult to regulate body temperature. Attempts by oiled birds to remove the oil via preening can cause them to ingest oil and may result in mortality. In addition, the ingestion of contaminated prey can result in physiological impairment and even death. Refer to Chapter 4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS for additional information on oiling effects to birds.

Though several species or species groups are mentioned above, the most vulnerable species to spilled oil in the offshore environment in the GOM during Phase 2 would be representatives of the diving bird (≤10 species) and seabird (≥20 species) groups (King and Sanger, 1979; Ribic et al., 1997; Davis et al., 2000). Unlike Phase 1, where passerines may be affected depending on the timing of the catastrophic event, timing or seasonal effects would be less important under the Phase 2 scenario (**Table B-4**) due to the spilled oil being restricted to the offshore environment, thereby limiting the potential impacts to the several avian species groups relegated to the coastal and nearshore environment (**Table B-9** of this EIS; also refer to Chapter 4.1.1.14.1 of the 2012-2017 WPA/CPA Multisale EIS). However, it is highly probable that representative species of diving birds and seabirds would differentially be impacted (**Table B-9** of this EIS; also refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS). Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS shows the actual number of birds identified to the species level for each of the species groups. This number is fairly representative of the suite of species available to be oiled. However, this number is dependent on efforts to correctly assign species to unidentified birds or unknowns, which is also a function of search effort. Search effort likely declined dramatically once the *Macondo* well was plugged/capped. The species composition and species-specific mortality estimates associated with a Phase 2 catastrophic event are unknown and would be dependent primarily on the blowout location, as well as the distribution, coverage, and proximity to the shoreline of spilled oil. Overall, avian mortalities for this Phase would probably not result in population-level impacts for species present at the time of the blowout (refer to **Table B-9** of this EIS and to Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS). However, it should be clear that many species of seabirds and diving birds have life-history strategies that do not allow subpopulations to recover quickly from major mortality events or perturbations (Ricklefs, 1983 and 1990; Russell, 1999; Saether et al., 2004; also refer to Table 4-13 and Figure 4-18 of the 2012-2017 WPA/CPA Multisale EIS).

Some discussion of available information provided from the *Deepwater Horizon* explosion, oil spill, and response is relevant here with respect to temporal aspects of oiled birds (**Figure B-7**). The first oiled bird (northern gannet, a seabird) recovered after the *Macondo* well event was collected just 10 days post-blowout. While gannets breed in coastal colonies in the Canadian North Atlantic, the population, including a major concentration in the northern GOM, over-winters in the deeper waters of the offshore environment. Belanger et al. (2010) provided some interesting results relative to live versus dead birds collected based on the actual date each bird was collected. Interestingly, they documented a dramatic and statistically significant decline in the number of live birds collected after 110 days compared with live birds collected during the first 72 days. These authors also documented a dramatic and statistically significant increase in the number of dead birds collected after 110 days (Belanger et al., 2010, Figures 2 and 3). As a temporal reference, oil reached the shoreline near Venice, Louisiana, ≥10 days post-blowout, covering a distance of approximately 90 mi (145 km) (Oil Spill Commission, 2011; also refer to Chapter 4.2.1.3.1 of the 2012-2017 WPA/CPA Multisale EIS) (**Figure B-7**). It should be understood that, for the Phase 2 scenario considered here, it is assumed that spilled oil will not contact the shoreline.

Overall, avian mortality estimates are unknown and are difficult to predict given the uncertainty (Conroy et al., 2011, pages 1209-1210; Williams, 2011, page 1348) associated with the scenario and specific characteristics associated with the spill (refer to **Appendix C**), as well as environmental conditions that are probably 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 avian mortality. Phase 3 would include much greater avian species diversity and abundance due to the oil reaching nearshore, coastal beach/dune, salt- and brackish marsh habitats (**Table B-9** of this EIS; also refer to Table 4-12 of the 2012-2017 WPA/CPA Multisale EIS).

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 (refer to Chapter 4.1.1.14.1 of the 2012-2017 WPA/CPA Multisale EIS). For example, the northern Gulf Coast supports a large proportion of populations of several beach-nesting bird species (USDOI, FWS, 2011b). During Phase 3, oil is expected to contact not only the beach but also other important habitats used by a diverse and abundant assemblage of avian species. Habitats potentially impacted by a catastrophic spill would also likely include the nearshore environment, as well as the salt- and brackish marsh habitats. Potential impacts and total avian mortality from Phase 3 would be greater than any of the other phases considered herein due to (1) avian diversity and abundance in the nearshore environment (**Table B-9** of this EIS; also refer to Tables 4-9 through 4-11 of the 2012-2017 WPA/CPA Multisale EIS) and (2) the dispersion of oil from a catastrophic spill, which would reach the shoreline and enter the salt- and brackish marsh environments. Similar to Phases 1 and 2, the timing and location of the spill are important factors in determining the severity of impacts to the avian community. In addition, the duration of potential oil exposure to various species of birds would also be important.

As the *Macondo* well blowout and spill 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. At present, the estimates of avian mortality associated with the *Exxon Valdez* oil spill far exceed current estimates of avian mortality associated with the *Deepwater Horizon* explosion, oil spill, and response even though the *Deepwater Horizon* spill volume/size far exceed that of the *Exxon Valdez* (refer to Table 4-15 of the 2012-2017 WPA/CPA Multisale EIS). Based on data from the *Deepwater Horizon* explosion, oil spill, and response, a similar catastrophic spill would probably result in greater than 10,000 carcasses collected (*Deepwater Horizon* explosion, oil spill, and response = 7,258 collected) representing greater than 100 potentially impacted species (*Deepwater Horizon* explosion, oil spill, and response = 104 species identified) (refer to **Table B-9**, superscript 1 and also superscript b). It should be recognized that the number of avian carcasses collected post-spill represents some unknown fraction or proportion of the total modeled estimate of realized mortality (Flint et al., 1999; Byrd et al., 2009; Ford and Zafonte, 2009); the number of avian carcasses collected is biased low (Piatt et al., 1990a-b; Piatt and Ford, 1996; Castege et al., 2007). Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS should provide reasonable estimates of oiling rates for the seven avian species groups in the northern Gulf of Mexico if another catastrophic spill were to occur and the timing, oil spill characteristics, and spill behavior were similar to the *Deepwater Horizon* explosion, oil spill, and response. It should be noted that the top five most impacted (based on number collected) avian species from the *Deepwater Horizon* explosion, oil spill, and response were all representatives of the seabird group: laughing gull (n = 2,981, 40% oiling rate); brown pelican (n = 826, 41% oiling rate); northern gannet (n = 475, 63% oiling rate); royal tern (n = 289, 52% oiling rate); and black skimmer (n = 253, 22% oiling rate) (**Table B-9** of this EIS and Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS).

Additional information is provided herein from an OSRA catastrophic oil-spill analysis (refer to **Appendix C and Tables B-5 and B-6**). **Tables B-5 and B-6** refer to conditional probabilities expressed as the percent chance of contact to avian resources or their habitats from two release points (LP 6 and LP 7) in the EPA, the condition being that a spill is assumed to have occurred at the given location. These sites are modeled release points for spilled oil. Season and spill duration are taken into account within the model. For both LP 6 and LP 7, the estimated conditional probability of contact (%) varies as a function of resource, season, and duration. It is estimated that shoreline oiling would last 1-5 months from a shallow-water catastrophic spill event and 3-4 months from a deepwater catastrophic event. It is estimated that there would be contact to the shoreline within 30 days of the spill for both shallow-water and deepwater spill locations. Two catastrophic OSRA model runs were used to estimate conditional probabilities of contact to resources from two different launch points (LP 6 and LP 7) as described in **Chapter B.1.2.3**, the condition being that a spill is assumed to have occurred at a given location. The results are given in **Tables B-5 and B-6**. The conditional probability of oil contacting avian habitat was estimated by using the probabilities of contact to State coastlines (Texas, Louisiana, Mississippi, Alabama, and Florida). A greater than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from

LP 7. Texas has a greater than 5 percent conditional probability of oil contacting its coastline from both LP 6 and LP 7 after 60 days in winter, summer, and fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days for winter, summer, and fall, and from LP 7 after 30 days for spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in all seasons from LP 6 and in winter, spring, and summer from LP 7. Mississippi and Alabama had a less than 5 percent conditional probability of oil contacting their coastlines for both LP 6 and LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in the spring and after 60 days in winter, spring, and summer, and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for a catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) after 60 days. Avian habitat on the Chandeleur Islands would have a less than or equal to 0.5 percent conditional probability of oil contact in any season from either LP 6 or LP 7.

It should be noted that oil from the *Deepwater Horizon* explosion and oil spill reached the shoreline less than 14 days after the blowout occurred (Oil Spill Commission, 2011). The OSRA does not take into account or consider the following with respect to avian resources and their habitats: (1) species-specific densities; (2) species-specific habitat preferences, food habits, or behavior; (3) relative vulnerabilities to oiling among the avian species groups or among species within each of the groups (**Table B-9** of this EIS and Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS; also refer to Williams et al., 1995; Camphuysen, 2006); and (4) it does not take into account or consider species-specific life-history strategies, their demography, or a species' recovery potential (refer to Table 4-13 and Figures 4-18 and 4-19 of the 2012-2017 WPA/CPA Multisale EIS).

In summary, Phase 3 of a catastrophic oil spill has the greatest potential for negative impacts (i.e., direct mortality) to avian resources due to its contact with the shoreline and inundation of other habitats 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 scenario, specific characteristics associated with the spill, spatial and temporal variation in environmental conditions, and recognition that the avian resources (both species diversity and abundance) available to be oiled will also vary temporally and spatially. Overall, the OSRA catastrophic analysis indicated relatively low probabilities of contact (≤0.5%) to avian resources or their habitats irrespective of the launch point (**Tables B-5 and B-6**). A worst-case scenario in the event of a catastrophic oil spill that reached the nearshore environment would occur in the presence of a hurricane with strength or magnitude similar to Hurricanes Katrina, Rita, or Ike during the breeding season. Such an overlap of two low-probability events during the breeding season could potentially push spilled oil even farther inland and also distribute oil vertically into the vegetation. Such an event would not only negatively impact diving birds, seabirds, shorebirds, marsh- and wading birds, and waterfowl but also the more terrestrial avian species groups including passerines and raptors. Such effects would most likely be long-term (due to direct mortality of individuals, but also due to major habitat loss) and could potentially result in population-level impacts to a number of avian species. Threatened and endangered avian species would likely be the most severely impacted by such an event depending on the spatial and temporal aspects of both the spill and the hurricane.

Endangered and Threatened Birds

A detailed discussion of threatened and endangered species is provided in Chapter 4.1.1.14.1 of the 2012-2017 WPA/CPA Multisale EIS. Of the 18 species considered, 13 species are known to occur in the EPA (**Table B-10**). However, only the piping plover (*Charadrius melodus*), roseate tern (*Sterna dougallii dougallii*), wood stork (*Mycteria americana*), whooping crane (*Grus americana*), Mississippi sandhill crane (*Grus canadensis pulla*), bald eagle (*Haliaeetus leucocephalus*), eastern brown pelican (*Pelecanus occidentalis*), Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), and red knot (*Calidris canutus rufa*) were analyzed and are considered further here. Phase 3 would likely result in the greatest net negative impacts (primarily direct mortality) to threatened and endangered avian species due to contact with the shoreline and potential movement of spilled oil inland to other habitats during this phase (**Table B-4**). In addition, the presence of spilled oil would result in indirect and potentially long-term effects to threatened and endangered avian species' habitats and their preferred foods. Phases 1 and 2 would likely result in very limited impacts, if any, due to the scenarios as defined with oil restricted to the offshore environment.

In general, the potential direct impact (i.e., mortality) to any or all of these threatened or endangered (including recently delisted and candidate) species is directly 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 and the availability, distribution, and energetic benefits of their preferred foods in the absence of a given species. Of the species listed, the wood stork, Mississippi sandhill crane, bald eagle, eastern brown pelican, and Cape Sable seaside sparrows are year-round residents, whereas the piping plover, roseate tern, whooping crane, and red knot represent either wintering species or transients that utilize coastal habitats in the GOM as staging areas during migration. There are "resident" whooping cranes considered as "nonessential, experimental flocks" within the Gulf Coast States of Alabama, Louisiana, Mississippi, and Florida. These birds would be considered as "resident," whereas the component of the ESA-listed species occurring primarily as a wintering flock in Texas (i.e., the Aransas National Wildlife Refuge) is considered a migratory flock. It is important to recognize these differences relative to whether or not individuals of a given species would be present and available to be oiled should a catastrophic oil spill event occur. Similarly, species-specific differences in habitat use and behavior would further separate which species would be most vulnerable to a spill given the timing of the spill, spill distribution, and other spill-related characteristics.

Of the species considered, probably only the eastern brown pelican and possibly the bald eagle (ingestion of contaminated fish and birds) would potentially be impacted during Phases 1 and 2. The other species are restricted to the nearshore, coastal, salt- and brackish, and upland habitats, which would not be impacted during these phases given the scenario (**Table B-4**). Phase 4 impacts to threatened and endangered avian species would probably be limited to short-term disturbance-related effects and potential impacts to habitats including destruction, alteration, or fragmentation from associated recovery activities (ABC, 2010; NASI, 2010).

As the *Macondo* well blowout and spill 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 B-9**). There were 106 least terns (*Sterna antillarum*) collected (n = 106, 46% oiling rate), but these individuals were considered as members of the coastal breeding population and not the ESA-listed population (Interior or noncoastal population). Of the species considered, only the eastern brown pelican was impacted by the *Deepwater Horizon* explosion, oil spill, and response (n = 826, 41% oiling rate); this species was delisted on November 17, 2009 (74 FR 59444-59472). No other carcasses of threatened and endangered species were collected as part of the post-*Deepwater Horizon* explosion, oil spill, and response monitoring efforts (**Table B-9**; USDOI, FWS, 2011b).

Additional information is provided herein from an OSRA catastrophic oil-spill analysis (refer to **Appendix C**, **Tables B-5 and B-6**). **Tables B-5 and B-6** refer to conditional probabilities expressed as percent chance of contact to avian resources or their habitats from two release points (LP 6 and LP 7), the condition being that a spill is assumed to have occurred at the given location. Season and spill duration are taken into account within the model. Overall, conditional probabilities for a given threatened and endangered avian resource are similar to those found for all avian species. Even though wood stork, piping plover, aplomado falcon, and whooping crane have limited habitat area as compared with birds in general, their habitats still fall in the same OSRA domains as discussed for all birds above. It is estimated that shoreline oiling would last 1-5 months from a shallow-water catastrophic spill event and 3-4 months from a deepwater catastrophic event. It is estimated that there would be contact to the shoreline within 30 days of the spill for both shallow-water and deepwater spill locations.

Two catastrophic OSRA model runs were used to estimate conditional probabilities of contact to resources from two different launch points (LP 6 and LP 7) as described in **Chapter B.1.2.3**, the condition being that a spill is assumed to have occurred at a given location. The results are given in **Tables B-5 and B-6**. The conditional probability of oil contacting avian habitat was estimated by using the probabilities of contact to State coastlines (Texas, Louisiana, Mississippi, Alabama, and Florida). A greater than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from LP 7. Texas has a greater than 5 percent conditional probability of oil contacting its coastline from both LP 6 and LP 7 after 60 days in winter, summer, and fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days for winter, summer, and fall, and from LP 7 after 30 days for spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in all seasons from LP 6 and in winter, spring, and summer from LP 7. Mississippi and Alabama had a less than 5 percent conditional probability of oil contacting their coastlines for both LP 6 and LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in the spring and after 60 days in winter, spring, and summer, and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for a catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) after 60 days. Avian habitat on the Chandeleur Islands would have a less than or equal to 0.5 percent conditional probability of oil contact in any season from either LP 6 or LP 7.

Caveats regarding the OSRA catastrophic run with respect to avian resources were addressed above and would also apply to threatened and endangered avian resources considered here.

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

There is a high probability of underestimating the impacts of oil spills on avian species potentially encountering oil. Despite being oiled, some birds are capable of flight and may later succumb to the oiling for a myriad of reasons (refer to Chapters 4.1.1.14.1 and 4.2.1.16.3 of the 2012-2017 WPA/CPA Multisale EIS). Often overlooked and understudied are the long-term, sublethal, chronic effects due to sublethal exposure to oil (Butler et al., 1988; Alonso-Alvarez et al., 2007; Pérez et al., 2010). Also, individuals having been oiled in the Gulf of Mexico as the result of 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, in turn, negatively affect habitat-use decisions, territory establishment, pairing success, and ultimately lead to reduced reproductive success (Norris, 2005 and 2006; Harrison et al., 2011; Mitchell 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). Refer to Henkel et al. (2012) for a review of potential carry-over effects to shorebirds potentially impacted by the *Deepwater Horizon* explosion, oil spill, and response.

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. Decreases in either reproductive success or survival (or both) could result in population-level effects as was observed for certain avian species more than 10 years after the *Exxon Valdez* catastrophic spill (Esler et al., 2002, 2010; Golet et al., 2002). Long-term, sublethal, chronic effects may exceed immediate 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 demographic, i.e., breeding-age females (Croxall and Rothery, 1991; Oro et al., 2004; Aubry et al., 2011). 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; some populations for some species may never recover (refer to Figure 4-13 of the 2012-2017 WPA/CPA Multisale EIS; refer to Peterson et al., 2003, but also to Wiens et al., 2010).

In general, 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 habitat loss, alteration, or fragmentation from restoration efforts. 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 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 oversight by Federal and State agencies charged with the conservation of migratory bird resources.

Limited information available to date with respect to avian impacts from the *Deepwater Horizon* explosion, oil spill, and response suggests much lower mortality than would have been predicted by the spill size or volume alone (Belanger et al., 2010), though spill volume or size tends to be a poor predictor of avian mortality (Burger, 1993; Tan et al., 2010). The final modeled estimates of avian mortality will greatly exceed the number of avian carcasses collected (n = 7,258; **Table B-9**), but overall, the *Deepwater Horizon* explosion, oil spill, and response appears to have directly resulted in far fewer dead, oiled birds than the *Exxon Valdez* catastrophic spill (refer to Table 4-15 of the 2012-2017 WPA/CPA Multisale EIS). It should be recognized that the avian-related mortality associated with the *Deepwater Horizon* explosion, oil spill, and response (considered a catastrophic event) represents a small fraction of birds killed when compared with collisions with offshore oil and gas platforms. Russell (2005, page 304) states, "an average Gulf platform may cause 50 deaths by collision [only] per year," so using this number, the number of deaths the *Deepwater Horizon* rig would have caused through collisions had it remained intact for its 40-year term would be about 2,000. That is about 5,258 less than the number of avian carcasses collected due to the *Deepwater Horizon* explosion, oil spill, and response just given above. In the GOM, an estimated 200,000-321,000 avian deaths occur annually; primarily due to collisions with platforms (Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS; also refer to Russell, 2005). Over the life of the GOM platform archipelago, the estimated total avian mortality is on the order of 7-12 million birds (refer to Figure 4-15 of the 2012-2017 WPA/CPA Multisale EIS). Oil spills, regardless of size, are but one of a myriad of anthropogenic avian mortality sources. Even the cumulative total avian mortality associated with all the North American oil spills to date is only a small fraction when compared with estimates of annual avian mortality attributed to collisions with buildings and windows, predation by housecats, and collisions with powerlines and communication towers (Klem, 2009; Manville, 2009; Table 4-7 of the 2012-2017 WPA/CPA Multisale EIS).

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 species present at the time of the blowout and resulting fire. Seabirds are highly vulnerable to becoming oiled and also 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 avian mortality. Phase 3 would include impacts to much greater avian species' richness and abundance (particularly during the breeding season) due to oil reaching habitats, including the nearshore, coastal beaches and dunes, and salt and brackish 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 habitat loss, alteration, or fragmentation from restoration efforts.

Phases 1 (initial event) and 2 (offshore spill) would likely result in very limited impacts to threatened and endangered bird species because the two scenarios have oil restricted to the offshore environment. Phase 3 (onshore contact) would likely result in the greatest net negative impacts to threatened and endangered bird species due to contact with the shoreline and potential movement of spilled oil inland to other habitats during this phase.

B.3.1.17. Fish Resources and Essential Fish Habitat

Phase 1—Initial Event

Depending on the type of blowout and the proximity of marine life to it (**Table B-1**), an eruption of gases and fluids may generate not only a toxic effect but also pressure waves and noise significant enough to injure or kill local biota. Within a few thousand meters of the blowout, resuspended sediments may clog fish gills and interfere with respiration. Settlement of resuspended sediments may, in turn, smother invertebrates or interfere with their respiration. Essential fish habitat (EFH) in the vicinity of the blowout could have adverse effects from the event. These EFH resources are discussed in the water quality (**Chapter B.3.1.1.2**), live bottoms (**Chapter B.3.1.1.6**), topographic features (**Chapter B.3.1.1.7**), *Sargassum* communities (**Chapter B.3.1.1.8**), chemosynthetic and nonchemosynthetic deepwater benthic communities (**Chapters B.3.1.1.9 and B.3.1.1.10**, respectively), and soft bottom benthic communities (**Chapter B.3.1.1.11**) chapters.

Phase 2—Offshore Spill

With the initiation of a catastrophic blowout incident, 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, but if a blowout occurs on a production platform and other wells feed the fire, it could burn for over a month. The drilling rig or platform may sink, and if this 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 and could be beyond avoidance zones. Regardless of water depth, the immediate response would be from search and rescue vessels and aircraft, such as USCG cutters, helicopters, rescue planes, and firefighting vessels.

Early life stages of animals are usually more sensitive to oil than adults (Boesch and Rabalais, 1987; NRC, 2005). Weathered crude oil has been shown in laboratory experiments to cause malformation, genetic damage, and even mortality at low levels in fish embryos of Pacific herring (Carls et al., 1999). Because natural crude oil found in the Gulf of Mexico would generally float on the surface, fish species whose eggs and larvae are found at or near the water surface are most at risk from an offshore spill. Species whose spawning periods coincide with the timing of the highest oil concentrations would be at greatest risk.

Adult fish may be less at risk than earlier life stages, in part because they are less likely to concentrate at the surface and may avoid contact with floating oil. The effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), the effects from direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms (tainting or accumulation in the food chain), and changes in biological habitat (decreased dissolved oxygen) (Moore and Dwyer, 1974). The extent of the impacts of the oil would depend on the properties of the oil and the time of year of the event.

If there is a subsea catastrophic blowout, it is assumed dispersants would be used. Then there could be effects on multiple life history stages and trophic levels. There is limited knowledge of the toxicity of dispersants mixed with oil to specific species or life stages of ichthyoplankton and the likely extent of mortality because the combination of factors is difficult to determine. The combined toxic effects of the oil and any dispersants that may be used would not be apparent unless a significant portion of a year-class is absent from next year’s fishery (e.g., shrimps, crabs, snapper, and tuna). The North Atlantic bluefin tuna is an example of a fish/fishery in the Gulf of Mexico that could be at risk to lose a year-class. It has a relatively narrow peak spawning period in April and May and floating eggs. A catastrophic blowout during the spring season could cause a negative effect to this population. The Gulf of Mexico is one of only two documented spawning grounds for the Atlantic bluefin tuna; the other is in the Mediterranean Sea and spawning is clustered in a specific type of habitat along the continental slope. While the western Atlantic stock has suffered and a long-term rebuilding plan has failed to revive the population or the fishery, NOAA made a determination on May 27, 2011, that Atlantic bluefin tuna did not warrant species protection under the ESA at that time. The NOAA does plan to revisit this decision by 2013 when more information will be available concerning any effects of the *Deepwater Horizon* explosion, oil spill, and response. In addition, a new stock assessment will be available from the International Commission for the Conservation of Atlantic Tunas.

An example of a catastrophic event in the EPA was modeled using OSRA (**Tables B-5 through B-8**). Because fish occur throughout the GOM, it is assumed that some individuals would be contacted with oil. Specific habitats that are discussed with regards to the Eastern Planning Area OSRA example and in the Appendix are water quality (**Chapter B.3.1.1.2**), wetlands (**Chapter B.3.1.1.4**), seagrass communities (**Chapter B.3.1.1.5**), live bottoms (**Chapter B.3.1.1.6**), topographic features (**Chapter B.3.1.1.7**), *Sargassum* communities (**Chapter B.3.1.1.8**), chemosynthetic and nonchemosynthetic deepwater communities (**Chapters B.3.1.1.9 and B.3.1.1.10**, respectively), and soft bottom benthic communities (**Chapter B.3.1.1.11**).

Studies by USEPA, Office of Research and Development (2010) using representative species provide some indication of the relative toxicity of Louisiana sweet crude oil, dispersants, and oil/dispersant mixes. Bioassays were conducted using two Gulf species—a mysid shrimp (*Amercamysis bahia*) and a small estuarine fish, the inland silverside (*Menidia beryllinina*)—to evaluate the acute toxic effects of oil, eight dispersants, and oil/dispersant mixtures. In addition, USEPA used standard *in vitro* techniques using the same dispersants to (1) evaluate the acute toxicity on three cell lines over a range of concentrations and (2) evaluate the effects of these dispersants on androgen and estrogen function using human cell lines (to see if they are likely to disrupt hormonal systems). All dispersants showed cytotoxicity in at least one cell type at concentrations between 10 and 110 ppm. Results of the *in vitro* toxicity tests were similar to the whole animal tests. For all eight dispersants, for both species, the dispersants alone were less toxic than the dispersant/oil mixture. Louisiana sweet crude oil alone was determined to be more toxic to both the mysid shrimp and silverside fish than the dispersants alone. The results of the testing for disruption of androgen and estrogen function indicate that the dispersants do not show biologically significant endocrine activity via androgen or estrogen pathways (USEPA, Office of Research and Development, 2010).

The GOM waters out to 100 fathoms (182 m; 600 ft) have EFH's described and identified for managed species (GMFMC, 2005; USDOC, NOAA, 2009). There are Fisheries Management Plans for shrimp, red drum, reef fishes, coastal migratory pelagics, spiny lobsters, coral and coral reefs, and highly migratory species (GMFMC, 2004; USDOC, NOAA, 2009). These species could use the GOM for EFH at different life history stages. The Highly Migratory Species Fisheries Management Plan was recently amended to update EFH and Habitat Areas of Particular Concerns for the Atlantic bluefin tuna spawning area (USDOC, NOAA, 2009).

These EFH's in the Gulf of Mexico are discussed in various chapters of this Appendix: water column (**Chapter B.3.1.1.2**); wetlands (**Chapter B.3.1.1.4**); seagrass communities (**Chapter B.3.1.1.5**), live bottoms (**Chapter B.3.1.1.6**); topographic features (**Chapter B.3.1.1.7**), *Sargassum* communities (**Chapter B.3.1.1.8**); chemosynthetic and nonchemosynthetic deepwater benthic communities (**Chapters B.3.1.1.9 and B.3.1.1.10**, respectively), and soft bottom benthic communities (**Chapter B.3.1.1.11**); these EFH's are also summarized in **Appendix D**. There are current NTL's (NTL 2009-G39 and NTL 2009-G40) and stipulations that provide guidance and clarification of the regulations with respect to many of these biologically sensitive underwater features and areas and benthic communities, which are considered EFH.

Plankton

Open-water organisms, such as phytoplankton and zooplankton, are essential to the marine food web. They play an important role in regulating climate, contribute to marine snow, and are an important source of nutrients for mesopelagic and benthic habitats. Also, monthly ichthyoplankton collections over the years 2004-2006 offshore of Alabama have confirmed that peak seasons for ichthyoplankton concentrations on the shelf are spring and summer (Hernandez et al., 2010). If a catastrophic blowout occurs in the spring and summer, it could cause greater harm to fish populations and not just individual fish. Therefore, an offshore oil spill would not only have an impact on these populations but also on the species that depend on them.

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 because of an 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 evenly, and in some cases stimulate growth of important species (Gonzalez et al., 2009; Graham et al., 2010; Hing et al., 2011).

Phase 3—Onshore Contact

It is estimated that shoreline oiling would last 1-5 months from a shallow-water catastrophic spill event and 3-4 months from a deepwater catastrophic spill. It is estimated that there would be contact to the shoreline within 30 days of the spill for both shallow-water and deepwater spill locations. Though response methods would be monitored, there would also be some impact from these efforts on contacted coastal habitats. An example of a catastrophic event in the EPA was modeled using OSRA (**Tables B-5 and B-6**). The estimated probability of oil contacting nearshore habitat were estimated by using the conditional probabilities of contact to State coastlines (Texas, Louisiana, Mississippi, Alabama, and Florida), the condition being that a spill is assumed to have occurred at the given location. A less than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from LP 7. Texas has a greater than 5 percent conditional probability of oil contacting its coastline from either LP 6 or LP 7 after 60 days in winter, summer, or fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in all seasons and from LP 7 after 30 days in spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in winter, spring, and summer from LP 7. Mississippi and Alabama had a less than 5 percent conditional probability of oil contacting their coastlines for either LP 6 or LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in the spring and 60 days in winter, spring, and summer and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for an onshore catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) and after 60 days.

The life history of estuarine-dependent species involves spawning on the continental shelf; the transportation of eggs, larvae, or juveniles back to the estuary nursery grounds; and migration of the adults back to the sea for spawning (Deegan, 1989; Beck et al., 2001). Estuaries in the Gulf of Mexico are extremely important nursery areas and are considered EFH for fish and other aquatic life (Beck et al., 2001). Oiling of these areas, depending on the severity, can destroy nutrient-rich marshes and erode coastlines that have been significantly damaged by recent hurricanes.

The Gulf of Mexico supports a wide variety of finfish, and most of the commercial finfish resources are linked either directly or indirectly to the estuaries that ring the Gulf of Mexico. Darnell et al. (1983) observed that the density distribution of fish resources in the Gulf was highest nearshore off of the central Gulf Coast. For all seasons, the greatest abundance occurred between Galveston Bay and the mouth of the Mississippi River. Oyster beds could be damaged by freshwater diversions that release tens of thousands of cubic feet of freshwater per second for months in an effort to keep oil out of the marshes. Adult oysters survive well physiologically in salinities from those of estuarine waters (about 7.5 parts per thousand sustained) to full strength seawater (Davis, 1958). While oysters may tolerate small changes in salinity for a few weeks, a rapid decrease in salinity over months would kill oysters. In the event of a catastrophic oil spill, at least 1 year's oyster production in the area receiving fresh water would be lost because of exposure to freshwater and/or oil.

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

In addition to possible small fish kills because of direct impacts (as described under Phases 2 and 3), a catastrophic spill could affect fish populations in the long term. Due to a catastrophic spill, a significant portion of a year class of fish could be absent from the following year's fishery, reducing overall population numbers. However, sublethal impacts, especially for long-lived species (e.g., snapper and grouper), could be masked by reduced fishing pressure because of closures. In addition healthy fish resources and fishery stocks depend on ideal habitat (EFH) for spawning, breeding, feeding, and growth to maturity. There could be long-term effects to coastal habitats from buried or sequestered oil becoming resuspended after a disturbance. Thus, a catastrophic spill that affects these areas could result in long-term impacts, including destruction to a portion of their natural habitats.

Overall Summary and Conclusion (Phases 1-4)

Depending on the type of blowout and the proximity of marine life to it, an eruption of gases and fluids may generate not only a toxic effect but also pressure waves and noise significant enough to injure or kill local biota and destroy habitat in the immediate vicinity (Phase 1). Adult fish may be less at risk than earlier life stages, in part because they are less likely to concentrate at the surface and may avoid contact with floating oil. Effects of oil on organisms can include direct lethal toxicity, sublethal disruption of physiological processes (internal lesions), the effects from direct coating by oil (suffocation by coating gills), incorporation of hydrocarbons in organisms (tainting or accumulation in the food chain), and changes in biological habitat (decreased dissolved oxygen) (Phase 2). Estuaries in the Gulf of Mexico are extremely important nursery areas and are considered EFH for fish and other aquatic life (Beck et al., 2001). Oiling of these areas, depending on the severity, can destroy nutrient-rich marshes and erode coastlines that have been significantly damaged by recent hurricanes (Phase 3). Due to a catastrophic spill, a significant portion of a year class of fish could be absent from the following year's fishery, reducing overall population numbers. However, sublethal impacts, especially for long-lived species (e.g., snapper and grouper), could be masked by reduced fishing pressure because of closures (Phase 4).

B.3.1.18. 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, the subsequent fire could burn for over a month, during which time commercial vessels would be expected to avoid the area so as to not interfere with response activities. This could impact the livelihood and income of these 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.

Phase 2—Offshore Spill

The Gulf of Mexico is one of the largest producers of seafood in the continental United States. In 2010 the Gulf of Mexico provided 40 percent of the commercial fishery landings in the continental U.S. (excluding Alaska), with over 1.5 billion pounds valued at nearly $670 million (USDOC, NMFS, 2012d). Various commercial species are fished from State waters through the Exclusive Economic Zone and are found throughout the water column as well as at the surface and near the seafloor. 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 the productive shelf and estuarine habitat. In the event of a catastrophic offshore spill, it is assumed that a large quantity of oil would be released daily whether this spill occurred in State or Federal waters. Although the oil would generally float, it is also assumed that dispersants would be used preventing much of the oil from reaching the surface.

As an example of the areas that could be affected by such a catastrophic oil spill in the EPA, two OSRA model runs were performed using two different launch points as described in **Chapter B.1.2.3**. The resulting tables show conditional probabilities (expressed as percent chance) of an oil spill contacting resources in the GOM for each launch point and for each season, the condition being that a spill is assumed to have occurred at the given location. Because the commercial species are so widespread over the GOM, all of the tables are referenced (**Tables B-5 through B-8**).

Oil that is not volatilized, dispersed, or emulsified by dispersants has the potential to affect finfish through direct ingestion of hydrocarbons or ingestion of contaminated prey. Finfish are, however, mobile and generally avoid adverse conditions. Less mobile species or planktonic larval stages are more susceptible to the effects of oil and dispersants.

Actual effects of any oil that is released and comes in contact with populations of commercially important species will depend on the API gravity of the oil, its ability to be metabolized by microorganisms, and the time of year of the spill. The effects on the populations will be at a maximum during the spawning season of any commercially important population, exposing larvae and juveniles to oil. The effects on commercial species may also include tainting of flesh or the perception of tainting in the market. This can, depending on the extent and duration of the spill, affect marketability of commercial species.

Even though sensory testing may show no detectable oil or dispersant odors or flavors and the chemical test results could be well below the known levels of concern, NOAA Fisheries would be expected to close large portions of the Gulf of Mexico during a high-volume spill. This would be done as a precautionary measure to ensure public safety and to assure consumer confidence in Gulf seafood (USDOC, NMFS, 2010b). Up to 30-40 percent of the Gulf of Mexico's Exclusive Economic Zone could be closed to commercial fishing as the spill continues and expands (USDOC, NMFS, 2010c). This area could represent 50-75 percent of the Gulf's seafood production (Flynn, 2010). The size of the closure area may peak about 50 days into the spill and could persist another 2-3 months until the well is killed or capped and the remaining oil is recovered or dissipates. During this period, portions or all of individual State waters would also be closed to commercial fishing.

The economic impacts of closures on commercial fishing are difficult to predict because they are dependent on the season and would vary by fishery. If fishers cannot make up losses throughout the remainder of the season, a substantial part of their annual income would be lost. In some cases, commercial fishers will leave the industry and some may move to areas still open to fishing, but at a greater cost because of longer transit times. Marketing issues are also possible; even if the catch is uncontaminated, the public may lack confidence in the product. The duration of the public's perception of seafood tainting is also difficult to predict and depends to some extent on the duration of the spill and public awareness of the spill.

Phase 3—Onshore Contact

Shoreline contact of oil is estimated to persist from 1 to 5 months in the event of a shallow-water catastrophic spill and for up to 6 months from a deepwater catastrophic spill. The OSRA probability tables show the conditional probabilities (expressed as percent chance) for a shoreline contact for each season, the condition being that a spill is assumed to have occurred at the given location.

A greater than 0.5 percent conditional probability of oil contacting any state occurs 10 days after a catastrophic spill event from LP 6 and 30 days after a catastrophic spill event from LP 7. Texas has a greater than 5 percent estimated conditional probability of oil contacting its coastline from both LP 6 and LP 7 after 60 days in winter, summer, and fall. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days for winter, summer, and fall and from LP 7 after 30 days for spring. Louisiana has a greater than 5 percent conditional probability of oil contacting its coastline after 60 days in all seasons from LP 6 and in winter, spring, and summer from LP 7. Mississippi and Alabama has a less than 5 percent conditional probability of oil contacting their coastlines for both LP 6 and LP 7. Florida has a greater than 5 percent conditional probability of oil contacting its coastline from LP 6 after 30 days in the spring and after 60 days in winter, spring, and summer and from LP 7 after 30 days in winter and spring and after 60 days in winter, spring, and summer for a catastrophic spill event. The largest probabilities of contact from LP 6 were for Louisiana (22%) and Florida (34%) after 60 days.

This scenario, depending on the season of occurrence, would cause disruption in commercial fishing activity because many commercial fishermen operate inshore in State waters.

In addition to closures in Federal waters, portions of individual State waters would also be closed to commercial fishing. The economic impacts of closures on commercial fishing are complicated to predict because it is dependent on season and would vary by fishery. If fishers cannot make up losses in the remainder of the season, a substantial part of their annual income will be lost. In some cases, commercial fishers may move to areas still open to fishing, but at a greater cost because of longer transit times and, in some instances, additional license costs. Some commercial fishermen may also augment their income by aiding in the cleanup effort and/or renting the boats as vessels of opportunity.

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

The Gulf of Mexico is an important biological and economic area in terms of commercial seafood production and recreational fishing. Commercial fishermen in the Gulf of Mexico harvested over 1.5 billion pounds of finfish and shellfish in 2010 (USDOC, NMFS, 2012d). The economic impacts of closures on commercial fishing are complicated to predict because the economic effects are dependent on season and would vary by fishery. If fishermen cannot make up losses by fishing the remainder of the season or by participating as contractors in the cleanup, a substantial part of their annual income could be lost and may force them out of the industry. While the commercial fishing industry of Texas did not sustain measurable direct or indirect economic effects following the 1979 *Ixtoc I* blowout and spill (Restrepo et al., 1982), 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). Data regarding the duration of the negative perception of Gulf seafood following the *Deepwater Horizon* explosion, oil spill, and response are not yet available. It is reasonable to assume that a negative perception could impact the value of commercial fish resources for several seasons.

Overall Summary and Conclusion (Phases 1-4)

The Gulf of Mexico is one of the largest producers of seafood in the continental United States. Various commercial species are fished from State waters through the Exclusive Economic Zone and are found throughout the water column. The primary economic impacts of oil spill on commercial fisheries are the closure of State or Federal waters to fishing and the perception of seafood tainting by the market. Both of these factors are difficult to predict. Closures depend on the size, timing, depth of water, and location of the spill as well as the fishery involved. Perception depends on length of the spill and public perception. Both of these factors could affect the livelihood of the fishing community.

B.3.1.19. Recreational Fishing

Phase 1—Initial Phase

About 20 percent of the recreational fishing activity in the Gulf of Mexico 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. 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 square miles (mi^2) (229,271 square kilometers [km^2]) were closed to recreational fishing activity at the peak of the *Macondo* well oil spill. 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 B.3.1.17**). The NOAA's Center for Coastal Monitoring and Assessment (USDOC, NOAA, 2012a) provides a set of maps that display the locations in the Gulf of Mexico where certain fish species are prevalent. 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.

In 2011, the percent of each Gulf Coast State's recreational fishing activity that occurred in State and Federal ocean waters combined (i.e., not inland waters) were as follows: Texas (6%); Louisiana (5%); Mississippi (2%); Alabama (42%); and West Florida (34%) (USDOC, NMFS, 2012e; Texas Parks and Wildlife Department, 2012). **Chapter 4.1.1.19** of this EIS provides a further breakdown of recreational fishing activity by state. In **Table B-7**, the probabilities of a catastrophic spill from LP 6 reaching various points in State waters within 60 days in each season are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas (10, 1, 11, 10); west Louisiana (14, 10, 15, 13); east Louisiana (5, 5, 11, 4); Mississippi (1, 2, <1, 1); Alabama (2, 5, 1, 2); Florida Panhandle (7, 22, 2, 1); West Florida (8, 24, 7, 1); Tortugas (5, 6, 3, 1); Southeast (10, 5, 4, 2); and Northeast (<1, 1, <1, <1). In **Table B-8**, the probabilities of a catastrophic spill from LP 7 reaching various points in State waters within 60 days in each season are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas (13, 2, 14, 6); west Louisiana (9, 12, 12, 5); east Louisiana (2, 3, 2, 1); Mississippi (<1, 1, <1, <1); Alabama (1, 3, <1, <1); Florida Panhandle (3, 8, <1, <1); West Florida (12, 22, 9, 3); Tortugas (7, 6, 4, 1); Southeast (14, 12, 10, 5); and Northeast (1, 1, 1, 1).

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. In 2011, the percent of each Gulf State's recreational fishing activity that occurred inland were as follows: Texas (94%); Louisiana (95%); Mississippi (98%); Alabama (58%); and West Florida (66%) (USDOC, NMFS, 2012e; Texas Parks and Wildlife Department, 2012). The impacts to recreational fishing would also depend on the time of year of the spill. In 2011, 31 percent of angler trips in the Gulf occurred between January and April, 41 percent of angler trips occurred between May and August, and 28 percent of angler trips occurred between September and December (USDOC, NMFS, 2012e). In addition, fishing tournaments are often scheduled for the summer months and would be difficult to reschedule in the aftermath of a catastrophic spill.

The OSRA model catastrophic runs were used to estimate the conditional probability of contact to resources from a catastrophic spill at two launch points (LP 6 and LP 7) in the EPA, the condition being that a spill is assumed to have occurred from the given location. In **Table B-5**, the conditional probabilities of a catastrophic spill from LP 6 reaching the coast of each Gulf Coast State within 60 days in each season are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas (9, <1, 10, 10); Louisiana (16, 11, 22, 13); Mississippi (1, 2, <1, 1); Alabama (2, 4, 1, 1); and Florida (13, 34, 7, 2). In **Table B-6**, the conditional probabilities of a catastrophic spill from LP 7 reaching the coast of each Gulf Coast State within 60 days in each season are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas (11, 2, 12, 7); Louisiana (9, 12, 11, 4); Mississippi (<1, 1, <1, <1); Alabama (1, 2, <1, <1); and Florida (15, 21, 9, 5).

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. 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 loss of opportunities for recreational fishing activity 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 B.3.1.1.17** for more information). However, 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.

Overall Summary and Conclusion (Phases 1-4)

Recreational fishing activity could be noticeably impacted in the event of a catastrophic spill. This is particularly the case if the spill reached shore or if the spill occurred during peak times and places of recreational fishing activity. The long-term impacts of a catastrophic spill 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.

B.3.1.20. 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 90 percent of the recreational diving activity in the Gulf of Mexico 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.

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 discussed above. 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. For example, a representative of Pinellas County estimated that this area had lost roughly $70 million in hotel revenue even though beaches in this area did not receive any oil damage. 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 will be affected even if the destination is only within close proximity to a spill.

As previously mentioned, recreational diving is one offshore recreational activity that would be particularly affected by a catastrophic oil spill. The OSRA model catastrophic runs were used to estimate the conditional probability of contact to resources from a catastrophic spill at two launch points (LP 6 and LP 7) in the EPA, the condition being that a spill is assumed to have occurred from the given location. According to the OSRA model runs discussed in **Table B-7**, the conditional probabilities of particular recreational diving areas being reached within 60 days by an oil spill from LP 6 are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas Clipper and South Texas Platform (<1, <1, 2, 1); Port Lavaca/Liberty Ship Reef (2, <1, 3, 4); High Island (2, <1, 1, 3); West Cameron (3, <1, 4, 5); Cognac Platform (1, 2, 2, 1); Horseshoe Rigs (1, 1, 2, <1); Vermilion Area (3, 2, 6, 5); Vermillion Area (South Addition) (3, <1, 9, 8); Bay Marchand (<1, 1, 1, <1); South Timbalier (5, 5, 13, 5); South Timbalier (South Addition) (4, 3, 8, 9); Florida Panhandle (7, 25, 3, <1); Tampa (1, 3, 2, <1); Southeast Florida (2, 7, 4, <1); Daytona Beach (<1, 1, 1, <1); East Flower Garden Bank (1, <1, 1, <1); West Flower Garden Bank (<1, <1, 1, 1); Chandeleur Islands (2, 3, 5, <1); Tortugas Ecological Reserve (North) (1, 2, 2, <1); Tortugas Ecological Reserve (South) (2, 6, 3, <1); and Florida Keys National Marine Sanctuary (5, 14, 8, <1).

In **Table B-8** the conditional probabilities of particular recreational diving areas being reached within 60 days by an oil spill from LP 7 are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas Clipper and South Texas Platform (<1, <1, 3, <1); Port Lavaca/Liberty Ship Reef (2, 1, 5, 2); High Island (2, <1, 2, <1); West Cameron (3, 1, 7, <1); Cognac Platform (<1); Vermillion Area (3, 3, 9, <1); Vermilion Area (South Addition) (3, 2, 8, 1), Bay Marchand (<1, 1, 2, <1); South Timbalier (3, 7, 13, 1); South Timbalier (South Addition) (4, 5, 9, 2); Florida Panhandle (3, 9, <1, <1); Tampa (<1, 4, <1, <1); Southeast Florida (4, 13, 8, <1); Daytona Beach (<1, 1, 1, <1); East Flower Garden Bank (1, <1, 2, 1); West Flower Garden Bank (<1, <1, 2, 1); Chandeleur Islands (1, 2, 1, <1); Tortugas Ecological Reserve (North) (1, 2, 2, <1); Tortugas Ecological Reserve (South) (3, 9, 6, <1); and Florida Keys National Marine Sanctuary (7, 23, 16, <1).

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 (ESI's) provide overall measures of the sensitivity of a particular coastline to a potential oil spill. The ESI's rank coastlines from 1 (least sensitive) to 10 (most sensitive). Marshes and swamps are examples of resources that have ESI's of 10 due to the extreme difficulty of removing oil from these areas; marsh and swamp areas are particularly prevalent in Louisiana. The ESI's 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 the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2012b). The ESI maps also provide point indicators for recreational resources.

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*'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* 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); the Gulf Coast Claims Facility closed in early 2012 subsequent to preliminary court approval of a settlement program. 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 change in hotel and sales tax receipts for individual Gulf Coast counties 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 will 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 will 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 metro 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.

An oil spill would have particular impacts on recreational economies dependent on beaches. According to the catastrophic OSRA model runs discussed in **Table B-5**, the conditional probabilities of particular beach areas being reached within 60 days by an oil spill from LP 6 are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas Coastal Bend Beach Area (1, <1, 4, 3); Texas Matagorda Beach Area (4, <1, 3, 3); Texas Galveston Beach Area (3, <1, 2, 3); Texas Sea Rim State Park (1, <1, <1, 1); Louisiana Beach Areas (4, 4, 4, 3); Alabama/Mississippi Gulf Islands (2, 4, 1, 1); Alabama Gulf Shores (1, 2, <1, 1); Florida Panhandle (5, 20, 2, <1); Florida Big Bend (<1, 9, 1, <1); Florida Southwest Beach Area (<1, 2, 1, <1); Florida Ten Thousand Islands Beach Area (1, <1, <1, <1); Florida Southeast Beach Area (6, 3, 3, 2). In **Table B-6**, the conditional probabilities of particular beach areas being reached within 60 days by an oil spill from LP 7 are (the probabilities for the winter, spring, summer, and fall seasons are presented, respectively): Texas Coastal Bend Beach Area (2, <1, 3, 3); Texas Matagorda Beach Area (3, 1, 5, 2); Texas Galveston Beach Area (5, 1, 3, 2); Texas Sea Rim State Park (1, <1, 3, 2); Louisiana Beach Areas (2, 4, 5, <1); Alabama/Mississippi Gulf Islands (1, 2, <1, 1); Alabama Gulf Shores (<1, 2, <1, <1); Florida Panhandle (2, 6, <1, <1); Florida Big Bend (<1, 4, <1, <1); Florida Southwest Beach Area (1, 3, 1, <1); Florida Ten Thousand Islands Beach Area (1, 1, 1, <1); Florida Southeast Beach Area (10, 7, 6, 4); Florida Central East Beach Area (1, 1, 1, <1); and Florida Northeast Beach Area (<1, <1, 1, <1).

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) attempts to quantify these effects by analyzing the impacts of recent catastrophic events on recreational economies. For example, they analyzed the *Ixtoc I* well blowout and spill of 1979, the scale and nature of which was reasonably similar to the *Macondo* well blowout and spill of 2010. In this example, it took approximately 3 years for beaches to be cleaned and for recreational activity to return to similar levels as before the spill. They also looked at the *Prestige* oil spill of 2002 off the coast of Spain. Given the nature and size of that spill, recreational activity was able to return to pre-spill levels in approximately 1 year. Alaska's tourism economy took approximately 2 years to recover from the *Exxon Valdez* spill.

Overall Summary and Conclusion (Phases 1-4)

A catastrophic spill can cause noticeable impacts to recreational resources such as beaches. A catastrophic spill can also have complex effects on recreational activity that depends on tourism. The longer-term implications of a catastrophic oil spill on 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.

B.3.1.21. Archaeological Resources

Phase 1—Initial Event

Offshore Archaeological Resources

BOEM protects all known, discovered, and potentially historic and prehistoric archaeological resources on the OCS by requiring appropriate avoidance criteria as well as directives to investigate these resources. Onshore archaeological resources, prehistoric and historic sites, 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 hydrocarbons.

Based on historical information, over 2,100 potential shipwreck locations have been identified on the Gulf of Mexico OCS (USDOI, MMS, 2007). 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. Of the 2,100 recorded wrecks, only 233 records were determined to have associated spatial data possessing sufficient accuracy for BOEM's needs.

In certain circumstances, 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. As part of the environmental reviews conducted for postlease activities, available information will be evaluated regarding the potential presence of archaeological resources within the EPA proposed action area to determine if additional archaeological resource surveys and mitigations are warranted. Having complete 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 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. This could result in currently unknown effects from dispersed oil droplets settling to the seafloor. Though information on the actual impacts to submerged cultural resources is inconclusive at this time, oil settling to the seafloor could come in contact with archaeological resources. At present, there is no evidence of this having occurred. A recent experimental study has suggested that, while the degradation of wood in terrestrial environments is initially retarded by contamination with crude oil, at later stages, the biodeterioration of wood was accelerated (Ejechi, 2003). While there are different environmental constraints that affect the degradation of wood in terrestrial and waterlogged environments, soft-rot fungal activity, one of the primary wood degrading organisms in submerged environments, was shown to be increased in the presence of crude oil. There is a possibility that oil from a catastrophic blowout could come in contact with wooden 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 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 the size of anchors and the length of mooring chains needed to safely secure vessels. Additionally, multiple offshore vessel decontamination stations would likely be established in shallow water outside of ports or entrances to inland waterways, as seen for the *Deepwater Horizon* explosion, oil spill, and response. The anchoring of vessels could result in damage to both known and undiscovered archaeological sites; the potential to impact archaeological resources increases as the density of anchoring activities in these areas increases.

Shallow Water

The potential for damaging archaeological resources increases as the oil spill and related response activities progress landward. In shallower waters, most of the damage would be associated with oil cleanup and response activities. Thousands of vessels would respond to a shallow-water blowout and would likely anchor, potentially damaging both known and undiscovered archaeological sites. Additional anchoring would be associated with offshore vessel decontamination stations, as described above. As the spill moves into the intertidal zone, the chance of direct contact between the oil and archaeological resources increases. As discussed above, this could result in increased degradation of wooden shipwrecks and artifacts.

Additionally, in shallower waters, shipwrecks often act as a substrate to corals and other organisms, becoming an essential component of the marine ecosystem. These organisms often form a protective layer over the shipwreck, virtually encasing the artifacts and hull remains. If these fragile ecosystems were destroyed as a result of the oil spill and the protective layer was removed, the shipwreck would then be exposed to increased degradation until it reaches a new level of stasis with its surroundings.

Regardless of water depth, because oil is a hydrocarbon, heavy oiling could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g., ^{14}C-dating). Interference with the accuracy of ^{14}C-dating would result in the loss of valuable data necessary to understand and interpret the sites.

Phase 3—Onshore Contact

Onshore Archaeological Resources

Regardless of the water depth in which the catastrophic blowout occurs, it is assumed that more than 1,000 mi (1,609 km) of shoreline could be oiled to some degree. Onshore prehistoric and historic sites would be impacted to some extent by a high-volume spill from a catastrophic blowout that reaches shore. According to Louisiana State Archaeologist Charles McGimsey, sites on barrier islands could suffer the heaviest impact. A few prehistoric sites in Louisiana, located inland from the coastline in the marsh and along bayous, could experience some light oiling. As discussed above, impacts would include the loss of ability to accurately date organic material from archaeological sites because of contamination or increased research costs to clean samples for analysis. Efforts to prevent coastal cultural resources from becoming contaminated by oil would likely be overwhelmed in the event of a hurricane and by the magnitude of shoreline impacted. The most significant damage to archaeological sites could be related to cleanup and response efforts. Fortunately, 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 response, and archaeologists are, at present, embedded in Shoreline Cleanup Assessment Teams (SCAT) and are consulting with cleanup crews. Historic preservation representatives are 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). Despite these efforts, some archaeological sites suffered damage from looting or from spill cleanup activities (most notably the parade ground at Fort Morgan, Alabama) (Odess, official communication, 2011).

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

Onshore Archaeological Resources

Regardless of the water depth in which the catastrophic blowout occurs, it is assumed that more than 1,000 mi (1,609 km) of shoreline could be oiled to some degree. Onshore prehistoric and historic sites would be impacted to some extent by a high-volume spill from a catastrophic blowout that reaches shore. A few prehistoric sites in Louisiana, located inland from the coastline in the marsh and along bayous, could experience some light oiling. As discussed above, impacts would include the permanent loss of ability to accurately date organic material from archaeological sites because of contamination. As discussed above, the most significant damage to archaeological sites could be related to cleanup and response efforts. Long-term recovery would prove difficult if not impossible. 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 or archaeological recovery is problematic outside of Federal lands because of existing laws and regulations. Most coastal prehistoric sites in Louisiana, for example, 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 action, which in the case of a spill, would be the response and not the actual spill. The Natural Resource Damage Assessment (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 to natural resources that occurs 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. In the event of a catastrophic oil spill, the most likely source of irreversible impact is, ironically, from the spill response itself, and the danger increases dramatically as the response approaches the shoreline. 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 are likely to meet with varied success depending upon the type of site and availability of funding.

B.3.1.22. 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 events and 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 B.3.1.20**. Possible fisheries closures are addressed in **Chapters B.3.1.18 and B.3.1.19**. As cleanup and remediation efforts evolve, there would be increased activity at ports and coastal cities, leading to increased traffic on road infrastructure and at port facilities. This follows from consideration of BOEM's scenario estimates of up to 3,000 vessels, 25-50 planes/helicopters, and up to 25,000 workers for a shallow-water event and up to 7,000 vessels, 50-100 planes/helicopters, and up to 50,000 workers for a deepwater event. Waste disposal activities associated with boom deployment and retrieval would increase demand at waste disposal facilities. BOEM's scenario estimates 5 million feet (1.5 million meters) of boom deployment and 35,000 bbl of dispersant applied at the surface for a shallow-water event or 11 million feet (3.4 million meter) of boom deployment and 33,000 bbl of dispersant applied at the surface and 16,500 bbl of dispersant applied subsea for a deepwater event. 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.

Phase 3—Onshore Contact

In the event of a catastrophic spill, impacts on land use and 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, as described below.

For a shallow-water event, BOEM estimates 5-10 staging areas and 200-300 skimmers. For a deepwater event, scenario estimates call for 10-20 staging areas and 500-600 skimmers. Given these estimates and the several thousand responders that 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 fail to materialize.

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, 2010c and 2010d).

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 and the region's experience in the few years 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 (as it is currently with regard to the *Deepwater Horizon* explosion, oil spill, and response) 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 utilized for restoration 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. To date, it is not clear from past experiences whether vegetation loss or erosion created by a spill could result in changes in land use. 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.

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 traditional 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 no more than 7 percent of the total daily waste normally accepted in these landfills. It is also not expected that any properties utilized for restoration activities throughout Phase 3 would not suffer any long-term land use or economic impacts.

B.3.1.23. Demographics

Phase 1—Initial Event

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). Since the impacts of a catastrophic spill on employment would take time to evolve, the initial impacts on demographics would be minimal. Therefore, there would likely be no adverse impacts to demographics as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event.

Phase 2—Offshore Spill

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). For example, there could be some suspension of oil/gas activities in the immediate aftermath of the spill. This could cause some workers to seek employment outside of the OCS industry, for example in onshore oil/gas extraction or on overseas offshore projects. However, since the OCS oil and gas industry would likely eventually recover, the long-term impacts on demographics would be small. There could also be impacts on demographics if employment in recreation, tourism, or fishing industries were affected, due to either actual or perceived impacts of the spill. However, the impacts on these industries would become more acute if the spill were to reach shore.

Phase 3—Onshore Contact

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). For example, impacts to recreation/tourism and recreational and commercial fishing activities would become more acute if the spill were to reach shore. There would also be a larger presence of cleanup workers in some areas if the spill were to reach shore. For example, 48,200 workers were employed in response activities at the peak of the response effort following the *Macondo* well blowout and spill (RestoreTheGulf.gov, 2011). However, these impacts would be temporary and would be governed by the dynamics of the particular spill. There could also be impacts to demographics if there were impacts on the response workers' health or if the demographics of the response workers were noticeably different from the local population.

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

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). The spill's impacts on employment, and therefore demographics, would primarily be felt in the oil/gas, recreational fishing, commercial fishing, and recreation/tourism industries. However, it is unlikely that a catastrophic spill would cause substantial long-term changes to a region's demographics. For example, the demographics data in Woods and Poole Economics, Inc. (2011) did not suggest large demographic changes to any Gulf regions subsequent to the *Deepwater Horizon* explosion, oil spill, and response.

Overall Summary and Conclusion (Phases 1-4)

The impacts of a catastrophic spill on demographics would primarily be driven by the spill's impacts on employment (refer to **Chapter B.3.1.24**). These impacts would likely be temporary and would be governed by the particular dynamics of the spill.

B.3.1.24. 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 B.3.1.18**), recreational fishing (**Chapter B.3.1.19**), and recreational resources (**Chapter B.3.1.20**). 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

In contrast to a less severe accidental event, suspension of some oil and gas activities would be likely following a catastrophic event. Depending on the duration and magnitude, 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. The economic impacts of a catastrophic spill would likely be more heavily concentrated in smaller businesses than in the larger companies due to their difficulty in finding substitute revenue sources. Much of the employment loss would be concentrated in coastal oil-service parishes in Louisiana (St. Mary, Terrebonne, Lafourche, Iberia, and Plaquemines Parishes) and counties/parishes where drilling-related employment is most concentrated (Harris County, Texas, in which Houston is located, and Lafayette Parish, Louisiana). There could also be economic impacts due to the impacts on commercial fishing (**Chapter B.3.1.18**), recreational fishing (**Chapter B.3.1.19**), and recreational resources (**Chapter B.3.1.20**).

Phase 3—Onshore Contact

By the end of a catastrophic spill, a large number of personnel (up to 25,000 in the event of a shallow-water spill and up to 50,000 in the event of a deepwater spill) 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, these new jobs would not make up for lost jobs, in terms of dollar revenue. In most cases, cleanup personnel are paid less (e.g., $15-$18 per hour compared with roughly $45 per hour on a drilling rig), 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 B.3.1.18**), recreational fishing (**Chapter B.3.1.19**), and recreational resources (**Chapter B.3.1.20**) 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 will likely be used by individuals to pay for necessities such as mortgages or groceries, while businesses who receive funds will likely use them to maintain payroll and current payments on equipment. As of March 2012, over $6 billion had been paid through the Gulf Coast Claims Facility, which mitigated some of the economic impacts of the *Deepwater Horizon* explosion, oil spill, and response (Gulf Coast Claims Facility, 2012).

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

While a catastrophic spill could immediately impact several Gulf Coast States for several months through fishing closures, loss of tourism, and any suspension of oil and gas activities, anticipating the long-term economic and employment impacts in the Gulf of Mexico is a difficult task. Many of the potentially affected jobs, like fishing charters, are self-employed. Thus, they would not necessarily file for unemployment and will not be included in business establishment surveys used to estimate State unemployment levels. In addition, unemployment numbers in states are based on nonagricultural jobs, and the fishing industry is considered within the agriculture category. On the other side, it is also a challenge to estimate how many of these displaced workers have been hired to clean up the spill. For example, while thousands of vessels of opportunity would be active in the spill response, not all of these would be displaced commercial fishermen from the affected areas. The positive employment impacts related to response activities are likely to be shorter-term than the negative impacts discussed above. However, the long-term economic impacts of a catastrophic spill will likely depend on the speed at which the oil/gas, commercial fishing, recreational fishing, and recreational industries recover.

Overall Summary and Conclusion (Phases 1-4)

There would be a number of economic impacts that would arise from a catastrophic oil spill. The most direct effects would be on the recreation/tourism, commercial fishing, and recreational fishing industries that depend on damaged resources. There could also be substantial negative effects on the oil/gas industry due to moratoriums or rule changes that would arise. Finally, there could be substantial impacts due to the relief operations and economic mitigation activities that would occur in the aftermath of a catastrophic spill.

B.3.1.25. Environmental Justice

Phase 1—Initial Event

There would likely be no adverse impacts to environmental justice 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 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

The environmental justice policy, based on Executive Order 12898 of February 11, 1994, directs agencies to incorporate into NEPA documents an analysis of potentially disproportionate and detrimental environmental and health effects of their proposed actions on minorities and low-income populations and communities. While the spill is still offshore, the primary environmental justice concern would be large commercial fishing closures disproportionately impacting minority fishers. In the event of a catastrophic spill, Federal and State agencies would be expected to close substantial portions of the Gulf to commercial and recreational fishing (USDOC, NOAA, 2010e). While oystering occurs “onshore,” oyster beds are also likely to be closed to harvests during Phase 2 of a catastrophic spill because of concerns about oil contamination and increased freshwater diversions to mitigate oil intrusion into the marshes. These closures would directly impact commercial fishermen and oystermen, and indirectly impact such downstream activities as shrimp processing facilities and oyster shucking houses. The mostly African-American communities of Phoenix, Davant, and Point a la Hache in Plaquemines Parish, Louisiana, are home to families with some of the few black-owned oyster leases. Just as these leases have been threatened by freshwater diversion projects for coastal restoration, they could be threatened by Phase 2 of a catastrophic spill (Mock, 2010).

The Gulf of Mexico coast hosts multiple minority and low-income groups whose use of natural resources of the offshore and coastal environments make them vulnerable to fishing closures. While not intended as an inventory of the area’s diversity, we have identified several Gulf of Mexico coast populations of particular concern. An estimated 20,000 Vietnamese American fishermen and shrimpers live along the Gulf of Mexico coast; by 1990, over 1 in 20 Louisiana fishers and shrimpers had roots in Southeast Asia even though they comprised less than half a percent of the State’s workforce (Bankston and Zhou, 1996). Vietnamese Americans account for about one-third of all the fishermen in the central Gulf of Mexico (Ravitz, 2010). Islaños, African Americans, and Native American groups are also engaged in commercial fishing and oystering. Historically, Vietnamese Americans and African Americans have worked in the fish processing and oyster shucking industries. Shucking houses particularly, have provided an avenue into the mainstream economy for minority groups.

Therefore, fishing closures during Phase 2 of a catastrophic spill impacting the central Gulf of Mexico may disproportionately affect such minority groups as the Vietnamese Americans, Native Americans, African Americans, and Islaños (Hemmerling and Colten, 2003).

Phase 3—Onshore Contact

While most coastal populations along the Gulf of Mexico coast are not generally minority or low income, several communities on the coasts of St. Mary, Lafourche, Terrebonne, St. Bernard, and Plaquemines Parishes, Louisiana, have minority or low-income population percentages that are higher than their state average. These minority populations are predominately Native American, Islaños, or African American. For example, a few counties or parishes along the Gulf Coast have more than a 2-percent Native American population (USDOI, MMS, 2007); about 2,250 Houma Indians (a State of Louisiana recognized tribe) are concentrated in Lafourche Parish, Louisiana, comprising 2.4 percent of the parish’s population, and about 800 Chitimacha (a federally recognized tribe) make up 1.6 percent of St. Mary Parish’s population. While these are not significant numbers on their own, viewed in the context of Louisiana’s overall 0.6 percent Native American average, these communities take on greater environmental justice importance.

Gulf Coast minority and low-income groups are particularly vulnerable to the coastal impacts of a catastrophic oil spill due to their greater than average dependence on the natural resources in the offshore and coastal environments. Besides their economic reliance on commercial fishing and oystering, coastal low-income and minority groups rely heavily on these fisheries and other traditional subsistence fishing, hunting, trapping, and gathering activities to augment their diets and household incomes (refer to Hemmerling and Colton, 2003, for an evaluation of environmental justice considerations for south Lafourche Parish). Regular commuting has continued this reliance on the natural resources of the coastal environments even when populations have been forced to relocate because of landloss and the destruction from hurricane events.

State fishery closures because of a catastrophic oil spill could disproportionately affect minority and low-income groups. Shoreline impacts could generate additional subsistence-related effects. Therefore, these minority groups may be disproportionately affected if these coastal areas were impacted by a catastrophic spill and the resulting response.

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

After the spill is stopped, the primary environmental justice concerns relate to possible long-term health impacts to cleanup workers, a predominately minority population, and to possible disposal of oil-impacted solid waste in predominantly minority areas.

An analysis of socioeconomic characteristics shows that people of Cajun ethnicity in the Gulf Coast States are often found to be of a comparatively low socioeconomic status and to work jobs in the textile and oil industries (Henry and Bankston, 1999). Past studies suggest that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations (Tolbert, 1995). One BOEM-funded study in Louisiana found income inequality decreased during the oil boom of the 1980's and increased with the decline (Tolbert, 1995). If there is a suspension of oil and gas activities in response to a catastrophic spill, many oil- and gas-related service industries would attempt to avoid massive layoffs by cutting costs and deferring maintenance during the recovery. This was the case with the *Deepwater Horizon* explosion, oil spill, and response, and the long-term impacts are still not fully understood.

Onshore and Offshore Cleanup Workers

By the end of a catastrophic spill, up to 25,000 (shallow water) or 50,000 (deepwater) personnel would be expected to be responding to the spill. The majority of these would be field responders (United Incident Command, 2010e). As seen by the *Deepwater Horizon* explosion, oil spill, and response, the racial composition of cleanup crews was so conspicuous that Ben Jealous, the president of the National Association for the Advancement of Colored People, sent a public letter to BP Chief Operations Officer Tony Hayward on July 9, 2010, demanding to know why African Americans were over-represented in "the most physically difficult, lowest paying jobs, with the most significant exposure to toxins" (National Association for the Advancement of Colored People, 2010). While regulations require the wearing of protective gear and only a small percentage of cleanup workers suffer immediate illness and injuries (Center for Disease Control and Prevention, 2010), exposure could have long-term health impacts (e.g., increased rates of some types of cancer) (Savitz and Engel, 2010; Kirkeleit et al., 2008). 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 the 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). The USEPA's monitoring data have not shown that the use of dispersants during the *Deepwater Horizon* explosion, oil spill, and response resulted in a presence of chemicals that surpassed human health benchmarks (Trapido, 2010). The potential for the long-term human health effects are largely unknown. However, the National Institute of Environmental Health Sciences is conducting a study known as the "Gulf Long-Term Follow-Up 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 Long-Term Follow-up Study" will monitor oil-spill cleanup workers for 10 years and represents a national effort to determine if the Gulf oil spill led to physical or mental health problems (U.S. Dept. of Health and Human Services, NIEHS, 2010). The study has a target goal of 55,000 participants. As of October 2012, the National Institute of Environmental Health Sciences announced that over 29,000 cleanup workers and volunteers have enrolled in the "Gulf Long-Term Follow-up Study" (U.S. Dept. of Health and Human Services, NIEHS, 2012). Prior research on post-spill cleanup efforts found that the duration of cleaning work was a risk factor for acute toxic symptoms and that seamen had the highest occurrence of toxic symptoms compared with volunteers or paid workers. Therefore, participants in the "Vessels of Opportunity" program, which recruited local boat owners (including Cajun, Houma Indian, and Vietnamese American fishermen) to assist in cleanup efforts, would likely be one of the most exposed groups. African Americans are thought to have made up a high percentage of the cleanup workforce. The Occupational Safety and Health Administration (OSHA) released two matrices of gear requirements for onshore and offshore Gulf operations that were organized by task (U.S. Dept. of Labor, OSHA, 2010a). Of past oil-spill workers, 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). Therefore, a catastrophic spill may disproportionately affect seamen and onshore workers such as Cajuns, Vietnamese Americans, Houma Indian, and African Americans.

Solid-Waste Disposal

Following a catastrophic spill, environmental justice concerns arise related to the disposal of cleanup-related wastes near minority and/or low-income communities (Schleifstein, 2010). It is estimated that a catastrophic spill could generate several thousand tons of oil-impacted solid materials that would be disposed in landfills along the Gulf Coast. While no new landfills would be built because of a catastrophic spill, the use of existing landfills might exacerbate existing environmental justice issues. For example, Mobile, Alabama, and Miami, Florida, are majority minority urban centers with a majority of minority residents living within a 1-mi (1.6-km) radius of chosen landfills or liquid processing centers. While only a small percentage of *Deepwater Horizon* explosion, oil spill, and response waste was sent to these facilities—13 percent of the liquid waste to Liquid Environmental Solutions in Mobile and only 0.28 percent of the total liquid waste to Cliff Berry in Miami—they may receive more from potential future spills. Disposal procedures for the *Deepwater Horizon* explosion, oil spill, and response involved sorting waste materials into standard "waste stream types" at small, temporary stations, and then sending each type to existing facilities that were licensed to dispose of them. The location of temporary sorting stations was linked to the location of containment and cleanup operations. Hence, future locations of any sorting stations are not predictable since they would be determined by the needs of cleanup operations. However, waste disposal locations were determined by the specializations of existing facilities and by contractual relationships between them and the cleanup and containment firms. Louisiana received about 82 percent of the *Deepwater Horizon* explosion, oil spill, and response liquid waste recovered; of this, 56 percent was manifested to mud facilities located in Venice in Plaquemines Parish, Louisiana, and to Port Fourchon in Lafourche Parish, Louisiana, and then transferred to a processing facility in Port Arthur, Texas. The waste remaining after processing was sent to deep well injection landfills located in Fannett and Big Hill, Texas. The sites located in Venice and Port Fourchon, Louisiana, and in Port Arthur, Fannett, and Big Hill, Texas, have low-minority populations, but a few of these areas have substantial poverty rates relative to State and parish/county means.

Overall Summary and Conclusion (Phases 1-4)

For Phase 1 (Initial Event) of a catastrophic spill, there would likely be no adverse impacts to minority and low-income communities because of the long distance (>3 nmi; 3.5 mi; 5.6 km) from shore, as well as the short duration of the initial event, fire, and/or explosion. The primary environmental justice concerns during Phase 2 (Offshore Spill) would be large-scale fishing closures, oyster bed contamination and closures, and subsequent impacts to downstream activities such as shrimp processing facilities and oyster shucking houses. These may disproportionately affect such minority groups as the Vietnamese Americans, Native Americans, African Americans, and Islaños. Phase 3 (Onshore Contact), depending on the location, could result in disproportional impacts to those groups that rely heavily on oystering, commercial fishing, and other traditional subsistence fishing, hunting, trapping, and gathering activities to augment their diets and household incomes. During Phase 4 (Post-Spill, Long-Term Recovery and Response), the primary environmental justice concerns relate to possible long-term health impacts to cleanup workers, a predominately minority population, and to the possible disposal of oil-impacted solid waste in predominantly minority areas. As in the case of the *Deepwater Horizon* explosion, oil spill, and response, understanding long-term impacts would be dependent on the outcome of ongoing research by various interested parties, such as the National Institutes of Health and BOEM. Overall, depending on a number of mainly geographic variables such as the location of fisheries closures and oyster bed contamination and closures, as well as the demographic composition of cleanup workers, and if waste disposal was not distributed across the region at many different facilities, a catastrophic oil-spill event may have disproportionate effects on minority and low-income populations.

B.3.1.26. Species Considered due to U.S. Fish and Wildlife Service Concerns

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 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.

The scenarios for each phase, including cleanup methods, can be found **Table B-4**.

BOEM has only focused on species within coastal counties and parishes because those are the species that could be potentially impacted by oil and gas development activities, including a potential OCS spill. There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 1 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

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.

There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 2 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Phase 3—Onshore Contact

Phase 3 focuses on nearshore (e.g., inside bays and in close proximity to shoreline) and onshore spill response and 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 potential exposure of the resources throughout various life cycle stages.

The FWS has explicitly communicated interest in specific species within State boundaries along the Gulf Coast. The species within Louisiana, Mississippi, Alabama, and Florida have been designated as endangered, threatened, candidate, listed with critical habitat, proposed nonessential experimental population, or distinct vertebrate population. The greatest threats to the majority of these species are the loss of and/or modification to suitable habitat caused by urban and agricultural development.

The OSRA model catastrophic runs indicate environmental resources closest to the spill offshore typically had the greatest risk of contact. The model provides estimated conditional probabilities (expressed as percent chance) of a spill contacting an environmental resource, the condition being that a spill is assumed to have occurred at a given location. As the model run duration increased (3, 10, 30 and 60 days), more of the resources, including onshore potential contact, had meaningful probabilities of greater than 0.5 percent (refer to **Appendix C**). From LP 6 in the EPA, Plaquemines Parish, Louisiana, typically had amongst the highest 30- to 60-day conditional probabilities all year (winter, spring, summer, and fall) compared with other parishes and counties. From LP 7, Plaquemines Parish, Louisiana, and Dade and Monroe Counties, Florida, had amongst the highest 30- to 60-day conditional probabilities. The remaining counties and parishes typically had higher 30-day conditional probabilities during spring (April, May, June) from both launch points. For some launch points and 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 because the trajectories that have not contacted land within 30 days will remain at sea for 60 days or more.

At this time, there is no known record of a hurricane crossing the path of a large oil spill; the impacts of such have yet to be determined. The experience from Hurricanes Katrina and Rita in 2005 was that the oil released during the storms widely dispersed as far as the surge reached (USDOC, NOAA, National Weather Service, 2012). Due to their reliance on terrestrial habitats to carry out their life-history functions at a considerable distance from the GOM, the activities of an EPA proposed action are unlikely to have significant adverse effects on the size and recovery of any of the FWS-mentioned species or populations in Louisiana, Mississippi, Alabama, and Florida.

There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 3 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

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.

As data continue to be gathered and impact assessments completed, a better characterization of the full scope of impacts to populations in the GOM from the *Deepwater Horizon* explosion, oil spill, and response will be available. Relevant data on the status of populations after the *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated in this EIS, regardless of the cost or resources needed. In light of the incomplete or unavailable information, BOEM subject-matter experts have used available scientifically credible evidence in this analysis and applied it using accepted methods and approaches. Nevertheless, a complete understanding of the missing information is not essential to a reasoned choice among alternatives for this EIS. As of October 2011, there are 115 active leases in the EPA with ongoing (or the potential for) exploration, drilling, and production activities. In addition, non-OCS energy-related activities will continue to occur in the EPA irrespective of an EPA proposed action (i.e., habitat loss and competition). The potential for effects from changes to the affected environment (post-*Deepwater Horizon* explosion, oil spill, and response), accidental spills (including low-probability catastrophic spills), and cumulative effects remains whether or not the No Action or an Action alternative is chosen under this EIS.

There would likely be no adverse impacts to the species considered due to FWS concerns as a result of the events and the potential impact-producing factors that could occur throughout Phase 4 of a catastrophic spill event due to the distance of most activities, the heavy regulation of infrastructure and pipelines, and permitting and siting requirements.

Overall Summary and Conclusion (Phases 1-4)

Accidental blowouts, oil spills, and spill-response activities resulting from an EPA proposed action have the potential to impact small to large areas in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors (including tropical storms). The incremental contribution of an EPA proposed action would not be likely to result in a significant incremental impact on the FWS-mentioned species within the EPA; in comparison, non-OCS-related activities, such as habitat loss and competition, have historically proved to be of greater threat to the FWS-mentioned species.

In conclusion, within the CPA, which is directly adjacent to the EPA, there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting the FWS mentioned species populations; therefore, an EPA proposed action would be expected to have little or no effect on the FWS mentioned species.

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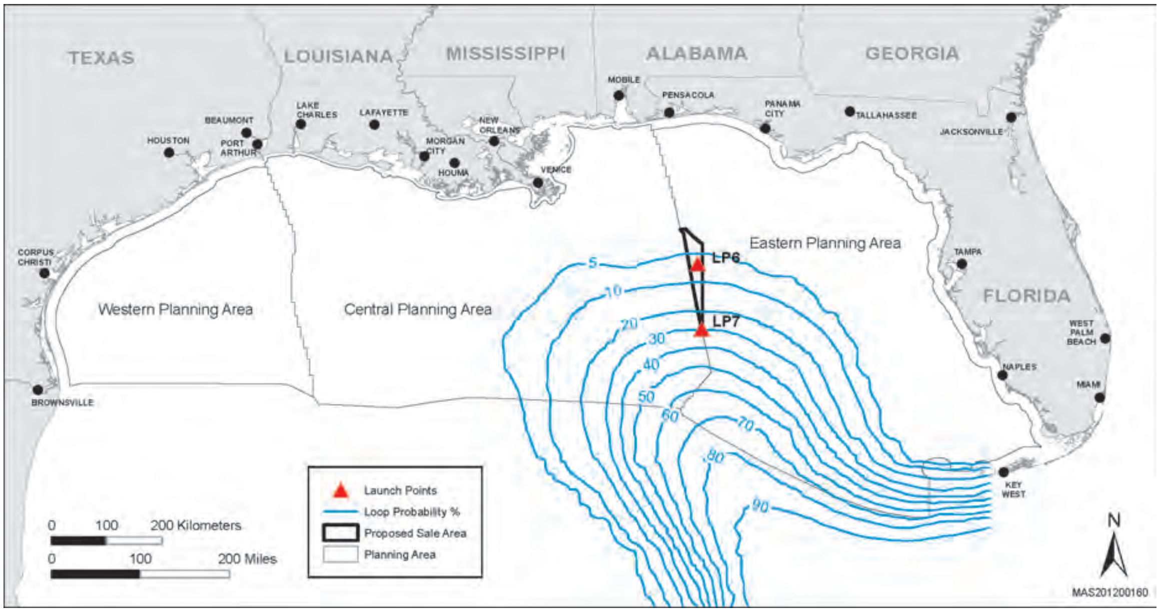

Figure B-1. Location of Two Hypothetical Oil-Spill Launch Points for OSRA within the Study Area. (Spatial variability of the Loop Current is from Vukovich [2007] and is shown as percent of time that the Loop Current watermass is associated with a particular location.)

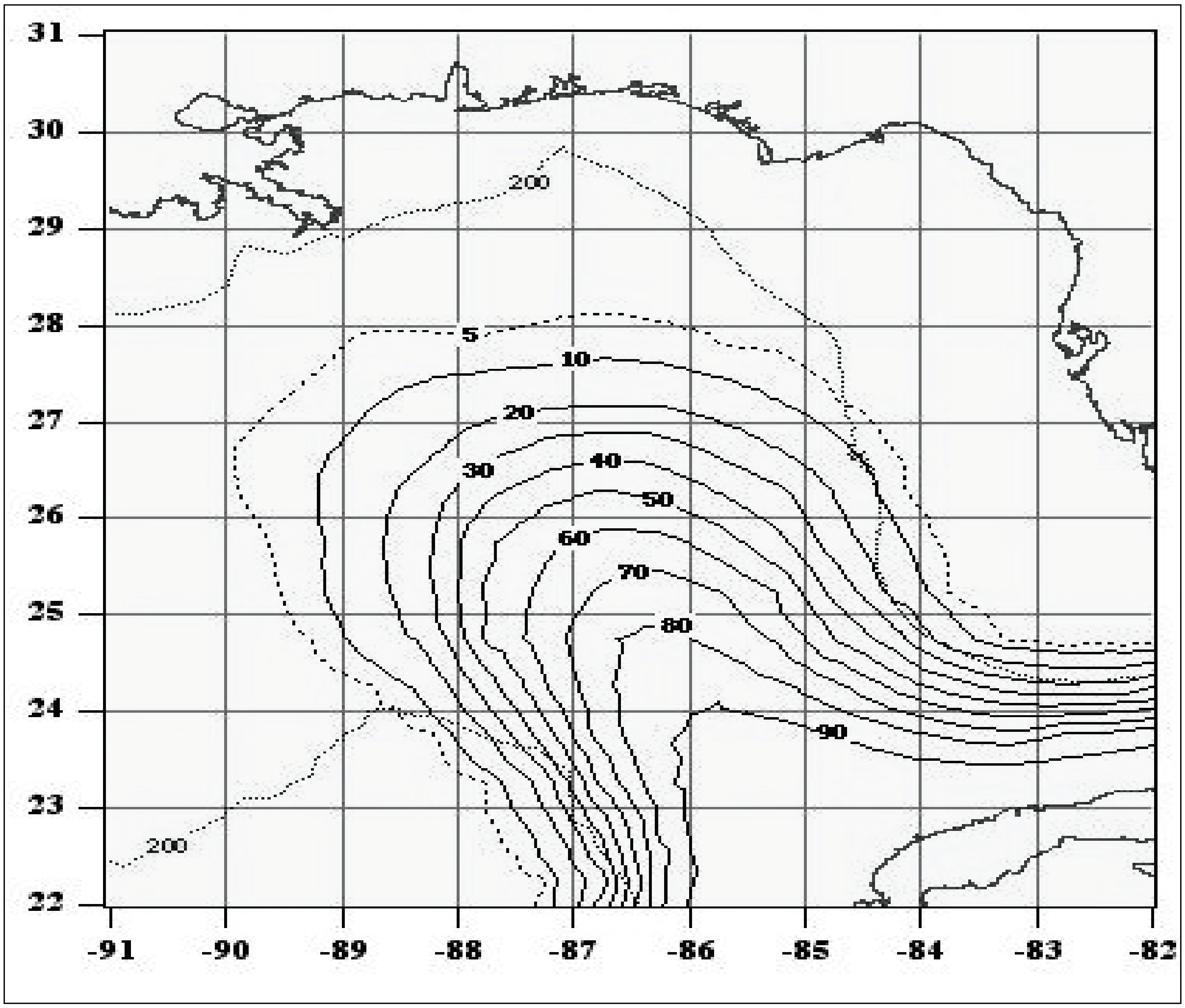

Figure B-2. Spatial Frequency (%) of the Watermass Associated with the Loop Current in the Eastern Gulf of Mexico based on Data for the Period 1976-2003 (Vukovich, 2005).

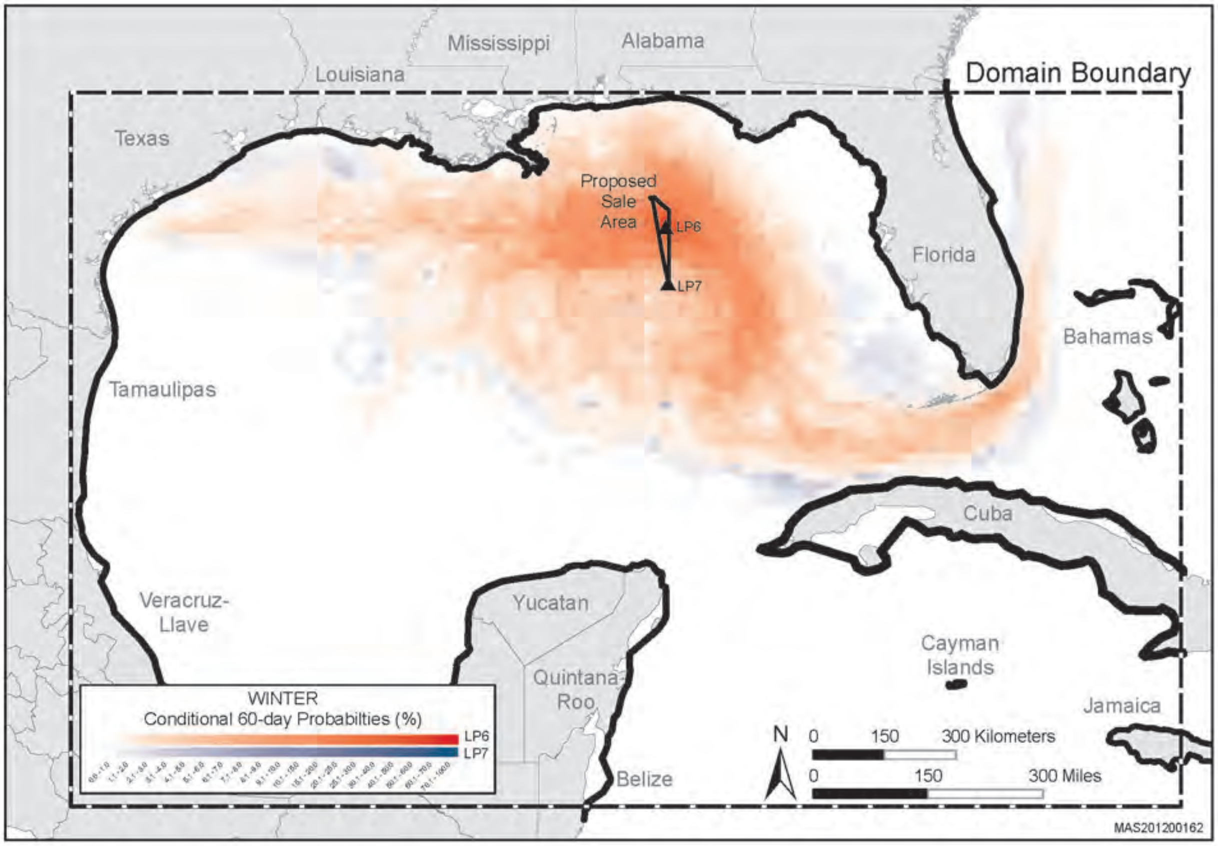

Figure B-3. Winter Season (January, February, and March) Conditional Probabilities for Launch Point 6 Overlaid on Launch Point 7 to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

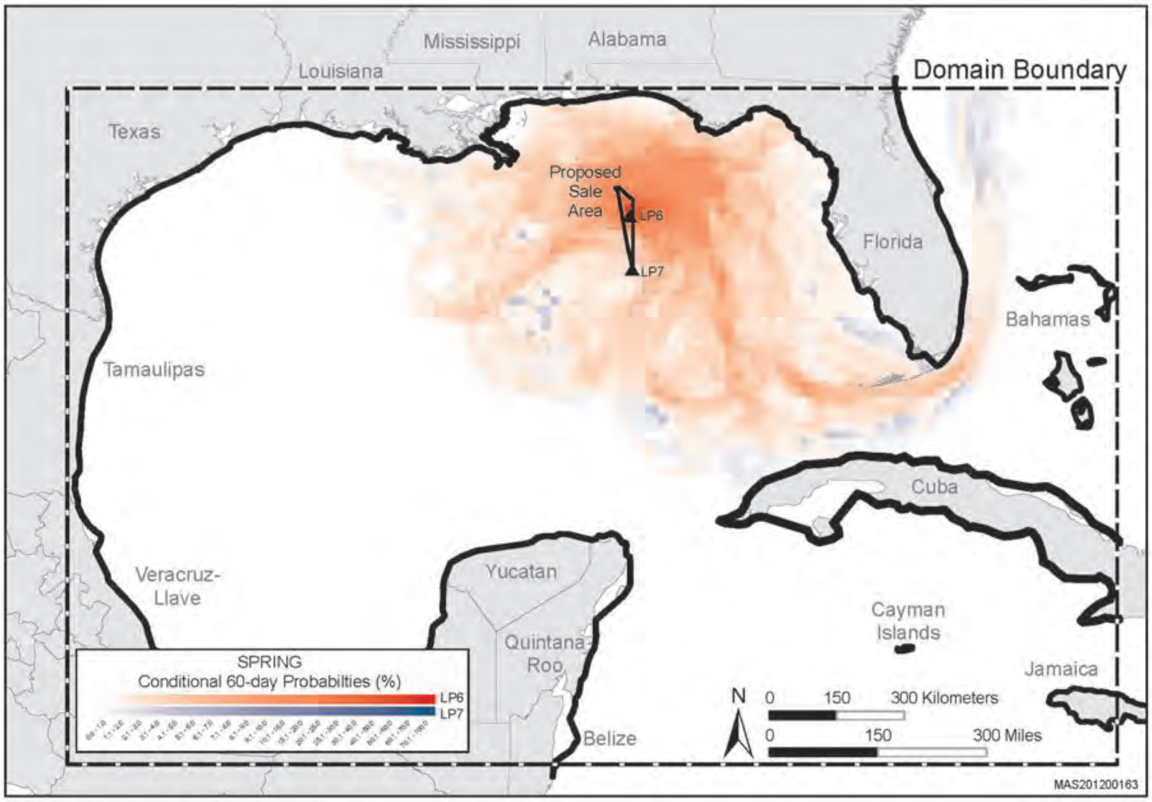

Figure B-4. Spring Season (April, May, and June) Conditional Probabilities for Launch Point 6 Overlaid on Launch Point 7 to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

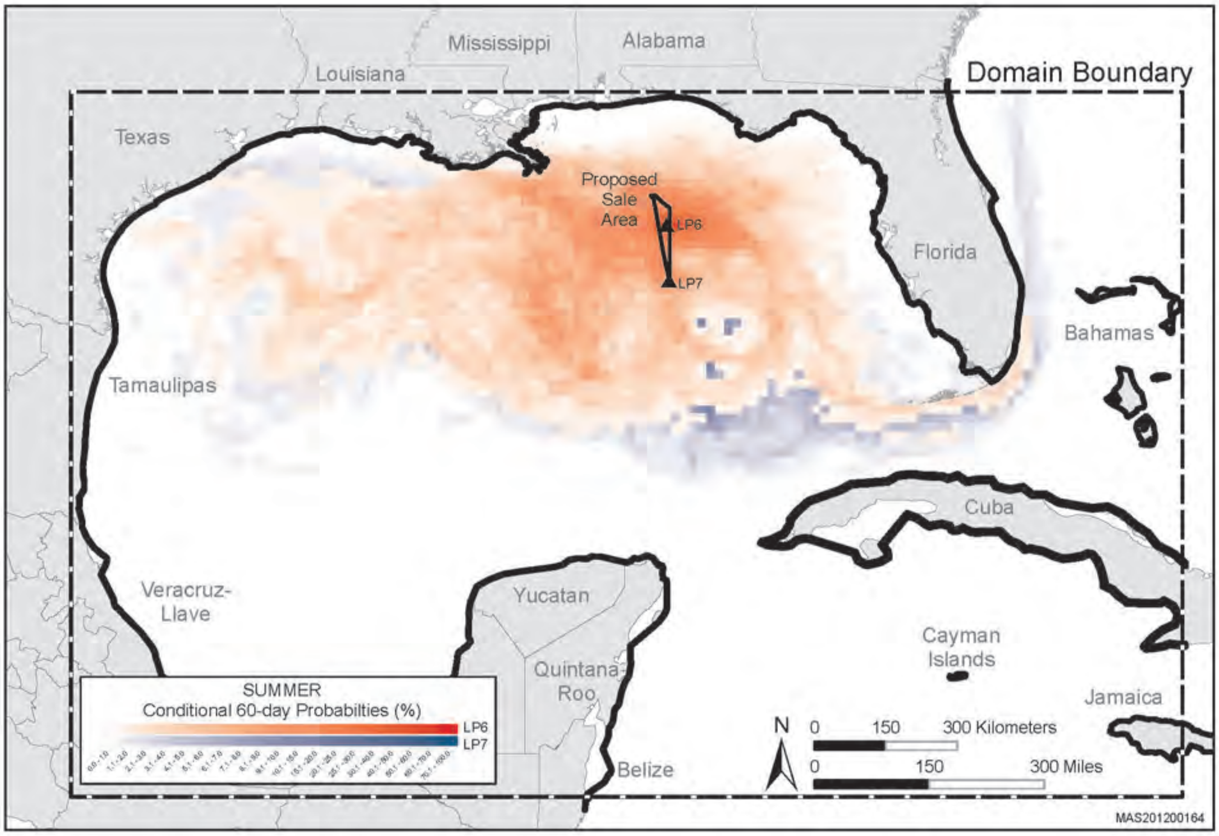

Figure B-5. Summer Season (July, August, and September) Conditional Probabilities for Launch Point 6 Overlaid on Launch Point 7 to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

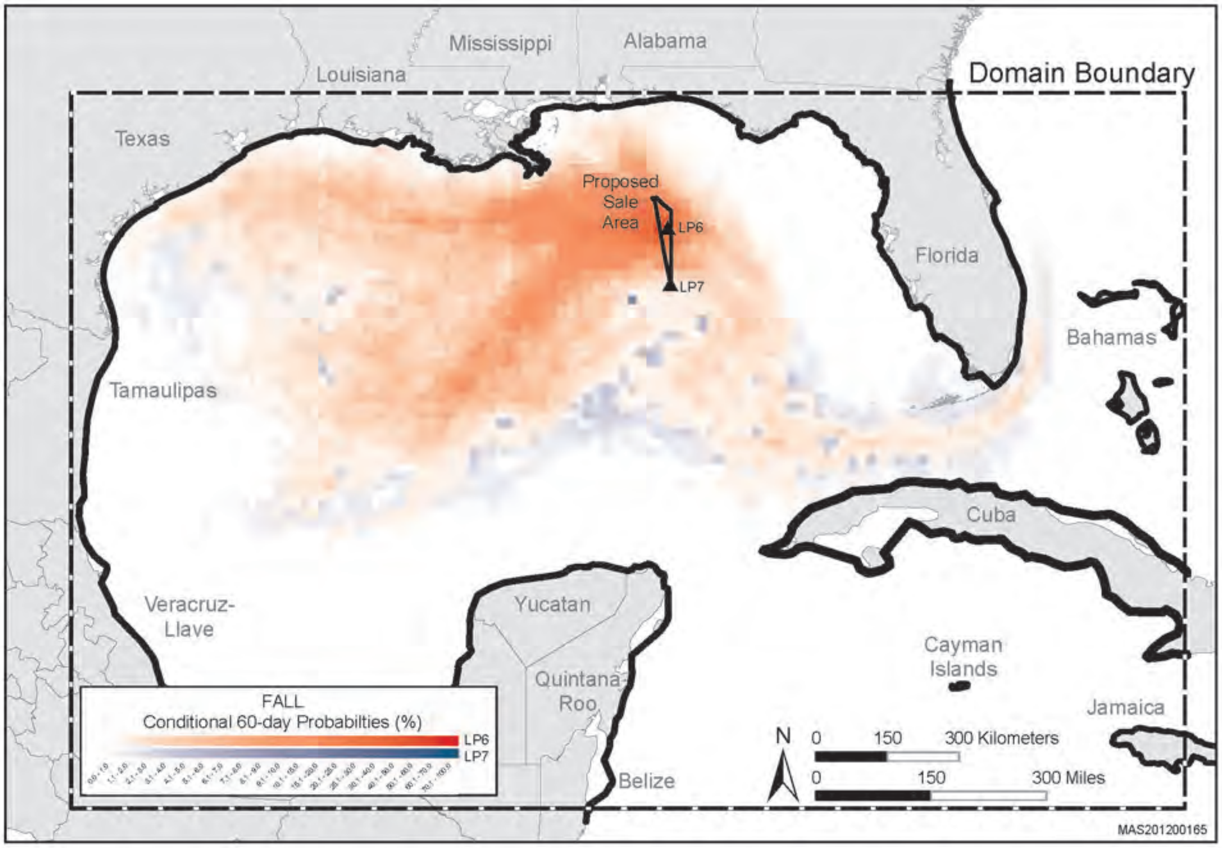

Figure B-6. Fall Season (October, November, and December) Conditional Probabilities for Launch Point 6 Overlaid on Launch Point 7 to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.

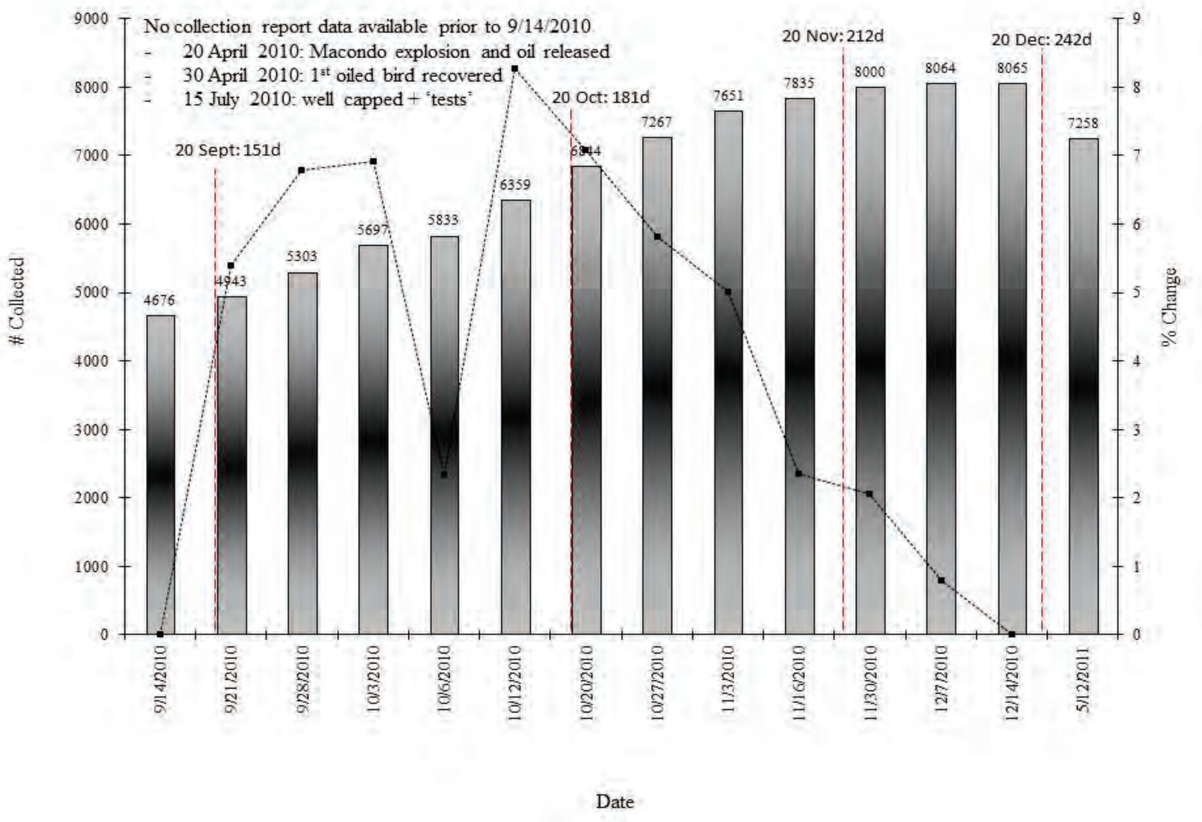

Figure B-7. Summary of Avian Species Collected by Date Obtained from the U.S. Fish and Wildlife Service as Part of the *Deepwater Horizon* Post-Spill Monitoring and Collection Process through May 12, 2011 (USDOI, FWS, 2011b). (This figure represents the date the data were released and reported and does not represent the actual date individual birds were collected. Data on the Y-axis reflects the cumulative # of individual birds collected, identified, and summarized by date; data on the Z-axis reflects proportional change from one reporting date to the next. The data used in this figure are verified as per FWS's QA/QC processes. The mean # of birds collected between intervals is 184.4 + 89.3 SE [-807 min, 526 max for 13 collection intervals] and the mean % change between intervals is 3.0 + 1.3% [-11.12% min., 8.27% max]. Unfortunately, we have no data on change in search effort temporally (or spatially) and also lack data prior to September 14, 2010; therefore, data at that point represent the baseline or "0" for determining interval differences. Disclaimer: All data should be considered provisional, incomplete, and subject to change. For more information, refer to FWS's Weekly Bird Impact Data and Consolidated Wildlife Reports [USDOI, FWS, 2011b]; for additional information on the chronological change in number of birds collected, refer to Belanger et al., 2010).

Table B-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 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 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 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, 1999). Stopping this kind of blowout would probably involve relief wells. Any recovery of oil at the seabed would be very difficult.

Table B-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
API °	>31.1°	31.1°-22.3°	<22.3°
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 PAH’s)	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 PAH’s)	PAH components (e.g., phenanthrene, anthracene—3 ring PAH’s)
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 B-3

Annual Volume of Produced Water Discharged by Depth
(millions of barrels)

Year	Shelf 0-60 m	Shelf 60-200 m	Slope 200-400 m	Deepwater 400-800 m	Deepwater 800-1,600 m	Ultra-Deepwater 1,601-2,400 m	Ultra-Deepwater >2,400 m	Total
2000	370.6	193.1	35.5	25.6	12.2	0.0	0.0	637.0
2001	364.2	185.2	35.0	32.0	16.6	0.0	0.0	633.0
2002	344.6	180.4	32.5	35.2	21.4	0.0	0.0	614.1
2003	359.4	182.9	31.2	39.0	35.5	0.2	0.0	648.2
2004	346.7	160.5	29.3	36.9	39.2	1.9	0.0	614.5
2005	270.1	113.5	23.1	33.5	43.0	5.8	0.0	489.0
2006	260.3	99.7	20.6	35.1	61.5	12.4	0.0	489.6
2007	307.0	139.4	22.2	40.0	70.3	15.5	0.1	594.5
2008	252.7	118.6	15.9	32.7	60.1	16.5	0.1	496.6
2009	263.9	108.3	19.9	39.2	65.3	25.0	0.1	521.7

Source: USDOI, BOEMRE, 2010b.

Table B-4

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	2-5 months	4-6 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
API° Gravity	Fresh oil will float (API° >10)	Fresh oil will float (API° >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 Planes/Helicopters	25/50	50/100
Boom (million feet)	5	11
Dispersant Application (surface application) (2)	35,000 bbl	33,000-bbl surface application and 16,500-bbl subsea application
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 approximately 37% or 88,522 mi^2 (229,270 km^2) closed to recreational and commercial fishing.

Table B-4. 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 months	3-6 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 = 100-1,000 miles	90 days = 100-1,000 miles
	120 days = >1,000 miles	120 days = >1,000 miles
	[1] Not cumulative. [2] Length was extrapolated	
Oil Characteristics and Appearance		--Essentially stable emulsions mixed with sand. --Typically initially stranded as surface layers and as discrete droplets/summer 2010.
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.
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	--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

Table B-4. 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).

	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.	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		
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.
Oil Characteristics and Appearance		As stranded oil weathered, some became buried through natural beach processes and appeared as surface residual balls (SRB) <10 cm (4 in) or as patties (SRP) 10 cm-1 m (4 in-3 ft).
Response Considerations for Sand Beaches, Marshes, and Nearshore Waters	Refer to Phase 3 above.	Refer to Phase 3 above.

(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 B-5

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Onshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
3	Kenedy, TX	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1
5	Nueces, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
7	Calhoun, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
8	Matagorda, TX	–	–	–	3	–	–	–	–	–	–	–	2	–	–	–	2
9	Brazoria, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
10	Galveston, TX	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	2
12	Jefferson, TX	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
13	Cameron, LA	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
14	Vermilion, LA	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
15	Iberia, LA	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
17	Terrebonne, LA	–	–	1	3	–	–	1	2	–	–	2	3	–	–	1	2
18	Lafourche, LA	–	–	1	2	–	–	1	1	–	–	1	2	–	–	1	2
19	Jefferson, LA	–	–	1	1	–	–	1	1	–	–	–	–	–	–	1	1
20	Plaquemines, LA	–	–	3	5	–	–	2	4	–	1	8	11	–	1	4	6
21	St. Bernard, LA	–	–	–	1	–	–	1	1	–	–	2	3	–	–	–	–
23	Harrison, MS	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
24	Jackson, MS	–	–	–	1	–	–	1	1	–	–	–	–	–	–	–	1
25	Mobile, AL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
26	Baldwin, AL	–	–	–	1	–	–	2	2	–	–	–	–	–	–	–	1
27	Escambia, FL	–	–	1	2	–	–	2	3	–	–	–	–	–	–	–	–
29	Okaloosa, FL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
30	Walton, FL	–	–	1	1	–	–	2	3	–	–	–	–	–	–	–	–

Table B-5. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
31	Bay, FL	–	–	–	1	–	–	3	5	–	–	–	–	–	–	–	–
32	Gulf, FL	–	–	–	–	–	–	3	3	–	–	–	–	–	–	–	–
33	Franklin, FL	–	–	–	1	–	–	2	4	–	–	–	1	–	–	–	–
36	Taylor, FL	–	–	–	–	–	–	1	4	–	–	–	–	–	–	–	–
37	Dixie, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
38	Levy, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
39	Citrus, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
40	Hernando, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
41	Pasco, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
42	Pinellas, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
47	Lee, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
49	Monroe, FL	–	–	1	3	–	–	–	1	–	–	–	1	–	–	–	1
50	Dade, FL	–	–	–	2	–	–	–	1	–	–	–	1	–	–	–	–
51	Broward, FL	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
52	Palm Beach, FL	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
62	TX	–	–	–	9	–	–	–	–	–	–	–	10	–	–	1	10
63	LA	–	–	6	16	–	–	5	11	–	2	14	22	–	1	7	13
64	MS	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	1
65	AL	–	–	–	2	–	–	3	4	–	–	–	1	–	–	1	1
66	FL	–	–	4	13	–	–	15	34	–	–	2	7	–	–	1	2
67	Tamaulipas, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
68	Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
74	Cuba	–	–	1	3	–	–	–	–	–	–	–	1	–	–	1	4
87	West Indian Manatee Habitat	–	–	4	13	–	–	15	34	–	–	2	7	–	–	1	2

Table B-5. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
88	West Indian Sporadic Habitat (Apr-Oct)	–	–	1	3	–	–	5	8	–	–	3	4	–	–	–	–
89	West Indian Rare Habitat (Apr-Oct)	–	–	2	12	–	–	5	11	–	2	12	24	–	1	2	2
90	Alabama Beach Mouse Habitat	–	–	–	1	–	–	2	2	–	–	–	–	–	–	–	1
91	Perdido Key Beach Mouse Habitat	–	–	1	4	–	–	3	5	–	–	–	1	–	–	–	1
92	Santa Rosa Beach Mouse Habitat	–	–	1	2	–	–	1	2	–	–	–	–	–	–	–	–
93	Choctawhatchee Beach Mouse Habitat	–	–	2	2	–	–	6	10	–	–	–	1	–	–	–	–
94	St. Andrew Beach Mouse Habitat	–	–	–	1	–	–	5	8	–	–	–	1	–	–	–	–
95	Southeastern Beach Mouse Habitat	–	–	1	3	–	–	–	1	–	–	–	2	–	–	–	1
97	Smalltooth Sawfish Critical Habitat	–	–	1	4	–	–	–	2	–	–	–	1	–	–	–	1
99	Gulf Sturgeon Critical Habitat	–	–	4	9	–	–	17	28	–	–	3	6	–	–	1	3
100	Gulf Sturgeon Habitat	–	–	5	13	–	–	20	39	–	1	9	15	–	1	3	6
101	TX Coastal Bend Beach Area	–	–	–	1	–	–	–	–	–	–	–	4	–	–	–	3
102	TX Matagorda Beach Area	–	–	–	4	–	–	–	–	–	–	–	3	–	–	–	3
103	TX Galveston Beach Area	–	–	–	3	–	–	–	–	–	–	–	2	–	–	–	3
104	TX Sea Rim State Park	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
105	LA Beach Areas	–	–	1	4	–	–	2	4	–	–	1	4	–	–	2	3
106	AL/MS Gulf Islands	–	–	–	2	–	–	2	4	–	–	–	1	–	–	1	1
107	AL Gulf Shores	–	–	–	1	–	–	2	2	–	–	–	–	–	–	–	1
108	FL Panhandle Beach Area	–	–	3	5	–	–	12	20	–	–	–	2	–	–	–	–
109	FL Big Bend Beach Area	–	–	–	–	–	–	2	9	–	–	–	1	–	–	–	–
110	FL Southwest Beach Area	–	–	–	–	–	–	–	2	–	–	1	1	–	–	–	–
111	FL Ten Thousand Islands Area	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
112	FL Southeast Beach Area	–	–	1	6	–	–	–	3	–	–	–	3	–	–	1	2

Note: Values of <0.5% are indicated by "–". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure B-1** for the location of Launch Point 6. Refer to **Figures 3-7 through 3-23** for the location of the named areas.

Table B-6

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7
Will Contact a Certain Onshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
1	Cameron, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
3	Kenedy, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
4	Kleberg, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
5	Nueces, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
6	Aransas, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
7	Calhoun, TX	–	–	–	1	–	–	–	–	–	–	–	2	–	–	–	–
8	Matagorda, TX	–	–	–	2	–	–	–	1	–	–	–	3	–	–	–	2
9	Brazoria, TX	–	–	–	1	–	–	–	–	–	–	–	2	–	–	–	1
10	Galveston, TX	–	–	–	3	–	–	–	–	–	–	1	2	–	–	–	1
12	Jefferson, TX	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
13	Cameron, LA	–	–	–	1	–	–	–	1	–	–	–	2	–	–	–	–
14	Vermilion, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
15	Iberia, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
17	Terrebonne, LA	–	–	1	2	–	–	1	2	–	–	1	2	–	–	1	1
18	Lafourche, LA	–	–	–	1	–	–	1	2	–	–	1	3	–	–	–	–
19	Jefferson, LA	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
20	Plaquemines, LA	–	–	1	3	–	–	2	3	–	–	2	3	–	–	2	2
21	St. Bernard, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
25	Mobile, AL	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
26	Baldwin, AL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
27	Escambia, FL	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
30	Walton, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
31	Bay, FL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–

Table B-6. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
32	Gulf, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
33	Franklin, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
36	Taylor, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
37	Dixie, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
41	Pasco, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
42	Pinellas, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
47	Lee, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
49	Monroe, FL	–	–	2	4	–	–	1	3	–	–	1	2	–	–	1	1
50	Dade, FL	–	–	2	4	–	–	1	2	–	–	1	3	–	–	1	2
51	Broward, FL	–	–	–	2	–	–	–	1	–	–	1	1	–	–	–	1
52	Palm Beach, FL	–	–	1	2	–	–	–	1	–	–	–	1	–	–	–	1
62	TX	–	–	–	11	–	–	1	2	–	–	2	12	–	–	1	7
63	LA	–	–	3	9	–	–	6	12	–	–	5	11	–	–	3	4
64	MS	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
65	AL	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	–
66	FL	–	–	7	15	–	–	6	21	–	–	3	9	–	–	2	5
67	Tamaulipas, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
68	Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
74	Cuba	–	–	2	4	–	–	–	1	–	–	–	1	–	–	2	5
87	West Indian Manatee Habitat	–	–	7	15	–	–	6	21	–	–	3	9	–	–	2	5
88	West Indian Sporadic Habitat (Apr-Oct)	–	–	–	1	–	–	2	4	–	–	–	1	–	–	–	–
89	West Indian Rare Habitat (Apr-Oct)	–	–	1	12	–	–	7	13	–	–	7	19	–	–	–	–
90	Alabama Beach Mouse Habitat	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
91	Perdido Key Beach Mouse Habitat	–	–	–	1	–	–	2	3	–	–	–	–	–	–	–	–
92	Santa Rosa Beach Mouse Habitat	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–

Table B-6. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
93	Choctawhatchee Beach Mouse Habitat	–	–	–	1	–	–	1	3	–	–	–	–	–	–	–	–
94	St. Andrew Beach Mouse Habitat	–	–	1	1	–	–	1	3	–	–	–	–	–	–	–	–
95	Southeastern Beach Mouse Habitat	–	–	2	4	–	–	1	3	–	–	1	2	–	–	1	2
97	Smalltooth Sawfish Critical Habitat	–	–	3	6	–	–	2	5	–	–	2	4	–	–	1	1
98	Short Nose Sturgeon Habitat (Sep-Mar)	–	–	1	1	–	–	–	–	–	–	–	1	–	–	–	–
99	Gulf Sturgeon Critical Habitat	–	–	1	3	–	–	5	11	–	–	–	1	–	–	–	1
100	Gulf Sturgeon Habitat	–	–	2	5	–	–	5	16	–	–	1	2	–	–	1	1
101	TX Coastal Bend Beach Area	–	–	–	2	–	–	–	–	–	–	–	3	–	–	–	3
102	TX Matagorda Beach Area	–	–	–	3	–	–	–	1	–	–	–	5	–	–	–	2
103	TX Galveston Beach Area	–	–	–	5	–	–	–	1	–	–	1	3	–	–	–	2
104	TX Sea Rim State Park	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
105	LA Beach Areas	–	–	1	2	–	–	2	4	–	–	2	5	–	–	–	–
106	AL/MS Gulf Islands	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	1
107	AL Gulf Shores	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
108	FL Panhandle Beach Area	–	–	1	2	–	–	3	6	–	–	–	–	–	–	–	–
109	FL Big Bend Beach Area	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–
110	FL Southwest Beach Area	–	–	–	1	–	–	–	3	–	–	–	1	–	–	–	–
111	FL Ten Thousand Islands Area	–	–	–	1	–	–	1	1	–	–	–	1	–	–	–	–
112	FL Southeast Beach Area	–	–	5	10	–	–	2	7	–	–	3	6	–	–	2	4
113	FL Central East Beach Area	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
114	FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–

Note: Values of <0.5% are indicated by "–". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure B-1** for the location of Launch Point 6. Refer to **Figures 3-7 through 3-23** for the location of the named areas.

Table B-7

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
2	Northwest Bahamas	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
8	TX State Waters	–	–	–	10	–	–	–	1	–	–	1	11	–	–	1	10
9	West LA State Waters	–	–	6	14	–	–	5	10	–	1	8	15	–	1	6	13
10	East LA State Waters	–	–	3	5	–	–	2	5	–	1	8	11	–	1	3	4
11	MS State Waters	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	1
12	AL State Waters	–	–	1	2	–	–	3	5	–	–	–	1	–	–	1	2
13	FL Panhandle State Waters	–	–	3	7	–	–	15	22	–	–	1	2	–	–	1	1
14	West FL State Waters	–	–	3	8	–	–	8	24	–	–	3	7	–	–	–	1
15	Tortugas State Waters	–	–	2	5	–	–	2	6	–	–	–	3	–	–	–	1
16	Southeast FL State Waters	–	–	3	10	–	–	1	5	–	–	1	4	–	–	1	2
17	Northeast FL State Waters	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
18	Mexican State Waters	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
31	Nearshore Seafloor (0-20 m), "N1"	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
32	Nearshore Seafloor (0-20 m), "N2"	–	–	–	4	–	–	–	–	–	–	–	7	–	–	1	4
33	Nearshore Seafloor (0-20 m), "N3"	–	–	–	9	–	–	–	–	–	–	–	6	–	–	2	10
34	Nearshore Seafloor (0-20 m), "N4"	–	–	2	8	–	–	1	3	–	–	3	6	–	–	5	9
35	Nearshore Seafloor (0-20 m), "N5"	–	–	7	15	–	–	6	8	–	1	10	18	–	2	9	14
36	Nearshore Seafloor (0-20 m), "N6"	–	–	3	5	–	–	3	5	–	1	8	11	–	1	3	4
37	Nearshore Seafloor (0-20 m), "N7"	–	–	2	4	–	–	3	5	–	–	3	3	–	–	2	3
38	Nearshore Seafloor (0-20 m), "N8"	–	–	1	3	–	–	4	6	–	–	1	1	–	–	1	2

Table B-7. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
39	Nearshore Seafloor (0-20 m), “N9”	–	–	3	6	–	–	15	22	–	–	1	2	–	–	–	1
40	Nearshore Seafloor (0-20 m), “N10”	–	–	–	1	–	–	6	16	–	–	2	4	–	–	–	–
41	Nearshore Seafloor (0-20 m), “N11”	–	–	1	3	–	–	1	6	–	–	2	3	–	–	–	–
42	Nearshore Seafloor (0-20 m), “N12”	–	–	5	13	–	–	4	13	–	–	2	7	–	–	1	2
43	Nearshore Seafloor (0-20 m), “N13”	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
44	Nearshore Seafloor (0-20 m), “N14”	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
45	Nearshore Seafloor (0-20 m), “N15”—Tortugas	–	–	1	3	–	–	1	3	–	–	–	2	–	–	–	–
46	Shelf Seafloor (20-300 m), “S1”	–	–	–	5	–	–	–	–	–	–	1	10	–	–	1	7
47	Shelf Seafloor (20-300 m), “S2”	–	–	1	13	–	–	–	–	–	–	2	13	–	–	5	15
48	Shelf Seafloor (20-300 m), “S3”	–	–	8	20	–	–	1	3	–	–	7	16	–	–	14	19
49	Shelf Seafloor (20-300 m), “S4”	–	1	17	28	–	–	7	11	–	3	18	29	–	6	24	30
50	Shelf Seafloor (20-300 m), “S5”	–	–	5	9	–	–	3	6	–	2	10	15	–	2	6	8
51	Shelf Seafloor (20-300 m), “S6”	–	–	6	10	–	1	6	9	–	3	9	13	–	2	7	8
52	Shelf Seafloor (20-300 m), “S7”	–	1	6	10	–	3	12	16	–	2	7	8	–	2	9	11
53	Shelf Seafloor (20-300 m), “S8”	1	7	14	18	–	18	40	47	–	3	11	15	–	1	8	9
54	Shelf Seafloor (20-300 m), “S9”	–	10	18	21	–	13	37	45	–	7	21	24	–	1	3	4
55	Shelf Seafloor (20-300 m), “S10”	–	2	14	20	–	–	13	24	–	–	10	16	–	–	3	4
56	Shelf Seafloor (20-300 m), “S11”	–	–	7	14	–	–	5	14	–	–	2	7	–	–	1	3
57	Shelf Seafloor (20-300 m), “S12”	–	–	4	13	–	–	2	10	–	–	1	6	–	–	1	4
58	Shelf Seafloor (20-300 m), “S13”	–	–	–	3	–	–	–	2	–	–	–	2	–	–	–	1
59	Shelf Seafloor (20-300 m), “S14”	–	–	–	2	–	–	–	2	–	–	–	1	–	–	–	1
60	Deepwater Seafloor (300 m–Outer Jurisdiction), “D1”	–	–	–	5	–	–	–	–	–	–	1	9	–	–	2	8
61	Deepwater Seafloor (300 m–Outer Jurisdiction), “D2”	–	–	–	4	–	–	–	–	–	–	1	10	–	–	2	9

Table B-7. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
62	Deepwater Seafloor (300 m–Outer Jurisdiction), “D3”	–	–	1	7	–	–	–	–	–	–	2	11	–	–	3	10
63	Deepwater Seafloor (300 m–Outer Jurisdiction), “D4”	–	–	1	7	–	–	–	–	–	–	5	14	–	–	4	14
64	Deepwater Seafloor (300 m–Outer Jurisdiction), “D5”	–	–	1	6	–	–	–	–	–	–	5	11	–	–	3	11
65	Deepwater Seafloor (300 m–Outer Jurisdiction), “D6”	–	–	3	12	–	–	–	–	–	–	5	13	–	–	9	15
66	Deepwater Seafloor (300 m–Outer Jurisdiction), “D7”	–	–	4	12	–	–	–	1	–	–	7	16	–	–	9	18
67	Deepwater Seafloor (300 m–Outer Jurisdiction), “D8”	–	–	3	10	–	–	–	1	–	–	9	15	–	–	9	20
68	Deepwater Seafloor (300 m–Outer Jurisdiction), “D9”	–	1	10	19	–	–	1	3	–	–	8	14	–	1	14	18
69	Deepwater Seafloor (300 m–Outer Jurisdiction), “D10”	–	1	11	20	–	–	3	6	–	–	13	22	–	2	17	25
70	Deepwater Seafloor (300 m–Outer Jurisdiction), “D11”	–	–	8	16	–	–	3	6	–	1	14	22	–	3	20	32
71	Deepwater Seafloor (300 m–Outer Jurisdiction), “D12”	–	2	19	29	–	–	8	12	–	4	18	28	–	11	31	37
72	Deepwater Seafloor (300 m–Outer Jurisdiction), “D13”	–	6	25	34	–	1	10	14	–	5	22	33	–	17	36	42
73	Deepwater Seafloor (300 m–Outer Jurisdiction), “D14”	–	4	20	31	–	2	11	15	–	7	24	35	–	17	41	49
74	Deepwater Seafloor (300 m–Outer Jurisdiction), “D15”	–	2	13	19	–	3	14	18	–	7	19	27	–	8	20	25
75	Deepwater Seafloor (300 m–Outer Jurisdiction), “D16”	–	14	36	43	–	7	21	26	1	16	35	48	1	36	56	61
76	Deepwater Seafloor (300 m–Outer Jurisdiction), “D17”	2	30	53	61	–	14	27	32	4	28	51	66	13	62	79	85
77	Deepwater Seafloor (300 m–Outer Jurisdiction), “D18”	10	35	49	53	3	21	34	37	10	30	47	56	29	65	73	77

Table B-7. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
78	Deepwater Seafloor (300 m–Outer Jurisdiction), “D19”	47	57	66	68	30	41	49	52	38	53	65	71	77	88	92	93
79	Deepwater Seafloor (300 m–Outer Jurisdiction), “D20”	8	23	41	47	5	11	20	26	5	21	35	44	9	26	35	43
80	Deepwater Seafloor (300 m–Outer Jurisdiction), “D21”	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
81	Deepwater Seafloor (300 m–Outer Jurisdiction), “D22”	37	49	54	56	48	66	73	76	30	41	47	51	16	26	32	32
82	Deepwater Seafloor (300 m–Outer Jurisdiction), “D23”	11	26	38	40	8	30	39	44	8	27	37	39	2	6	10	13
83	Deepwater Seafloor (300 m–Outer Jurisdiction), “D24”	36	52	64	67	37	47	56	58	44	55	62	63	14	26	38	43
84	Deepwater Seafloor (300 m–Outer Jurisdiction), “D25”	–	3	21	29	–	1	15	20	–	1	9	15	–	–	6	10
85	Deepwater Seafloor (300 m–Outer Jurisdiction), “D26”	–	10	28	35	–	5	17	21	–	3	11	16	–	3	14	20
86	Deepwater Seafloor (300 m–Outer Jurisdiction), “D27”	–	–	9	18	–	–	5	13	–	–	2	8	–	–	2	6
87	Deepwater Seafloor (300 m–Outer Jurisdiction), “D28”	–	–	4	12	–	–	2	8	–	–	1	4	–	–	1	4
88	Deepwater Seafloor (300 m–Outer Jurisdiction), “D29”	–	–	1	5	–	–	1	5	–	–	–	1	–	–	–	2
89	Deepwater Seafloor (300 m–Outer Jurisdiction), “D30”	–	–	–	4	–	–	1	4	–	–	–	1	–	–	–	1
90	North Atlantic Right Whale Critical Habitat	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
92	*Sargassum* (March/April)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
94	*Sargassum* (July/August)	–	–	–	–	1	1	1	1	66	66	66	66	–	–	–	–
95	Seagrass-Wakulla County	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
96	Seagrass-Jefferson County	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
97	Seagrass-Taylor County	–	–	–	–	–	–	2	5	–	–	–	–	–	–	–	–

Table B-7. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
98	Seagrass-Dixie County	–	–	–	–	–	–	1	3	–	–	–	–	–	–	–	–
99	Seagrass-Levy County	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
111	Topographic Features (32 Fathom Bank)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
113	Topographic Features (Claypile Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
115	Topographic Features (Coffee Lump Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	2
116	East Flower Garden Bank	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	1
117	West Flower Garden Bank	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
118	Topographic Features (MacNeil Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
119	Topographic Features (29 Fathom Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
121	Topographic Features (Rankin-2 Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
122	Topographic Features (Bright Bank)	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
123	Topographic Features (Geyer Bank)	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	1
124	Topographic Features (Elvers Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
125	Topographic Features (McGrail Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1
126	Topographic Features (Sonnier Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
127	Topographic Features (Bouma Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
128	Topographic Features (Rezak Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
129	Topographic Features (Sidner Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
130	Topographic Features (Parker Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	2
131	Topographic Features (Alderdice Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
135	Topographic Features (Ewing-1 Bank)	–	–	1	1	–	–	–	–	–	–	1	1	–	–	2	2
136	Topographic Features (Ewing-2 Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
137	Topographic Features (Diaphus Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1

Table B-7. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
138	Topographic Features (Sackett Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
139	Pinnacle Trend	–	1	6	9	–	3	11	14	–	1	6	8	–	2	8	10
140	Chandeleur Islands	–	–	2	3	–	–	2	3	–	–	3	5	–	–	1	2
141	Florida Middle Ground	–	–	1	2	–	–	5	8	–	–	2	4	–	–	–	–
142	Pulley Ridge	–	1	6	11	–	–	6	13	–	–	3	8	–	–	1	2
143	Madison Swanson	–	–	2	3	–	1	9	11	–	–	1	2	–	–	–	1
144	Steamboat Lumps	–	1	2	3	–	1	4	6	–	–	2	3	–	–	–	–
145	Dry Tortugas	–	–	1	3	–	–	1	3	–	–	–	2	–	–	–	–
146	Tortugas Ecological Reserve (North)	–	–	1	3	–	–	1	2	–	–	–	2	–	–	–	–
147	Tortugas Ecological Reserve (South)	–	–	3	6	–	–	3	6	–	–	1	3	–	–	1	1
148	Florida Keys National Marine Sanctuary	–	–	7	15	–	–	5	14	–	–	2	8	–	–	1	3
149	FL State Waters (both East Coast and Gulf)	–	–	2	5	–	–	2	6	–	–	–	3	–	–	–	1
150	Key Biscayne National Park	–	–	1	2	–	–	–	1	–	–	–	1	–	–	–	1
151	Texas Clipper and South Texas Platform – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1
152	Port Lavaca/Liberty Ship Reef – Dive Area (Apr-Nov)	–	–	–	2	–	–	–	–	–	–	–	3	–	–	–	4
153	High Island – Dive Area (Apr-Nov)	–	–	–	2	–	–	–	–	–	–	–	1	–	–	1	3
154	West Cameron – Dive Area (Apr-Nov)	–	–	–	3	–	–	–	–	–	–	–	4	–	–	3	5
156	Cognac Platform (Block MC 194)—Dive Area (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	1	2	–	–	1	1
157	Horseshoe Rigs (Block MP 306)—Dive Area (Apr-Nov)	–	–	–	1	–	–	1	1	–	–	1	2	–	–	–	–
158	Vermilion Area—Dive Area (Apr-Nov)	–	–	–	3	–	–	1	2	–	–	1	6	–	–	4	5
159	Vermilion Area, South Addition – Dive Area (Apr-Nov)	–	–	1	3	–	–	–	–	–	–	3	9	–	–	7	8

Table B-7. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
160	Bay Marchand – Dive Area (Apr-Nov)	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–
161	South Timbalier – Dive Area (Apr-Nov)	–	–	2	5	–	–	4	5	–	–	7	13	–	1	5	5
162	South Timbalier Area, South Addition – Dive Area (Apr-Nov)	–	–	1	4	–	–	2	3	–	–	5	8	–	1	8	9
163	Panhandle FL – Dive Area (Apr-Nov)	–	–	4	7	–	2	19	25	–	–	2	3	–	–	–	–
164	Tampa – Dive Area (Apr-Nov)	–	–	–	1	–	–	1	3	–	–	1	2	–	–	–	–
165	SE FL – Dive Area (Apr-Nov)	–	–	–	2	–	–	1	7	–	–	1	4	–	–	–	–
166	Daytona Beach – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
169	East Flower Garden Bank (Apr-Nov)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
170	West Flower Garden Bank (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
171	Chandeleur Islands (Apr-Nov)	–	–	1	2	–	–	2	3	–	–	3	5	–	–	–	–
172	Tortugas Ecological Reserve (North) (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	–
173	Tortugas Ecological Reserve (South) (Apr-Nov)	–	–	–	2	–	–	3	6	–	–	1	3	–	–	–	–
174	Florida Keys National Marine Sanctuary (Apr-Nov)	–	–	1	5	–	–	5	14	–	–	2	8	–	–	–	–

Note: Values of <0.5% are indicated by "–". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Values of >99.5% are indicated by "*". Refer to **Figure B-1** for the location of Launch Point 6. Refer to **Figures 3-7 through 3-23** for the location of the named areas.

Table B-8

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
8	TX State Waters	–	–	–	13	–	–	1	2	–	–	2	14	–	–	1	6
9	West LA State Waters	–	–	3	9	–	–	7	12	–	–	6	12	–	–	3	5
10	East LA State Waters	–	–	1	2	–	–	1	3	–	–	1	2	–	–	1	1
11	MS State Waters	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
12	AL State Waters	–	–	–	1	–	–	2	3	–	–	–	–	–	–	–	–
13	FL Panhandle State Waters	–	–	1	3	–	–	4	8	–	–	–	–	–	–	–	–
14	West FL State Waters	–	–	6	12	–	1	8	22	–	–	4	9	–	–	1	3
15	Tortugas State Waters	–	–	3	7	–	–	2	6	–	–	2	4	–	–	–	1
16	Southeast FL State Waters	–	–	6	14	–	–	4	12	–	–	5	10	–	–	2	5
17	Northeast FL State Waters	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
18	Mexican State Waters	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
31	Nearshore Seafloor (0-20 m), "N1"	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
32	Nearshore Seafloor (0-20 m), "N2"	–	–	–	4	–	–	–	–	–	–	–	6	–	–	1	3
33	Nearshore Seafloor (0-20 m), "N3"	–	–	1	10	–	–	1	2	–	–	2	9	–	–	1	6
34	Nearshore Seafloor (0-20 m), "N4"	–	–	2	7	–	–	3	5	–	–	4	8	–	–	1	2
35	Nearshore Seafloor (0-20 m), "N5"	–	–	4	9	–	–	7	10	–	–	7	15	–	–	4	5
36	Nearshore Seafloor (0-20 m), "N6"	–	–	–	2	–	–	2	3	–	–	1	2	–	–	1	1
37	Nearshore Seafloor (0-20 m), "N7"	–	–	–	1	–	–	2	3	–	–	–	1	–	–	1	1
38	Nearshore Seafloor (0-20 m), "N8"	–	–	–	1	–	–	2	3	–	–	–	–	–	–	–	1
39	Nearshore Seafloor (0-20 m), "N9"	–	–	1	3	–	–	4	8	–	–	–	–	–	–	–	–
40	Nearshore Seafloor (0-20 m), "N10"	–	–	–	–	–	–	2	8	–	–	–	1	–	–	–	–

Table B-8. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
41	Nearshore Seafloor (0-20 m), “N11”	–	–	1	4	–	–	2	10	–	–	2	4	–	–	1	1
42	Nearshore Seafloor (0-20 m), “N12”	–	–	10	18	–	1	9	20	–	–	8	15	–	–	3	6
43	Nearshore Seafloor (0-20 m), “N13”	–	–	1	3	–	–	1	2	–	–	1	1	–	–	–	1
44	Nearshore Seafloor (0-20 m), “N14”	–	–	1	1	–	–	–	1	–	–	–	1	–	–	–	1
45	Nearshore Seafloor (0-20 m), “N15”—Tortugas	–	–	2	4	–	–	1	4	–	–	1	3	–	–	–	1
46	Shelf Seafloor (20-300 m), “S1”	–	–	–	4	–	–	–	–	–	–	1	10	–	–	1	6
47	Shelf Seafloor (20-300 m), “S2”	–	–	2	12	–	–	1	1	–	–	2	17	–	–	5	13
48	Shelf Seafloor (20-300 m), “S3”	–	–	6	15	–	–	3	5	–	–	9	18	–	–	6	12
49	Shelf Seafloor (20-300 m), “S4”	–	–	10	17	–	–	11	15	–	2	15	26	–	2	10	13
50	Shelf Seafloor (20-300 m), “S5”	–	–	1	3	–	–	4	5	–	–	3	4	–	–	2	3
51	Shelf Seafloor (20-300 m), “S6”	–	–	1	3	–	–	3	6	–	–	2	4	–	–	2	3
52	Shelf Seafloor (20-300 m), “S7”	–	–	1	4	–	–	5	8	–	–	1	2	–	1	3	3
53	Shelf Seafloor (20-300 m), “S8”	–	1	3	8	–	1	14	20	–	–	2	3	–	–	1	2
54	Shelf Seafloor (20-300 m), “S9”	1	7	14	20	–	7	23	34	–	3	10	14	–	1	2	3
55	Shelf Seafloor (20-300 m), “S10”	–	4	17	25	–	5	17	29	–	4	14	19	–	1	4	7
56	Shelf Seafloor (20-300 m), “S11”	–	–	11	20	–	2	12	23	–	–	9	15	–	–	3	7
57	Shelf Seafloor (20-300 m), “S12”	–	–	9	18	–	1	7	17	–	–	8	13	–	–	3	7
58	Shelf Seafloor (20-300 m), “S13”	–	–	3	6	–	–	2	5	–	–	2	3	–	–	1	2
59	Shelf Seafloor (20-300 m), “S14”	–	–	1	4	–	–	1	4	–	–	2	4	–	–	–	1
60	Deepwater Seafloor (300 m–Outer Jurisdiction), “D1”	–	–	–	5	–	–	–	–	–	–	1	10	–	–	3	8
61	Deepwater Seafloor (300 m–Outer Jurisdiction), “D2”	–	–	–	4	–	–	–	–	–	–	2	10	–	–	3	9
62	Deepwater Seafloor (300 m–Outer Jurisdiction), “D3”	–	–	1	7	–	–	–	–	–	–	2	11	–	–	5	14

Table B-8. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
63	Deepwater Seafloor (300 m–Outer Jurisdiction), “D4”	–	–	1	6	–	–	–	–	–	–	4	15	–	–	6	18
64	Deepwater Seafloor (300 m–Outer Jurisdiction), “D5”	–	–	1	5	–	–	–	–	–	–	3	13	–	–	2	10
65	Deepwater Seafloor (300 m–Outer Jurisdiction), “D6”	–	–	4	10	–	–	1	2	–	–	5	13	–	–	8	17
66	Deepwater Seafloor (300 m–Outer Jurisdiction), “D7”	–	–	4	10	–	–	1	2	–	–	9	18	–	–	10	21
67	Deepwater Seafloor (300 m–Outer Jurisdiction), “D8”	–	–	3	8	–	–	1	2	–	–	9	18	–	–	8	20
68	Deepwater Seafloor (300 m–Outer Jurisdiction), “D9”	–	–	7	13	–	1	4	7	–	–	9	14	–	–	10	14
69	Deepwater Seafloor (300 m–Outer Jurisdiction), “D10”	–	–	12	18	–	2	6	10	–	1	15	24	–	2	20	28
70	Deepwater Seafloor (300 m–Outer Jurisdiction), “D11”	–	–	11	18	–	3	7	9	–	4	21	31	–	2	20	32
71	Deepwater Seafloor (300 m–Outer Jurisdiction), “D12”	–	2	13	19	–	1	10	15	–	5	17	28	–	5	16	19
72	Deepwater Seafloor (300 m–Outer Jurisdiction), “D13”	–	7	21	29	–	4	13	19	–	11	25	37	–	12	29	34
73	Deepwater Seafloor (300 m–Outer Jurisdiction), “D14”	–	11	29	40	–	10	19	27	–	17	33	43	–	16	43	54
74	Deepwater Seafloor (300 m–Outer Jurisdiction), “D15”	–	–	5	9	–	1	8	13	–	1	7	11	–	4	9	11
75	Deepwater Seafloor (300 m–Outer Jurisdiction), “D16”	–	8	18	26	–	5	16	23	–	10	24	33	–	20	31	35
76	Deepwater Seafloor (300 m–Outer Jurisdiction), “D17”	7	28	51	58	7	24	39	48	9	42	59	70	12	58	76	81
77	Deepwater Seafloor (300 m–Outer Jurisdiction), “D18”	2	11	21	27	2	15	25	31	3	14	23	28	10	26	33	36
78	Deepwater Seafloor (300 m–Outer Jurisdiction), “D19”	7	15	24	30	13	24	34	39	8	20	26	30	15	25	30	33

Table B-8. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
79	Deepwater Seafloor (300 m–Outer Jurisdiction), “D20”	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
80	Deepwater Seafloor (300 m–Outer Jurisdiction), “D21”	5	11	18	24	9	20	29	33	3	12	17	20	4	10	14	16
81	Deepwater Seafloor (300 m–Outer Jurisdiction), “D22”	2	7	12	19	1	14	25	30	–	4	8	11	2	5	10	11
82	Deepwater Seafloor (300 m–Outer Jurisdiction), “D23”	6	21	29	35	4	20	33	38	2	11	22	25	4	7	12	14
83	Deepwater Seafloor (300 m–Outer Jurisdiction), “D24”	75	82	84	85	75	82	85	86	67	75	78	79	51	57	63	65
84	Deepwater Seafloor (300 m–Outer Jurisdiction), “D25”	2	13	33	41	1	12	28	35	–	10	22	27	1	4	13	19
85	Deepwater Seafloor (300 m–Outer Jurisdiction), “D26”	6	30	47	53	10	27	42	46	4	18	30	34	3	15	30	37
86	Deepwater Seafloor (300 m–Outer Jurisdiction), “D27”	–	–	14	23	–	2	14	24	–	1	10	16	–	–	6	12
87	Deepwater Seafloor (300 m–Outer Jurisdiction), “D28”	–	–	8	16	–	–	6	15	–	–	5	9	–	–	2	8
88	Deepwater Seafloor (300 m–Outer Jurisdiction), “D29”	–	–	3	7	–	–	3	9	–	–	2	4	–	–	1	2
89	Deepwater Seafloor (300 m–Outer Jurisdiction), “D30”	–	–	1	5	–	–	2	7	–	–	2	4	–	–	–	2
90	North Atlantic Right Whale Critical Habitat	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
92	*Sargassum* (March/April)	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
93	*Sargassum* (May/June)	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	–
94	*Sargassum* (July/August)	–	–	–	–	1	1	1	1	66	66	66	66	–	–	–	–
97	Seagrass-Taylor County	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
98	Seagrass-Dixie County	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
99	Seagrass-Levy County	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–

Table B-8. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
113	Topographic Features (Claypile Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
114	Topographic Features (Appelbaum Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
115	Topographic Features (Coffee Lump Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
116	East Flower Garden Bank	–	–	–	1	–	–	–	–	–	–	–	2	–	–	1	2
117	West Flower Garden Bank	–	–	–	1	–	–	–	–	–	–	–	2	–	–	1	2
118	Topographic Features (MacNeil Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
120	Topographic Features (Rankin-1 Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
121	Topographic Features (Rankin-2 Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
122	Topographic Features (Bright Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
123	Topographic Features (Geyer Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
124	Topographic Features (Elvers Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
126	Topographic Features (Sonnier Bank)	–	–	–	1	–	–	–	–	–	–	1	1	–	–	–	–
127	Topographic Features (Bouma Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
128	Topographic Features (Rezak Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
129	Topographic Features (Sidner Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
130	Topographic Features (Parker Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
131	Topographic Features (Alderdice Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
135	Topographic Features (Ewing-1 Bank)	–	–	1	1	–	–	–	1	–	–	1	1	–	–	–	–
137	Topographic Features (Diaphus Bank)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
138	Topographic Features (Sackett Bank)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
139	Pinnacle Trend	–	–	1	3	–	–	4	7	–	–	1	2	–	1	3	3
140	Chandeleur Islands	–	–	–	1	–	–	1	2	–	–	–	1	–	–	–	–
141	Florida Middle Ground	–	–	–	1	–	–	3	6	–	–	–	–	–	–	–	–

Table B-8. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
142	Pulley Ridge	–	1	6	12	–	2	7	17	–	2	8	11	–	–	1	3
143	Madison Swanson	–	–	1	1	–	–	2	4	–	–	–	–	–	–	–	1
144	Steamboat Lumps	–	–	2	2	–	–	3	6	–	–	–	1	–	–	–	–
145	Dry Tortugas	–	–	2	3	–	–	1	4	–	–	1	2	–	–	–	1
146	Tortugas Ecological Reserve (North)	–	–	1	3	–	–	1	2	–	–	–	2	–	–	–	1
147	Tortugas Ecological Reserve (South)	–	–	5	9	–	1	4	9	–	–	3	6	–	–	1	1
148	Florida Keys National Marine Sanctuary	–	–	11	20	–	1	11	23	–	–	9	16	–	–	3	6
149	FL State Waters (both East Coast and Gulf)	–	–	3	7	–	–	2	6	–	–	2	4	–	–	–	2
150	Key Biscayne National Park	–	–	1	2	–	–	1	2	–	–	1	2	–	–	–	1
151	Texas Clipper and South Texas Platform – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
152	Port Lavaca/Liberty Ship Reef – Dive Area (Apr-Nov)	–	–	–	2	–	–	1	1	–	–	1	5	–	–	1	2
153	High Island – Dive Area (Apr-Nov)	–	–	–	2	–	–	–	–	–	–	1	2	–	–	–	–
154	West Cameron – Dive Area (Apr-Nov)	–	–	1	3	–	–	1	1	–	–	3	7	–	–	–	–
156	Cognac Platform (Mississippi Canyon Block 194) – Dive Area (Apr-Nov)	–	–	–	–	–	–	1	1	–	–	1	2	–	–	–	–
158	Vermilion Area—Dive Area (Apr-Nov)	–	–	1	3	–	–	2	3	–	–	4	9	–	–	–	–
159	Vermilion Area, South Addition – Dive Area (Apr-Nov)	–	–	1	3	–	–	1	2	–	–	4	8	–	–	1	1
160	Bay Marchand – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	–
161	South Timbalier – Dive Area (Apr-Nov)	–	–	1	3	–	–	4	7	–	–	6	13	–	–	1	1
162	South Timbalier Area, South Addition – Dive Area (Apr-Nov)	–	–	2	4	–	–	3	5	–	–	5	9	–	–	2	2
163	Panhandle FL – Dive Area (Apr-Nov)	–	–	1	3	–	–	4	9	–	–	–	–	–	–	–	–
164	Tampa – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–

Table B-8. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
165	SE FL – Dive Area (Apr-Nov)	–	–	1	4	–	–	5	13	–	–	4	8	–	–	–	–
166	Daytona Beach – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	–
169	East Flower Garden Bank (Apr-Nov)	–	–	–	1	–	–	–	–	–	–	–	2	–	–	1	1
170	West Flower Garden Bank (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	1
171	Chandeleur Islands (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	–	1	–	–	–	–
172	Tortugas Ecological Reserve (North) (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	–
173	Tortugas Ecological Reserve (South) (Apr-Nov)	–	–	1	3	–	1	4	9	–	–	3	6	–	–	–	–
174	Florida Keys National Marine Sanctuary (Apr-Nov)	–	–	2	7	–	1	11	23	–	–	9	16	–	–	–	–

Note: Values of <0.5% are indicated by "–". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure B-1** for the location of Launch Point 7. Refer to **Figures 3-7 through 3-23** for the location of the named areas.

Table B-9

Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup 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 B-9. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup 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

Table B-9. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup 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	
King rail	Marsh/Wading	1	0	0	0	0	0	0	0	1	1	0.00
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

Table B-9. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup 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-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
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

Table B-9. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup 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	
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
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

Table B-9. Birds Collected and Summarized by the U.S. Fish and Wildlife Service: Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup 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. 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
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** (refer to the **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, 2010) 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, 2010).

[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.

Table B-9. Birds Collected and Summarized by the U.S. Fish and Wildlife Service Post-*Deepwater Horizon* Explosion, Oil Spill, and Cleanup in the Gulf of Mexico[1, 2] (continued).

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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, 2005; Ford, 2006; Castege 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 Weise 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 will 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 will 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. 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).

* Corrected values are based on revisiting the original calculations after publication of the 2012-2017 WPA/CPA Multisale EIS. An additional estimate for total mortality based on Piatt and Ford (1996) is also provided.

Table B-10

Federally Listed Avian Species Considered by State and Associated Planning Area in the Gulf of Mexico[1]

Species	Status	Critical Habitat	IUCN Red List Status[2]	States	Planning Area
Red-cockaded Woodpecker	Endangered	No rules published	Vulnerable	AL, FL, LA, MS, TX	WPA, CPA, EPA
Least Tern[3]	Endangered	No rules published	Least Concern	AL, LA, TX (FL, MS)	WPA, CPA, EPA
Piping Plover	Threatened	Designated	Near Threatened	AL, FL, LA, MS, TX	WPA, CPA, EPA
Roseate Tern	Endangered	No rules published	Least Concern	FL only	EPA
Wood Stork	Endangered	No rules published	Least Concern	AL, FL, MS	CPA, EPA
Whooping Crane	Endangered	Designated	Endangered	TX, LA[4], FL[4]	WPA, CPA, EPA
Mississippi Sandhill Crane	Endangered	Designated	Not Yet Assessed	MS only	CPA
Attwater’s Prairie Chicken	Endangered	No rules published	Not Yet Assessed	TX only	WPA
N. Aplomado Falcon	Endangered	No rules published	Not Yet Assessed	TX only	WPA
Mountain Plover	Threatened	NA – proposed threatened	Near Threatened	TX only	WPA
Everglades Snail Kite	Endangered	Designated	Not Yet Assessed	FL only	EPA
Cape Sable Seaside Sparrow	Endangered	Designated	Not Yet Assessed	FL only	EPA
Audubon’s Crested Caracara	Threatened	No rules published	Not Yet Assessed	FL only	EPA
Sprague’s Pipit	Candidate	NA – Priority 2	Vulnerable	LA, TX	WPA, CPA
Bald Eagle	Delisted	No rules published	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Peregrine Falcon	Delisted	Designated	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Eastern Brown Pelican	Delisted	No rules published	Least Concern	AL, FL, LA, MS, TX	WPA, CPA, EPA
Red Knot	Candidate	NA – Priority 3	Least Concern	FL, LA, TX	WPA, CPA, EPA

[1] Information contained in this table was obtained via an email attachment from the U.S. Fish and Wildlife Service (FWS) on April 6, 2012 (USDOI, FWS, 2012) and from FWS’s “Endangered Species” website and associated queries for “species” available from FWS’s website (USDOI, FWS, 2011c). Additional information for each species can be found at:NatureServe Explorer (2011). Note: All species listed in this table are considered, but only the piping plover, roseate tern, whooping crane, wood stork, Mississippi sandhill crane, bald eagle, eastern brown pelican, and red knot will be analyzed.

[2] International Union for Conservation of Nature (IUCN) – The Red List classifies species as imperiled (Critically Endangered, Endangered, or Vulnerable), not imperiled (Near Threatened or Least Concern), extinct (Extinct, Extinct in the Wild), or Data Deficient (Butchart et al., 2004 and 2005; Harris et al., 2012). If species meet the quantitative thresholds of any of the following criteria, they will be added to the Red List: (1) decline in population size; (2) small geographic range; (3) small population size plus decline; (4) very small population size; or (5) quantitative analysis.

[3] The Interior population of the least tern was listed as endangered on May 28, 1985 (*Federal Register*, 1985) throughout much of its breeding range in the Midwest. This designation does not provide or extend Endangered Species Act (ESA) protection to the breeding population of Gulf Coast “population” of least terns. Similarly, ESA protection for breeding least terns only applies to certain segments or areas (inland rivers and lakes ~50 mi [80 km] inland) of Louisiana, Mississippi, and Texas.

[4] The whooping crane is considered endangered throughout its range in the U.S. except where nonessential, experimental flocks have been established. More recently, a release site (White Lake Wetlands Conservation Area, Vermilion Parish) was added in Louisiana (Table 4-14 of the 2012-2017 WPA/CPA Multisale EIS) with a release of 10 birds on February 22, 2011. To date, only 3 of the original 10 released cranes remain; an additional release of 16 cranes occurred on December 1, 2011. The Gulf Coast States that have these nonessential, experimental flocks include Alabama, Louisiana, Mississippi, and Florida; as well, wild whooping cranes may rarely occur as transients in Mississippi and Alabama, but they are not known to breed in either state.

APPENDIX C

BOEM-OSRA CATASTROPHIC RUN

C. 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, long-duration oil spill. Thus, assuming a hypothetical high-volume, long-duration oil spill occurred, this analysis emphasized modeling a spill that continued for 90 consecutive days by launching a spill trajectory every day for 90 days, with each trajectory tracked for up to 60 days. The OSRA for this analysis was conducted for only the trajectories of oil spills from two hypothetical spill locations to various onshore and offshore environmental resources. 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, 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 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 spills might travel on the ocean's surface and what environmental resources might be contacted if and when another catastrophic spill occurs, but it does not provide input on the probability of another catastrophic spill occurring.

Catastrophic OSRA Run Overview

The OSRA model, originally developed by Smith et al. (1982) and enhanced by this Agency over the years (Ji et al., 2002, 2004a, and 2004b), simulates oil-spill transport using model-simulated winds and ocean currents in the Gulf of Mexico. An oil spill on the ocean surface is moved around by the complex surface ocean currents exerting a shear force on the spilled oil from below. In addition, the prevailing wind exerts an additional shear force on the spill from above, and the combination of the two forces causes the transportation of the oil spill 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. The model calculates the movement of hypothetical spills by successively integrating time sequences of two spatially gridded input fields: the surface ocean currents and the sea-level winds. Thus, the OSRA model generates time sequences of hypothetical oil-spill locations—essentially, oil-spill trajectories.

At each successive time step, the OSRA model compares the location of the hypothetical spills against the geographic boundaries of onshore and offshore environmental resources. Resource locations are the same as for the typical OSRA run, as shown in **Figures 3-7 through 3-23**. The frequencies of oil-spill contact are computed for designated oil-spill travel times (e.g., 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 to resources from the two launch points (LP) in the Eastern Planning Area (**Figure C-1**), which are explained below.

The trajectories simulated by the OSRA model represent only hypothetical pathways of oil slicks; they do not involve any direct consideration of cleanup, dispersion, or weathering processes that could alter the quantity or properties of oil that might eventually contact the environmental resource locations. However, an implicit analysis of weathering and spill degradation can be considered by choosing a travel time for the simulated oil spills when they contact environmental resource locations 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 (one in each season from 1993 to1995), 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 longest time that oil from a catastrophic spill could persist floating on the surface. For comparison, 19 days was the calculated persistence time of *Deepwater Horizon* oil on the water's surface (**Chapter 3.2.1.4.4)**, and a 30-day catastrophic OSRA run has previously been used to simulate that particular spill event which occurred in spring through early summer (Ji et al., 2011).

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 superposing on that an empirical wind-induced drift of the hypothetical oil spills (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. The winds and currents are assumed to be statistically similar to those that will occur in the Gulf 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 will 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.

Another portion of the OSRA model tabulates the contacts by the simulated oil spills. A contact to shore will stop the trajectory of an oil spill; no re-washing is assumed in this model. After specified periods of time, the OSRA model will divide the total number of contacts to the environmental resources by the total number of simulated oil spills from each of the two LP's. These ratios are the estimated probabilities of oil-spill contact from offshore activities at that geographic location, assuming spill occurrence.

Conducting an oil-spill risk analysis needs detailed information on ocean currents and wind fields (Ji, 2004). The ocean currents used are numerically computed from an ocean circulation model of the Gulf of Mexico 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 models used are versions of the Princeton Ocean Model, which is an enhanced version of the earlier constructed Mellor-Blumberg Model.

The ocean model calculation was performed by Princeton University (Oey, 2005 and 2008). This simulation covered the 14-year period, 1993 through 2006, and the results were saved 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. 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 every 1.0 day from each of the launch points over the 14-year simulation period from January 1, 1993, to December 31, 2006 (**Figure C-1**). 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 1.0 day.

Several launch points were previously developed for the Western and Central Planning Areas (labeled LP 1-5) (USDOI, BOEM, 2012). The following launch point locations (LP 6-7) were developed for the Eastern Planning Area for the purpose of this analysis. Two launch points were identified, the first based on the approximate area with the possibility of finding the largest oil volume in the Eastern Planning Area and the second at the southernmost point of the planning area to look at increased Loop Current effects (**Figure C-1**):

Description	Longitude	Latitude	Launch Point (LP)
Eastern Planning Area (based on oil resource potential)	-86.75761	27.95762	6
Eastern Planning Area (southernmost point)	-86.70000	26.90000	7

The methodology used for launch point selection is not part of the OSRA model in the manner it has been typically run for this Agency's spill analyses. Gulf of Mexico OCS Region geologists and engineers used the following methodology to select LP 6. 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 are used to identify the geographic area where the potential for large undiscovered oil volumes are thought to exist. Due to the very limited number of OCS tracts offered in the proposed lease sale area, the statistical analysis described above was supplemented by an area-specific subsurface geological and geophysical data reconnaissance and interpretation. After LP 6 was selected, it was given to the OSRA analysts for use with the OSRA model.

Based on the weathering analyses (described above), individual OSRA model trajectories were analyzed up to 60 days, and any spill contacts occurring during this elapsed time are reported in the probability tables (**Tables C-1 through C-4**). Conditional probabilities of contact with environmental resources within 60 days of travel time were calculated for each of the hypothetical spill sites. The probability estimates were tabulated as 90-day groupings of the 60-day trajectories, as averages for the 14 years of the analysis from 1993 through 2006. These groupings were treated as seasonal probabilities that corresponded with quarters of the year: Winter, Q1 (January, February, and March); Spring, Q2 (April, May, and June); Summer, Q3 (July, August, and September); and Fall, Q4 (October, November, and December). These 3-month probabilities can be used to estimate the average contact with environmental resources during a spill, treated as one spill occurring each day for 90 days, within the quarter. The seasonal quarterly groupings take account of the differing meteorological and oceanographic conditions (wind and current patterns) during the year.

Catastrophic OSRA Results and Discussion

It should be noted that the study area only extends part way into the Atlantic Ocean, where oil spills in the Gulf might be transported via the exiting Loop Current. Both of the launch points are located relatively far offshore, and the trajectories are influenced by offshore winds and currents, including the deepwater Loop Current and associated eddies. As seen in **Figure C-1**, there is a differential influence of the Loop Current on the two launch points, with LP 6 and LP 7 associated 5-10 percent and ~30 percent of the time, respectively, with the Loop Current watermass (Vukovich, 2007). As noted, LP 7 was specifically chosen to estimate the increased effects of the Loop Current on trajectories at the southern extreme of the planning area. As expected, the hypothetical spill trajectories from LP 6 have a smaller chance of being transported through the Florida Straits than those from LP 7 (**Figures C-2 through C-5**). Based on an annual average, a maximum of 2 percent from LP 6 was estimated in the Florida Straits within 30 days, and 5 percent within 60 days. By comparison, a maximum of 5 percent from LP 7 was estimated in the Florida Straits within 30 days, and 10 percent within 60 days.

A comparison of the seasonal conditional probability figures shows some interesting differences in transport patterns (**Figures C-2 through C-5**). For example, the spring season has the lowest estimated conditional probabilities in the western Gulf of Mexico. In part, this is due to seasonal changes in winds. Monthly climatologies of wind stress for the Gulf of Mexico demonstrate that winds are generally out of the east for most of the year, except during the spring months (April, May, and June) when the winds shift towards the northwest (Rhodes et al., 1989). This change in winds during the spring confines spill trajectories from LP 6 and LP 7 more to the eastern Gulf, in contrast to the winter, summer, and fall seasons. It is also interesting to note that the fall season's trajectories are generally the least likely of all seasons to contact surface waters off the east coast of Florida. One explanation for this is that winds are strongest out of the west over the launch points during the fall months of October, November, and December (Rhodes et al., 1989), effectively moving surface oil towards the western Gulf and away from the Loop Current.

As one might expect, environmental resources closest to the spill sites typically had the greatest risk of contact. As the model run duration increases, more of the resources could have meaningful probabilities of contact (≥0.5%). (Refer to **Tables C-1 through C-4** for the probabilities expressed as percent chance of one or more offshore spills ≥1,000 bbl contacting the areas noted in **Figures 3-7 through 3-23**). 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 environmental resources and the shoreline from more distant spill locations. With increased travel time, the complex patterns of wind and ocean currents produce eddy-like motions of the oil spills and multiple opportunities for a spill to make contact with shoreline segments. 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 because the trajectories that have not contacted land within 30 days will remain at sea for 60 days or more.

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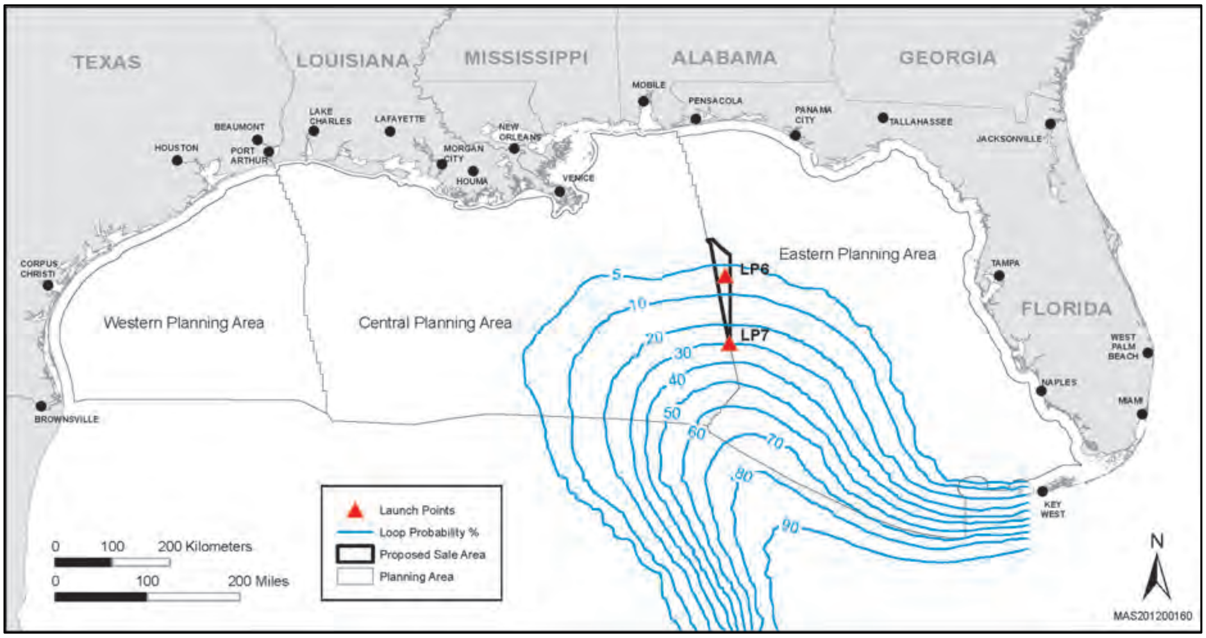

Figure C-1. Location of Two Hypothetical Oil-Spill Launch Points for OSRA within the Study Area. (Spatial variability of the Loop Current is from Vukovich [2007] and is shown as percent of time that the Loop Current watermass is associated with a particular location.)

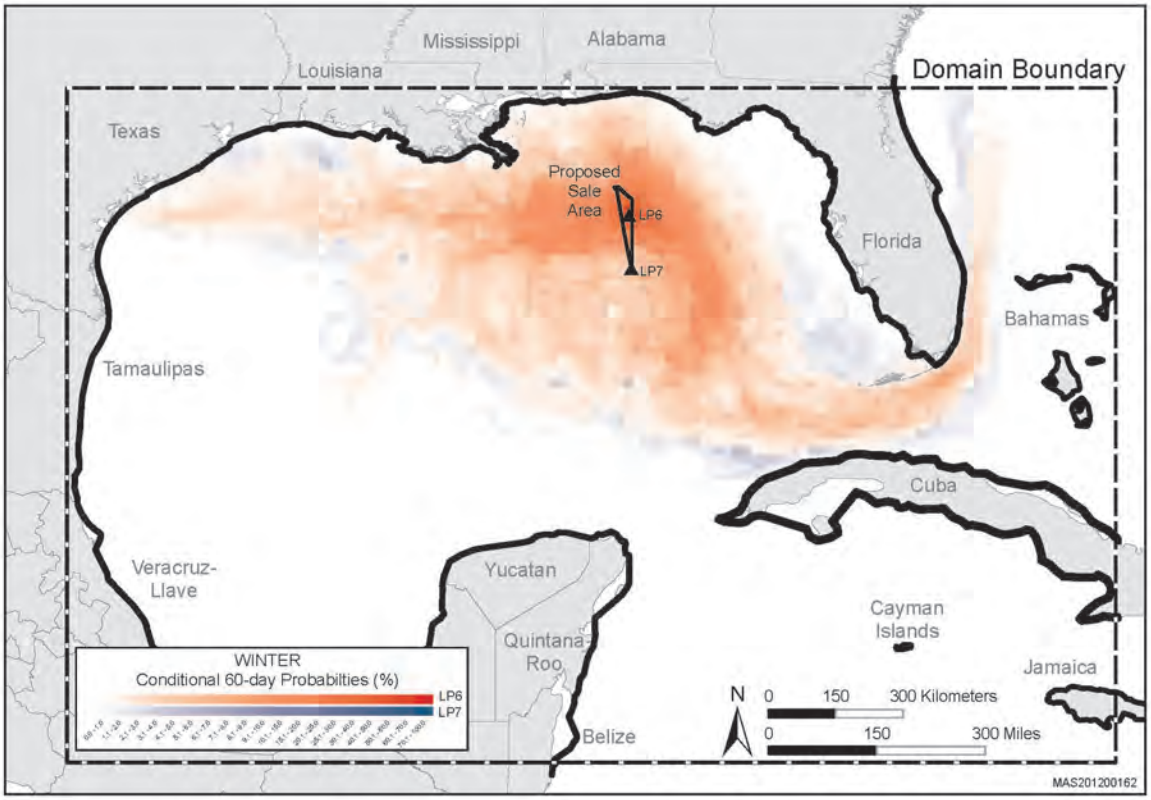

Figure C-2. Winter Season (January, February, and March) Conditional Probabilities for Launch Point Six (LP 6) Overlaid on Launch Point Seven (LP 7) to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

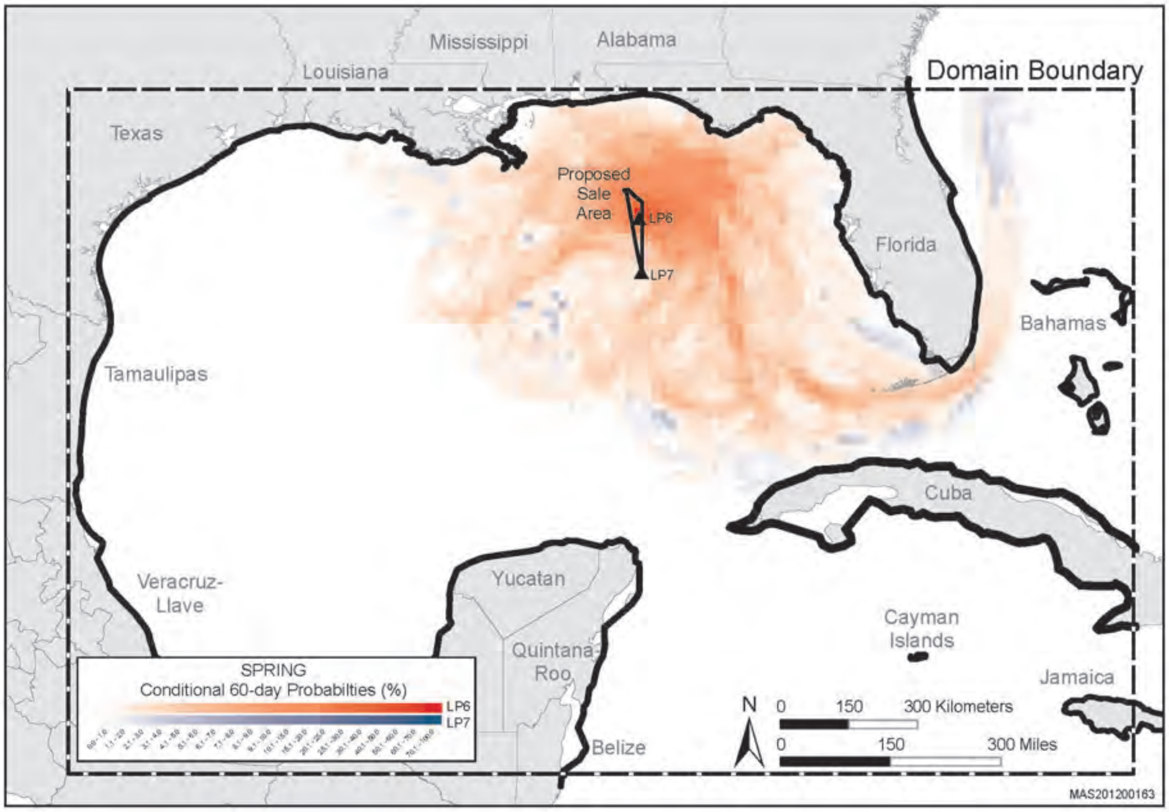

Figure C-3. Spring Season (April, May, and June) Conditional Probabilities for Launch Point Six (LP 6) overlaid on Launch Point Seven (LP 7) to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

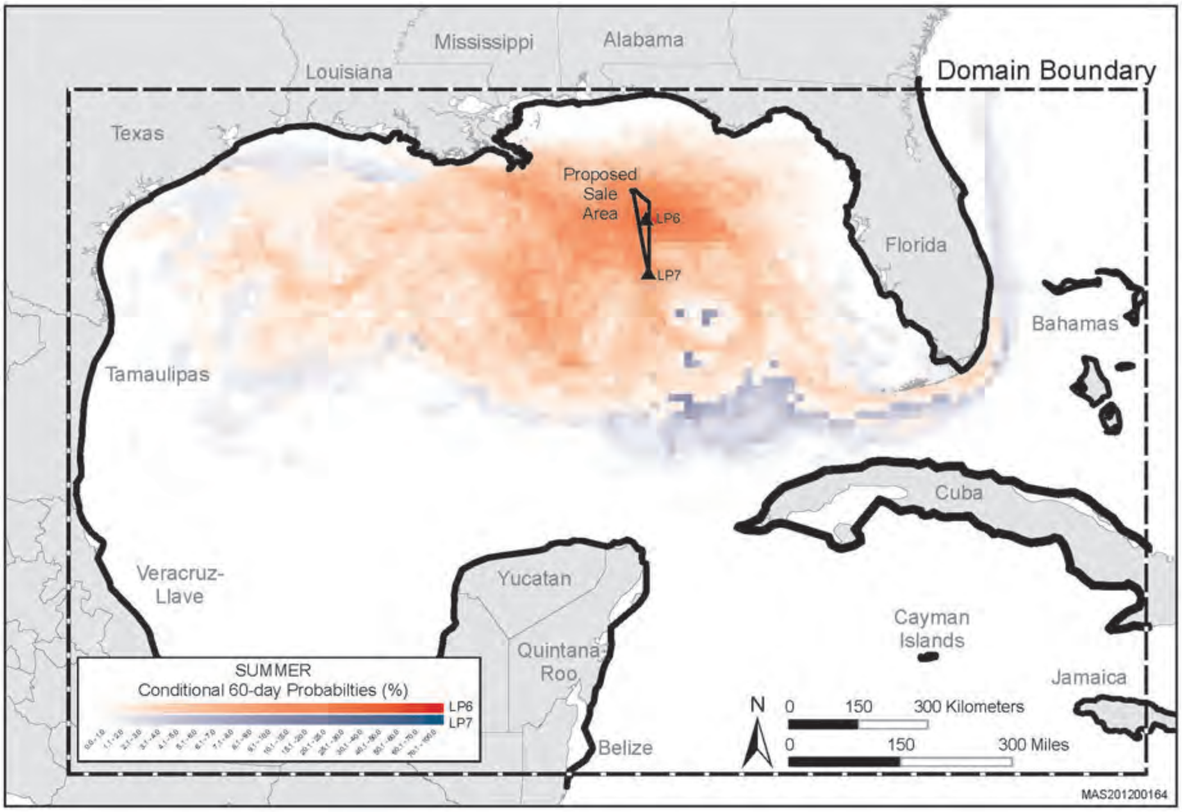

Figure C-4. Summer Season (July, August, and September) Conditional Probabilities for Launch Point Six (LP 6) Overlaid on Launch Point Seven (LP 7) to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

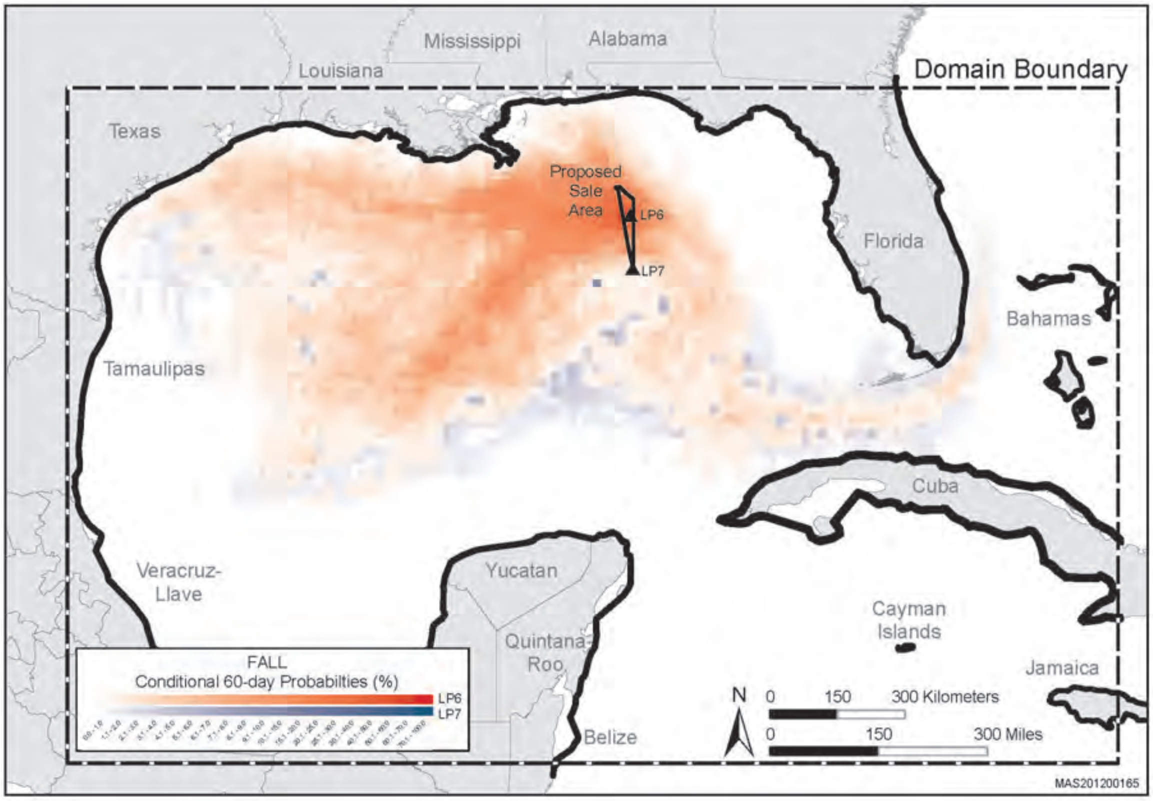

Figure C-5. Fall Season (October, November, and December) Conditional Probabilities for Launch Point Six (LP 6) Overlaid on Launch Point Seven (LP 7) to Estimate the Impacts of a Low-Probability, Catastrophic Spill Event. (Note: The assumption [condition] associated with a conditional probability is that a spill is assumed to have occurred.)

Table C-1

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Onshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
3	Kenedy, TX	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1
5	Nueces, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
7	Calhoun, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
8	Matagorda, TX	–	–	–	3	–	–	–	–	–	–	–	2	–	–	–	2
9	Brazoria, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
10	Galveston, TX	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	2
12	Jefferson, TX	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
13	Cameron, LA	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
14	Vermilion, LA	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
15	Iberia, LA	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
17	Terrebonne, LA	–	–	1	3	–	–	1	2	–	–	2	3	–	–	1	2
18	Lafourche, LA	–	–	1	2	–	–	1	1	–	–	1	2	–	–	1	2
19	Jefferson, LA	–	–	1	1	–	–	1	1	–	–	–	–	–	–	1	1
20	Plaquemines, LA	–	–	3	5	–	–	2	4	–	1	8	11	–	1	4	6
21	St. Bernard, LA	–	–	–	1	–	–	1	1	–	–	2	3	–	–	–	–
23	Harrison, MS	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
24	Jackson, MS	–	–	–	1	–	–	1	1	–	–	–	–	–	–	–	1
25	Mobile, AL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
26	Baldwin, AL	–	–	–	1	–	–	2	2	–	–	–	–	–	–	–	1
27	Escambia, FL	–	–	1	2	–	–	2	3	–	–	–	–	–	–	–	–
29	Okaloosa, FL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
30	Walton, FL	–	–	1	1	–	–	2	3	–	–	–	–	–	–	–	–

Table C-1. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
31	Bay, FL	–	–	–	1	–	–	3	5	–	–	–	–	–	–	–	–
32	Gulf, FL	–	–	–	–	–	–	3	3	–	–	–	–	–	–	–	–
33	Franklin, FL	–	–	–	1	–	–	2	4	–	–	–	1	–	–	–	–
36	Taylor, FL	–	–	–	–	–	–	1	4	–	–	–	–	–	–	–	–
37	Dixie, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
38	Levy, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
39	Citrus, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
40	Hernando, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
41	Pasco, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
42	Pinellas, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
47	Lee, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
49	Monroe, FL	–	–	1	3	–	–	–	1	–	–	–	1	–	–	–	1
50	Dade, FL	–	–	–	2	–	–	–	1	–	–	–	1	–	–	–	–
51	Broward, FL	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
52	Palm Beach, FL	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
62	TX	–	–	–	9	–	–	–	–	–	–	–	10	–	–	1	10
63	LA	–	–	6	16	–	–	5	11	–	2	14	22	–	1	7	13
64	MS	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	1
65	AL	–	–	–	2	–	–	3	4	–	–	–	1	–	–	1	1
66	FL	–	–	4	13	–	–	15	34	–	–	2	7	–	–	1	2
67	Tamaulipas, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
68	Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
74	Cuba	–	–	1	3	–	–	–	–	–	–	–	1	–	–	1	4
87	West Indian Manatee Habitat	–	–	4	13	–	–	15	34	–	–	2	7	–	–	1	2
88	West Indian Sporadic Habitat (Apr-Oct)	–	–	1	3	–	–	5	8	–	–	3	4	–	–	–	–

Table C-1. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
89	West Indian Rare Habitat (Apr-Oct)	–	–	2	12	–	–	5	11	–	2	12	24	–	1	2	2
90	Alabama Beach Mouse Habitat	–	–	–	1	–	–	2	2	–	–	–	–	–	–	–	1
91	Perdido Key Beach Mouse Habitat	–	–	1	4	–	–	3	5	–	–	–	1	–	–	–	1
92	Santa Rosa Beach Mouse Habitat	–	–	1	2	–	–	1	2	–	–	–	–	–	–	–	–
93	Choctawhatchee Beach Mouse Habitat	–	–	2	2	–	–	6	10	–	–	–	1	–	–	–	–
94	St. Andrew Beach Mouse Habitat	–	–	–	1	–	–	5	8	–	–	–	1	–	–	–	–
95	Southeastern Beach Mouse Habitat	–	–	1	3	–	–	–	1	–	–	–	2	–	–	–	1
97	Smalltooth Sawfish Critical Habitat	–	–	1	4	–	–	–	2	–	–	–	1	–	–	–	1
99	Gulf Sturgeon Critical Habitat	–	–	4	9	–	–	17	28	–	–	3	6	–	–	1	3
100	Gulf Sturgeon Habitat	–	–	5	13	–	–	20	39	–	1	9	15	–	1	3	6
101	TX Coastal Bend Beach Area	–	–	–	1	–	–	–	–	–	–	–	4	–	–	–	3
102	TX Matagorda Beach Area	–	–	–	4	–	–	–	–	–	–	–	3	–	–	–	3
103	TX Galveston Beach Area	–	–	–	3	–	–	–	–	–	–	–	2	–	–	–	3
104	TX Sea Rim State Park	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
105	LA Beach Areas	–	–	1	4	–	–	2	4	–	–	1	4	–	–	2	3
106	AL/MS Gulf Islands	–	–	–	2	–	–	2	4	–	–	–	1	–	–	1	1
107	AL Gulf Shores	–	–	–	1	–	–	2	2	–	–	–	–	–	–	–	1
108	FL Panhandle Beach Area	–	–	3	5	–	–	12	20	–	–	–	2	–	–	–	–
109	FL Big Bend Beach Area	–	–	–	–	–	–	2	9	–	–	–	1	–	–	–	–
110	FL Southwest Beach Area	–	–	–	–	–	–	–	2	–	–	1	1	–	–	–	–
111	FL Ten Thousand Islands Area	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
112	FL Southeast Beach Area	–	–	1	6	–	–	–	3	–	–	–	3	–	–	1	2

Note: Values of <0.5% are indicated by "–". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure C-1** for the location of Launch Point Six. Refer to **Figures 3-7 through 3-23** for the locations of the named areas.

Table C-2

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6
Will Contact a Certain Offshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
2	Northwest Bahamas	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
8	TX State Waters	–	–	–	10	–	–	–	1	–	–	1	11	–	–	1	10
9	West LA State Waters	–	–	6	14	–	–	5	10	–	1	8	15	–	1	6	13
10	East LA State Waters	–	–	3	5	–	–	2	5	–	1	8	11	–	1	3	4
11	MS State Waters	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	1
12	AL State Waters	–	–	1	2	–	–	3	5	–	–	–	1	–	–	1	2
13	FL Panhandle State Waters	–	–	3	7	–	–	15	22	–	–	1	2	–	–	1	1
14	West FL State Waters	–	–	3	8	–	–	8	24	–	–	3	7	–	–	–	1
15	Tortugas State Waters	–	–	2	5	–	–	2	6	–	–	–	3	–	–	–	1
16	Southeast FL State Waters	–	–	3	10	–	–	1	5	–	–	1	4	–	–	1	2
17	Northeast FL State Waters	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
18	Mexican State Waters	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
31	Nearshore Seafloor (0-20 m), “N1”	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
32	Nearshore Seafloor (0-20 m), “N2”	–	–	–	4	–	–	–	–	–	–	–	7	–	–	1	4
33	Nearshore Seafloor (0-20 m), “N3”	–	–	–	9	–	–	–	–	–	–	–	6	–	–	2	10
34	Nearshore Seafloor (0-20 m), “N4”	–	–	2	8	–	–	1	3	–	–	3	6	–	–	5	9
35	Nearshore Seafloor (0-20 m), “N5”	–	–	7	15	–	–	6	8	–	1	10	18	–	2	9	14
36	Nearshore Seafloor (0-20 m), “N6”	–	–	3	5	–	–	3	5	–	1	8	11	–	1	3	4
37	Nearshore Seafloor (0-20 m), “N7”	–	–	2	4	–	–	3	5	–	–	3	3	–	–	2	3
38	Nearshore Seafloor (0-20 m), “N8”	–	–	1	3	–	–	4	6	–	–	1	1	–	–	1	2

Table C-2. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
39	Nearshore Seafloor (0-20 m), “N9”	–	–	3	6	–	–	15	22	–	–	1	2	–	–	–	1
40	Nearshore Seafloor (0-20 m), “N10”	–	–	–	1	–	–	6	16	–	–	2	4	–	–	–	–
41	Nearshore Seafloor (0-20 m), “N11”	–	–	1	3	–	–	1	6	–	–	2	3	–	–	–	–
42	Nearshore Seafloor (0-20 m), “N12”	–	–	5	13	–	–	4	13	–	–	2	7	–	–	1	2
43	Nearshore Seafloor (0-20 m), “N13”	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
44	Nearshore Seafloor (0-20 m), “N14”	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
45	Nearshore Seafloor (0-20 m), “N15” - Tortugas	–	–	1	3	–	–	1	3	–	–	–	2	–	–	–	–
46	Shelf Seafloor (20-300 m), “S1”	–	–	–	5	–	–	–	–	–	–	1	10	–	–	1	7
47	Shelf Seafloor (20-300 m), “S2”	–	–	1	13	–	–	–	–	–	–	2	13	–	–	5	15
48	Shelf Seafloor (20-300 m), “S3”	–	–	8	20	–	–	1	3	–	–	7	16	–	–	14	19
49	Shelf Seafloor (20-300 m), “S4”	–	1	17	28	–	–	7	11	–	3	18	29	–	6	24	30
50	Shelf Seafloor (20-300 m), “S5”	–	–	5	9	–	–	3	6	–	2	10	15	–	2	6	8
51	Shelf Seafloor (20-300 m), “S6”	–	–	6	10	–	1	6	9	–	3	9	13	–	2	7	8
52	Shelf Seafloor (20-300 m), “S7”	–	1	6	10	–	3	12	16	–	2	7	8	–	2	9	11
53	Shelf Seafloor (20-300 m), “S8”	1	7	14	18	–	18	40	47	–	3	11	15	–	1	8	9
54	Shelf Seafloor (20-300 m), “S9”	–	10	18	21	–	13	37	45	–	7	21	24	–	1	3	4
55	Shelf Seafloor (20-300 m), “S10”	–	2	14	20	–	–	13	24	–	–	10	16	–	–	3	4
56	Shelf Seafloor (20-300 m), “S11”	–	–	7	14	–	–	5	14	–	–	2	7	–	–	1	3
57	Shelf Seafloor (20-300 m), “S12”	–	–	4	13	–	–	2	10	–	–	1	6	–	–	1	4
58	Shelf Seafloor (20-300 m), “S13”	–	–	–	3	–	–	–	2	–	–	–	2	–	–	–	1
59	Shelf Seafloor (20-300 m), “S14”	–	–	–	2	–	–	–	2	–	–	–	1	–	–	–	1
60	Deepwater Seafloor (300 m–Outer Jurisdiction), “D1”	–	–	–	5	–	–	–	–	–	–	1	9	–	–	2	8
61	Deepwater Seafloor (300 m–Outer Jurisdiction), “D2”	–	–	–	4	–	–	–	–	–	–	1	10	–	–	2	9

Table C-2. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
62	Deepwater Seafloor (300 m–Outer Jurisdiction), "D3"	–	–	1	7	–	–	–	–	–	–	2	11	–	–	3	10
63	Deepwater Seafloor (300 m–Outer Jurisdiction), "D4"	–	–	1	7	–	–	–	–	–	–	5	14	–	–	4	14
64	Deepwater Seafloor (300 m–Outer Jurisdiction), "D5"	–	–	1	6	–	–	–	–	–	–	5	11	–	–	3	11
65	Deepwater Seafloor (300 m–Outer Jurisdiction), "D6"	–	–	3	12	–	–	–	–	–	–	5	13	–	–	9	15
66	Deepwater Seafloor (300 m–Outer Jurisdiction), "D7"	–	–	4	12	–	–	–	1	–	–	7	16	–	–	9	18
67	Deepwater Seafloor (300 m–Outer Jurisdiction), "D8"	–	–	3	10	–	–	–	1	–	–	9	15	–	–	9	20
68	Deepwater Seafloor (300 m–Outer Jurisdiction), "D9"	–	1	10	19	–	–	1	3	–	–	8	14	–	1	14	18
69	Deepwater Seafloor (300 m–Outer Jurisdiction), "D10"	–	1	11	20	–	–	3	6	–	–	13	22	–	2	17	25
70	Deepwater Seafloor (300 m–Outer Jurisdiction), "D11"	–	–	8	16	–	–	3	6	–	1	14	22	–	3	20	32
71	Deepwater Seafloor (300 m–Outer Jurisdiction), "D12"	–	2	19	29	–	–	8	12	–	4	18	28	–	11	31	37
72	Deepwater Seafloor (300 m–Outer Jurisdiction), "D13"	–	6	25	34	–	1	10	14	–	5	22	33	–	17	36	42
73	Deepwater Seafloor (300 m–Outer Jurisdiction), "D14"	–	4	20	31	–	2	11	15	–	7	24	35	–	17	41	49
74	Deepwater Seafloor (300 m–Outer Jurisdiction), "D15"	–	2	13	19	–	3	14	18	–	7	19	27	–	8	20	25
75	Deepwater Seafloor (300 m–Outer Jurisdiction), "D16"	–	14	36	43	–	7	21	26	1	16	35	48	1	36	56	61
76	Deepwater Seafloor (300 m–Outer Jurisdiction), "D17"	2	30	53	61	–	14	27	32	4	28	51	66	13	62	79	85
77	Deepwater Seafloor (300 m–Outer Jurisdiction), "D18"	10	35	49	53	3	21	34	37	10	30	47	56	29	65	73	77

Table C-2. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
78	Deepwater Seafloor (300 m–Outer Jurisdiction), “D19”	47	57	66	68	30	41	49	52	38	53	65	71	77	88	92	93
79	Deepwater Seafloor (300 m–Outer Jurisdiction), “D20”	8	23	41	47	5	11	20	26	5	21	35	44	9	26	35	43
80	Deepwater Seafloor (300 m–Outer Jurisdiction), “D21”	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
81	Deepwater Seafloor (300 m–Outer Jurisdiction), “D22”	37	49	54	56	48	66	73	76	30	41	47	51	16	26	32	32
82	Deepwater Seafloor (300 m–Outer Jurisdiction), “D23”	11	26	38	40	8	30	39	44	8	27	37	39	2	6	10	13
83	Deepwater Seafloor (300 m–Outer Jurisdiction), “D24”	36	52	64	67	37	47	56	58	44	55	62	63	14	26	38	43
84	Deepwater Seafloor (300 m–Outer Jurisdiction), “D25”	–	3	21	29	–	1	15	20	–	1	9	15	–	–	6	10
85	Deepwater Seafloor (300 m–Outer Jurisdiction), “D26”	–	10	28	35	–	5	17	21	–	3	11	16	–	3	14	20
86	Deepwater Seafloor (300 m–Outer Jurisdiction), “D27”	–	–	9	18	–	–	5	13	–	–	2	8	–	–	2	6
87	Deepwater Seafloor (300 m–Outer Jurisdiction), “D28”	–	–	4	12	–	–	2	8	–	–	1	4	–	–	1	4
88	Deepwater Seafloor (300 m–Outer Jurisdiction), “D29”	–	–	1	5	–	–	1	5	–	–	–	1	–	–	–	2
89	Deepwater Seafloor (300 m–Outer Jurisdiction), “D30”	–	–	–	4	–	–	1	4	–	–	–	1	–	–	–	1
90	North Atlantic Right Whale Critical Habitat	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
92	*Sargassum* (March/April)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
94	*Sargassum* (July/August)	–	–	–	–	1	1	1	1	66	66	66	66	–	–	–	–
95	Seagrass-Wakulla County	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
96	Seagrass-Jefferson County	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
97	Seagrass-Taylor County	–	–	–	–	–	–	2	5	–	–	–	–	–	–	–	–

Table C-2. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
98	Seagrass-Dixie County	–	–	–	–	–	–	1	3	–	–	–	–	–	–	–	–
99	Seagrass-Levy County	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
111	Topographic Features (32 Fathom Bank)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
113	Topographic Features (Claypile Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
115	Topographic Features (Coffee Lump Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	2
116	East Flower Garden Bank	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	1
117	West Flower Garden Bank	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
118	Topographic Features (MacNeil Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
119	Topographic Features (29 Fathom Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
121	Topographic Features (Rankin-2 Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
122	Topographic Features (Bright Bank)	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
123	Topographic Features (Geyer Bank)	–	–	–	2	–	–	–	–	–	–	–	1	–	–	–	1
124	Topographic Features (Elvers Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
125	Topographic Features (McGrail Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1
126	Topographic Features (Sonnier Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
127	Topographic Features (Bouma Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
128	Topographic Features (Rezak Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
129	Topographic Features (Sidner Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
130	Topographic Features (Parker Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	2
131	Topographic Features (Alderdice Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
135	Topographic Features (Ewing-1 Bank)	–	–	1	1	–	–	–	–	–	–	1	1	–	–	2	2
136	Topographic Features (Ewing-2 Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
137	Topographic Features (Diaphus Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	1

Table C-2. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
138	Topographic Features (Sackett Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
139	Pinnacle Trend	–	1	6	9	–	3	11	14	–	1	6	8	–	2	8	10
140	Chandeleur Islands	–	–	2	3	–	–	2	3	–	–	3	5	–	–	1	2
141	Florida Middle Ground	–	–	1	2	–	–	5	8	–	–	2	4	–	–	–	–
142	Pulley Ridge	–	1	6	11	–	–	6	13	–	–	3	8	–	–	1	2
143	Madison Swanson	–	–	2	3	–	1	9	11	–	–	1	2	–	–	–	1
144	Steamboat Lumps	–	1	2	3	–	1	4	6	–	–	2	3	–	–	–	–
145	Dry Tortugas	–	–	1	3	–	–	1	3	–	–	–	2	–	–	–	–
146	Tortugas Ecological Reserve (North)	–	–	1	3	–	–	1	2	–	–	–	2	–	–	–	–
147	Tortugas Ecological Reserve (South)	–	–	3	6	–	–	3	6	–	–	1	3	–	–	1	1
148	Florida Keys National Marine Sanctuary	–	–	7	15	–	–	5	14	–	–	2	8	–	–	1	3
149	FL State Waters (both East Coast and Gulf)	–	–	2	5	–	–	2	6	–	–	–	3	–	–	–	1
150	Key Biscayne National Park	–	–	1	2	–	–	–	1	–	–	–	1	–	–	–	1
151	Texas Clipper and South Texas Platform – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1
152	Port Lavaca/Liberty Ship Reef – Dive Area (Apr-Nov)	–	–	–	2	–	–	–	–	–	–	–	3	–	–	–	4
153	High Island – Dive Area (Apr-Nov)	–	–	–	2	–	–	–	–	–	–	–	1	–	–	1	3
154	West Cameron – Dive Area (Apr-Nov)	–	–	–	3	–	–	–	–	–	–	–	4	–	–	3	5
156	Cognac Platform (Block MC 194) - Dive Area (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	1	2	–	–	1	1
157	Horseshoe Rigs (Block MP 306) - Dive Area (Apr-Nov)	–	–	–	1	–	–	1	1	–	–	1	2	–	–	–	–
158	Vermilion Area - Dive Area (Apr-Nov)	–	–	–	3	–	–	1	2	–	–	1	6	–	–	4	5
159	Vermilion Area, South Addition – Dive Area (Apr-Nov)	–	–	1	3	–	–	–	–	–	–	3	9	–	–	7	8

Table C-2. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 6 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
160	Bay Marchand – Dive Area (Apr-Nov)	–	–	–	–	–	–	1	1	–	–	1	1	–	–	–	–
161	South Timbalier – Dive Area (Apr-Nov)	–	–	2	5	–	–	4	5	–	–	7	13	–	1	5	5
162	South Timbalier Area, South Addition – Dive Area (Apr-Nov)	–	–	1	4	–	–	2	3	–	–	5	8	–	1	8	9
163	Panhandle FL – Dive Area (Apr-Nov)	–	–	4	7	–	2	19	25	–	–	2	3	–	–	–	–
164	Tampa – Dive Area (Apr-Nov)	–	–	–	1	–	–	1	3	–	–	1	2	–	–	–	–
165	SE FL – Dive Area (Apr-Nov)	–	–	–	2	–	–	1	7	–	–	1	4	–	–	–	–
166	Daytona Beach – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
169	East Flower Garden Bank (Apr-Nov)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
170	West Flower Garden Bank (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
171	Chandeleur Islands (Apr-Nov)	–	–	1	2	–	–	2	3	–	–	3	5	–	–	–	–
172	Tortugas Ecological Reserve (North) (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	–
173	Tortugas Ecological Reserve (South) (Apr-Nov)	–	–	–	2	–	–	3	6	–	–	1	3	–	–	–	–
174	Florida Keys National Marine Sanctuary (Apr-Nov)	–	–	1	5	–	–	5	14	–	–	2	8	–	–	–	–

Note: Values of <0.5% are indicated by "–". Values of >99.5% are indicated by "*". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure C-1** for the location of Launch Point Six. Refer to **Figures 3-7 through 3-23** for the locations of the named areas.

Table C-3

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7
Will Contact a Certain Onshore Environmental Resource within 60 Days.

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
1	Cameron, TX	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
3	Kenedy, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
4	Kleberg, TX	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
5	Nueces, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
6	Aransas, TX	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
7	Calhoun, TX	–	–	–	1	–	–	–	–	–	–	–	2	–	–	–	–
8	Matagorda, TX	–	–	–	2	–	–	–	1	–	–	–	3	–	–	–	2
9	Brazoria, TX	–	–	–	1	–	–	–	–	–	–	–	2	–	–	–	1
10	Galveston, TX	–	–	–	3	–	–	–	–	–	–	1	2	–	–	–	1
12	Jefferson, TX	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
13	Cameron, LA	–	–	–	1	–	–	–	1	–	–	–	2	–	–	–	–
14	Vermilion, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
15	Iberia, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
17	Terrebonne, LA	–	–	1	2	–	–	1	2	–	–	1	2	–	–	1	1
18	Lafourche, LA	–	–	–	1	–	–	1	2	–	–	1	3	–	–	–	–
19	Jefferson, LA	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
20	Plaquemines, LA	–	–	1	3	–	–	2	3	–	–	2	3	–	–	2	2
21	St. Bernard, LA	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
25	Mobile, AL	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
26	Baldwin, AL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
27	Escambia, FL	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
30	Walton, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–

Table C-3. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
31	Bay, FL	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
32	Gulf, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
33	Franklin, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
36	Taylor, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
37	Dixie, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
41	Pasco, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
42	Pinellas, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
47	Lee, FL	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
49	Monroe, FL	–	–	2	4	–	–	1	3	–	–	1	2	–	–	1	1
50	Dade, FL	–	–	2	4	–	–	1	2	–	–	1	3	–	–	1	2
51	Broward, FL	–	–	–	2	–	–	–	1	–	–	1	1	–	–	–	1
52	Palm Beach, FL	–	–	1	2	–	–	–	1	–	–	–	1	–	–	–	1
62	TX	–	–	–	11	–	–	1	2	–	–	2	12	–	–	1	7
63	LA	–	–	3	9	–	–	6	12	–	–	5	11	–	–	3	4
64	MS	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
65	AL	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	–
66	FL	–	–	7	15	–	–	6	21	–	–	3	9	–	–	2	5
67	Tamaulipas, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
68	Veracruz-Llave, Mexico	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
74	Cuba	–	–	2	4	–	–	–	1	–	–	–	1	–	–	2	5
87	West Indian Manatee Habitat	–	–	7	15	–	–	6	21	–	–	3	9	–	–	2	5
88	West Indian Sporadic Habitat (Apr-Oct)	–	–	–	1	–	–	2	4	–	–	–	1	–	–	–	–
89	West Indian Rare Habitat (Apr-Oct)	–	–	1	12	–	–	7	13	–	–	7	19	–	–	–	–
90	Alabama Beach Mouse Habitat	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
91	Perdido Key Beach Mouse Habitat	–	–	–	1	–	–	2	3	–	–	–	–	–	–	–	–

Table C-3. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Onshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
92	Santa Rosa Beach Mouse Habitat	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
93	Choctawhatchee Beach Mouse Habitat	–	–	–	1	–	–	1	3	–	–	–	–	–	–	–	–
94	St. Andrew Beach Mouse Habitat	–	–	1	1	–	–	1	3	–	–	–	–	–	–	–	–
95	Southeastern Beach Mouse Habitat	–	–	2	4	–	–	1	3	–	–	1	2	–	–	1	2
97	Smalltooth Sawfish Critical Habitat	–	–	3	6	–	–	2	5	–	–	2	4	–	–	1	1
98	Short Nose Sturgeon Habitat (Sep-Mar)	–	–	1	1	–	–	–	–	–	–	–	1	–	–	–	–
99	Gulf Sturgeon Critical Habitat	–	–	1	3	–	–	5	11	–	–	–	1	–	–	–	1
100	Gulf Sturgeon Habitat	–	–	2	5	–	–	5	16	–	–	1	2	–	–	1	1
101	TX Coastal Bend Beach Area	–	–	–	2	–	–	–	–	–	–	–	3	–	–	–	3
102	TX Matagorda Beach Area	–	–	–	3	–	–	–	1	–	–	–	5	–	–	–	2
103	TX Galveston Beach Area	–	–	–	5	–	–	–	1	–	–	1	3	–	–	–	2
104	TX Sea Rim State Park	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
105	LA Beach Areas	–	–	1	2	–	–	2	4	–	–	2	5	–	–	–	–
106	AL/MS Gulf Islands	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	1
107	AL Gulf Shores	–	–	–	–	–	–	1	2	–	–	–	–	–	–	–	–
108	FL Panhandle Beach Area	–	–	1	2	–	–	3	6	–	–	–	–	–	–	–	–
109	FL Big Bend Beach Area	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–
110	FL Southwest Beach Area	–	–	–	1	–	–	–	3	–	–	–	1	–	–	–	–
111	FL Ten Thousand Islands Area	–	–	–	1	–	–	1	1	–	–	–	1	–	–	–	–
112	FL Southeast Beach Area	–	–	5	10	–	–	2	7	–	–	3	6	–	–	2	4
113	FL Central East Beach Area	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
114	FL Northeast Beach Area	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–

Note: Values of <0.5% are indicated by "–". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure C-1** for the location of Launch Point Six. Refer to **Figures 3-7 through 3-23** for the locations of the named areas.

Table C-4

Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7
Will Contact a Certain Offshore Environmental Resource within 60 Days

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
8	TX State Waters	–	–	–	13	–	–	1	2	–	–	2	14	–	–	1	6
9	West LA State Waters	–	–	3	9	–	–	7	12	–	–	6	12	–	–	3	5
10	East LA State Waters	–	–	1	2	–	–	1	3	–	–	1	2	–	–	1	1
11	MS State Waters	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
12	AL State Waters	–	–	–	1	–	–	2	3	–	–	–	–	–	–	–	–
13	FL Panhandle State Waters	–	–	1	3	–	–	4	8	–	–	–	–	–	–	–	–
14	West FL State Waters	–	–	6	12	–	1	8	22	–	–	4	9	–	–	1	3
15	Tortugas State Waters	–	–	3	7	–	–	2	6	–	–	2	4	–	–	–	1
16	Southeast FL State Waters	–	–	6	14	–	–	4	12	–	–	5	10	–	–	2	5
17	Northeast FL State Waters	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	1
18	Mexican State Waters	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
31	Nearshore Seafloor (0-20 m), “N1”	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
32	Nearshore Seafloor (0-20 m), “N2”	–	–	–	4	–	–	–	–	–	–	–	6	–	–	1	3
33	Nearshore Seafloor (0-20 m), “N3”	–	–	1	10	–	–	1	2	–	–	2	9	–	–	1	6
34	Nearshore Seafloor (0-20 m), “N4”	–	–	2	7	–	–	3	5	–	–	4	8	–	–	1	2
35	Nearshore Seafloor (0-20 m), “N5”	–	–	4	9	–	–	7	10	–	–	7	15	–	–	4	5
36	Nearshore Seafloor (0-20 m), “N6”	–	–	–	2	–	–	2	3	–	–	1	2	–	–	1	1
37	Nearshore Seafloor (0-20 m), “N7”	–	–	–	1	–	–	2	3	–	–	–	1	–	–	1	1
38	Nearshore Seafloor (0-20 m), “N8”	–	–	–	1	–	–	2	3	–	–	–	–	–	–	–	1
39	Nearshore Seafloor (0-20 m), “N9”	–	–	1	3	–	–	4	8	–	–	–	–	–	–	–	–
40	Nearshore Seafloor (0-20 m), “N10”	–	–	–	–	–	–	2	8	–	–	–	1	–	–	–	–

Table C-4. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
41	Nearshore Seafloor (0-20 m), “N11”	–	–	1	4	–	–	2	10	–	–	2	4	–	–	1	1
42	Nearshore Seafloor (0-20 m), “N12”	–	–	10	18	–	1	9	20	–	–	8	15	–	–	3	6
43	Nearshore Seafloor (0-20 m), “N13”	–	–	1	3	–	–	1	2	–	–	1	1	–	–	–	1
44	Nearshore Seafloor (0-20 m), “N14”	–	–	1	1	–	–	–	1	–	–	–	1	–	–	–	1
45	Nearshore Seafloor (0-20 m), “N15” - Tortugas	–	–	2	4	–	–	1	4	–	–	1	3	–	–	–	1
46	Shelf Seafloor (20-300 m), “S1”	–	–	–	4	–	–	–	–	–	–	1	10	–	–	1	6
47	Shelf Seafloor (20-300 m), “S2”	–	–	2	12	–	–	1	1	–	–	2	17	–	–	5	13
48	Shelf Seafloor (20-300 m), “S3”	–	–	6	15	–	–	3	5	–	–	9	18	–	–	6	12
49	Shelf Seafloor (20-300 m), “S4”	–	–	10	17	–	–	11	15	–	2	15	26	–	2	10	13
50	Shelf Seafloor (20-300 m), “S5”	–	–	1	3	–	–	4	5	–	–	3	4	–	–	2	3
51	Shelf Seafloor (20-300 m), “S6”	–	–	1	3	–	–	3	6	–	–	2	4	–	–	2	3
52	Shelf Seafloor (20-300 m), “S7”	–	–	1	4	–	–	5	8	–	–	1	2	–	1	3	3
53	Shelf Seafloor (20-300 m), “S8”	–	1	3	8	–	1	14	20	–	–	2	3	–	–	1	2
54	Shelf Seafloor (20-300 m), “S9”	1	7	14	20	–	7	23	34	–	3	10	14	–	1	2	3
55	Shelf Seafloor (20-300 m), “S10”	–	4	17	25	–	5	17	29	–	4	14	19	–	1	4	7
56	Shelf Seafloor (20-300 m), “S11”	–	–	11	20	–	2	12	23	–	–	9	15	–	–	3	7
57	Shelf Seafloor (20-300 m), “S12”	–	–	9	18	–	1	7	17	–	–	8	13	–	–	3	7
58	Shelf Seafloor (20-300 m), “S13”	–	–	3	6	–	–	2	5	–	–	2	3	–	–	1	2
59	Shelf Seafloor (20-300 m), “S14”	–	–	1	4	–	–	1	4	–	–	2	4	–	–	–	1
60	Deepwater Seafloor (300 m–Outer Jurisdiction), “D1”	–	–	–	5	–	–	–	–	–	–	1	10	–	–	3	8
61	Deepwater Seafloor (300 m–Outer Jurisdiction), “D2”	–	–	–	4	–	–	–	–	–	–	2	10	–	–	3	9
62	Deepwater Seafloor (300 m–Outer Jurisdiction), “D3”	–	–	1	7	–	–	–	–	–	–	2	11	–	–	5	14

Table C-4. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
63	Deepwater Seafloor (300 m–Outer Jurisdiction), “D4”	–	–	1	6	–	–	–	–	–	–	4	15	–	–	6	18
64	Deepwater Seafloor (300 m–Outer Jurisdiction), “D5”	–	–	1	5	–	–	–	–	–	–	3	13	–	–	2	10
65	Deepwater Seafloor (300 m–Outer Jurisdiction), “D6”	–	–	4	10	–	–	1	2	–	–	5	13	–	–	8	17
66	Deepwater Seafloor (300 m–Outer Jurisdiction), “D7”	–	–	4	10	–	–	1	2	–	–	9	18	–	–	10	21
67	Deepwater Seafloor (300 m–Outer Jurisdiction), “D8”	–	–	3	8	–	–	1	2	–	–	9	18	–	–	8	20
68	Deepwater Seafloor (300 m–Outer Jurisdiction), “D9”	–	–	7	13	–	1	4	7	–	–	9	14	–	–	10	14
69	Deepwater Seafloor (300 m–Outer Jurisdiction), “D10”	–	–	12	18	–	2	6	10	–	1	15	24	–	2	20	28
70	Deepwater Seafloor (300 m–Outer Jurisdiction), “D11”	–	–	11	18	–	3	7	9	–	4	21	31	–	2	20	32
71	Deepwater Seafloor (300 m–Outer Jurisdiction), “D12”	–	2	13	19	–	1	10	15	–	5	17	28	–	5	16	19
72	Deepwater Seafloor (300 m–Outer Jurisdiction), “D13”	–	7	21	29	–	4	13	19	–	11	25	37	–	12	29	34
73	Deepwater Seafloor (300 m–Outer Jurisdiction), “D14”	–	11	29	40	–	10	19	27	–	17	33	43	–	16	43	54
74	Deepwater Seafloor (300 m–Outer Jurisdiction), “D15”	–	–	5	9	–	1	8	13	–	1	7	11	–	4	9	11
75	Deepwater Seafloor (300 m–Outer Jurisdiction), “D16”	–	8	18	26	–	5	16	23	–	10	24	33	–	20	31	35
76	Deepwater Seafloor (300 m–Outer Jurisdiction), “D17”	7	28	51	58	7	24	39	48	9	42	59	70	12	58	76	81
77	Deepwater Seafloor (300 m–Outer Jurisdiction), “D18”	2	11	21	27	2	15	25	31	3	14	23	28	10	26	33	36
78	Deepwater Seafloor (300 m–Outer Jurisdiction), “D19”	7	15	24	30	13	24	34	39	8	20	26	30	15	25	30	33

Table C-4. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
79	Deepwater Seafloor (300 m–Outer Jurisdiction), "D20"	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
80	Deepwater Seafloor (300 m–Outer Jurisdiction), "D21"	5	11	18	24	9	20	29	33	3	12	17	20	4	10	14	16
81	Deepwater Seafloor (300 m–Outer Jurisdiction), "D22"	2	7	12	19	1	14	25	30	–	4	8	11	2	5	10	11
82	Deepwater Seafloor (300 m–Outer Jurisdiction), "D23"	6	21	29	35	4	20	33	38	2	11	22	25	4	7	12	14
83	Deepwater Seafloor (300 m–Outer Jurisdiction), "D24"	75	82	84	85	75	82	85	86	67	75	78	79	51	57	63	65
84	Deepwater Seafloor (300 m–Outer Jurisdiction), "D25"	2	13	33	41	1	12	28	35	–	10	22	27	1	4	13	19
85	Deepwater Seafloor (300 m–Outer Jurisdiction), "D26"	6	30	47	53	10	27	42	46	4	18	30	34	3	15	30	37
86	Deepwater Seafloor (300 m–Outer Jurisdiction), "D27"	–	–	14	23	–	2	14	24	–	1	10	16	–	–	6	12
87	Deepwater Seafloor (300 m–Outer Jurisdiction), "D28"	–	–	8	16	–	–	6	15	–	–	5	9	–	–	2	8
88	Deepwater Seafloor (300 m–Outer Jurisdiction), "D29"	–	–	3	7	–	–	3	9	–	–	2	4	–	–	1	2
89	Deepwater Seafloor (300 m–Outer Jurisdiction), "D30"	–	–	1	5	–	–	2	7	–	–	2	4	–	–	–	2
90	North Atlantic Right Whale Critical Habitat	–	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–
92	*Sargassum* (March/April)	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
93	*Sargassum* (May/June)	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	–
94	*Sargassum* (July/August)	–	–	–	–	1	1	1	1	66	66	66	66	–	–	–	–
97	Seagrass-Taylor County	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
98	Seagrass-Dixie County	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
99	Seagrass-Levy County	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–

Table C-4. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
113	Topographic Features (Claypile Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
114	Topographic Features (Appelbaum Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
115	Topographic Features (Coffee Lump Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
116	East Flower Garden Bank	–	–	–	1	–	–	–	–	–	–	–	2	–	–	1	2
117	West Flower Garden Bank	–	–	–	1	–	–	–	–	–	–	–	2	–	–	1	2
118	Topographic Features (MacNeil Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
120	Topographic Features (Rankin-1 Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
121	Topographic Features (Rankin-2 Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
122	Topographic Features (Bright Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
123	Topographic Features (Geyer Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
124	Topographic Features (Elvers Bank)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
126	Topographic Features (Sonnier Bank)	–	–	–	1	–	–	–	–	–	–	1	1	–	–	–	–
127	Topographic Features (Bouma Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
128	Topographic Features (Rezak Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
129	Topographic Features (Sidner Bank)	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
130	Topographic Features (Parker Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	1	1
131	Topographic Features (Alderdice Bank)	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	1
135	Topographic Features (Ewing-1 Bank)	–	–	1	1	–	–	–	1	–	–	1	1	–	–	–	–
137	Topographic Features (Diaphus Bank)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
138	Topographic Features (Sackett Bank)	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–
139	Pinnacle Trend	–	–	1	3	–	–	4	7	–	–	1	2	–	1	3	3
140	Chandeleur Islands	–	–	–	1	–	–	1	2	–	–	–	1	–	–	–	–
141	Florida Middle Ground	–	–	–	1	–	–	3	6	–	–	–	–	–	–	–	–

Table C-4. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
142	Pulley Ridge	–	1	6	12	–	2	7	17	–	2	8	11	–	–	1	3
143	Madison Swanson	–	–	1	1	–	–	2	4	–	–	–	–	–	–	–	1
144	Steamboat Lumps	–	–	2	2	–	–	3	6	–	–	–	1	–	–	–	–
145	Dry Tortugas	–	–	2	3	–	–	1	4	–	–	1	2	–	–	–	1
146	Tortugas Ecological Reserve (North)	–	–	1	3	–	–	1	2	–	–	–	2	–	–	–	1
147	Tortugas Ecological Reserve (South)	–	–	5	9	–	1	4	9	–	–	3	6	–	–	1	1
148	Florida Keys National Marine Sanctuary	–	–	11	20	–	1	11	23	–	–	9	16	–	–	3	6
149	FL State Waters (both East Coast and Gulf)	–	–	3	7	–	–	2	6	–	–	2	4	–	–	–	2
150	Key Biscayne National Park	–	–	1	2	–	–	1	2	–	–	1	2	–	–	–	1
151	Texas Clipper and South Texas Platform – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
152	Port Lavaca/Liberty Ship Reef – Dive Area (Apr-Nov)	–	–	–	2	–	–	1	1	–	–	1	5	–	–	1	2
153	High Island – Dive Area (Apr-Nov)	–	–	–	2	–	–	–	–	–	–	1	2	–	–	–	–
154	West Cameron – Dive Area (Apr-Nov)	–	–	1	3	–	–	1	1	–	–	3	7	–	–	–	–
156	Cognac Platform (Block MC 194) - Dive Area (Apr-Nov)	–	–	–	–	–	–	1	1	–	–	1	2	–	–	–	–
158	Vermilion Area - Dive Area (Apr-Nov)	–	–	1	3	–	–	2	3	–	–	4	9	–	–	–	–
159	Vermilion Area, South Addition – Dive Area (Apr-Nov)	–	–	1	3	–	–	1	2	–	–	4	8	–	–	1	1
160	Bay Marchand – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	1	–	–	1	2	–	–	–	–
161	South Timbalier – Dive Area (Apr-Nov)	–	–	1	3	–	–	4	7	–	–	6	13	–	–	1	1
162	South Timbalier Area, South Addition – Dive Area (Apr-Nov)	–	–	2	4	–	–	3	5	–	–	5	9	–	–	2	2
163	Panhandle FL – Dive Area (Apr-Nov)	–	–	1	3	–	–	4	9	–	–	–	–	–	–	–	–
164	Tampa – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–

Table C-4. Conditional Probabilities Expressed as Percent Chance that an Oil Spill Starting at Launch Point 7 Will Contact a Certain Offshore Environmental Resource within 60 Days (continued).

	Season	Winter				Spring				Summer				Fall			
	Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
ID	Name	Percent Chance															
165	SE FL – Dive Area (Apr-Nov)	–	–	1	4	–	–	5	13	–	–	4	8	–	–	–	–
166	Daytona Beach – Dive Area (Apr-Nov)	–	–	–	–	–	–	–	1	–	–	1	1	–	–	–	–
169	East Flower Garden Bank (Apr-Nov)	–	–	–	1	–	–	–	–	–	–	–	2	–	–	1	1
170	West Flower Garden Bank (Apr-Nov)	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	1
171	Chandeleur Islands (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	–	1	–	–	–	–
172	Tortugas Ecological Reserve (North) (Apr-Nov)	–	–	–	1	–	–	1	2	–	–	–	2	–	–	–	–
173	Tortugas Ecological Reserve (South) (Apr-Nov)	–	–	1	3	–	1	4	9	–	–	3	6	–	–	–	–
174	Florida Keys National Marine Sanctuary (Apr-Nov)	–	–	2	7	–	1	11	23	–	–	9	16	–	–	–	–

Note: Values of <0.5% are indicated by "–". Values of >99.5% are indicated by "*". Any areas where the percent chance within 60 days of all seasons are all <0.5% are not shown. Refer to **Figure C-1** for the location of Launch Point Six. Refer to **Figures 3-7 through 3-23** for the locations of the named areas.

APPENDIX D

ESSENTIAL FISH HABITAT ASSESSMENT

D. ESSENTIAL FISH HABITAT ASSESSMENT

D.1. PROPOSED ACTIONS

Purpose of and Need for the Proposed Actions (Chapter 1.1)

The proposed Federal actions addressed in this environmental impact statement (EIS) are to offer for lease certain Outer Continental Shelf (OCS) blocks located in the Eastern Planning Area (EPA) of the Gulf of Mexico (GOM) (**Figure 1-1**). Under the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017* (Five-Year Program) (USDOI, BOEM, 2012), proposed EPA Lease Sale 225 is tentatively scheduled for 2014 and proposed EPA Lease Sale 226 is tentatively scheduled for 2016. The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with the Outer Continental Shelf Lands Act (OCSLA) of 1953 (67 Stat. 462), as amended (43 U.S.C. §§ 1331 *et seq*. [1988]). The proposed lease sales will provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas.

The need for the proposed actions is to further the orderly development of OCS resources. Oil serves as the feedstock for liquid hydrocarbon products; among them gasoline, aviation and diesel fuel, and various petrochemicals. The United States (U.S.) consumed 18.8 million barrels (MMbbl) of oil per day in 2011 (USDOE, Energy Information Administration, 2012a). The Energy Information Administration projects the total U.S. consumption of liquid fuels, including both fossil fuels and biofuels, to grow from 19.2 MMbbl per day in 2012 to 19.9 MMbbl per day in 2035 (USDOE, Energy Information Administration, 2012b). Altogether, net imports of crude oil and petroleum products (imports minus exports) accounted for 45 percent of our total petroleum consumption in 2011. The U.S. crude oil imports stood at 8.4 MMbbl per day in 2011. Petroleum product imports were 2.4 MMbbl per day in 2011. Exports totaled 2.9 MMbbl per day in 2011, mainly in the form of distillate fuel oil, petroleum coke, and residual fuel oil. Our biggest supplier of crude oil and petroleum-product imports was Canada (29%), with countries in the Persian Gulf being the second largest source (22%) in 2011 (USDOE, Energy Information Administration, 2012c). Oil produced from the GOM would also reduce the environmental risks associated with transoceanic oil tankering from sources overseas.

This EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. At the completion of the National Environmental Policy Act (NEPA) process, a decision will be made only for proposed EPA Lease Sale 225. An additional NEPA review will be conducted for proposed EPA Lease Sale 226 to address any new information relevant to that proposed action.

Prelease Process (Chapter 1.4)

Scoping for this EIS was conducted in accordance with Council Environmental Quality (CEQ) regulations implementing NEPA. The Bureau of Ocean Energy Management (BOEM) also conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the prelease process for the proposed lease sales and this EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), U.S. Department of Defense (USDOD or DOD), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), State Governors' offices, and industry groups. On August 29, 2012, the Area Identification (Area ID) decision was made. One Area ID was prepared for both proposed lease sales. BOEM mailed copies of the Draft EIS for review and comment to public and private agencies, interest groups, and local libraries. To initiate the public review and comment period on the Draft EIS, BOEM published a Notice of Availability (NOA) in the *Federal Register*. In addition, public notices were mailed with the Draft EIS and were placed on BOEM's Internet website at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx.

A consistency review was performed pursuant to the Coastal Zone Management Act (CZMA) and a Consistency Determination (CD) will be prepared for each affected State prior to each proposed EPA lease sale. To prepare the CD's, BOEM reviews each State's Coastal Management Program (CMP) and analyzes the potential impacts as outlined in this EIS, new information, and applicable studies as they pertain to the enforceable policies of each CMP. Based on the analyses, BOEM's Director makes an assessment of consistency, which is then sent to each State with the Proposed Notice of Sale (NOS).

This Final EIS will be published approximately 5 months prior to the first proposed sale, EPA Lease Sale 225, which is tentatively scheduled for 2014. To initiate the public review and 30-day minimum comment period, BOEM will publish an NOA in the *Federal Register*. BOEM will send copies of the Final EIS for review and comment to Federal, State, and private agencies, interest groups, and local libraries. In addition, public notices will be mailed with this Final EIS and will be placed on BOEM's Internet website at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/NEPA/nepaprocess.aspx. After the end of the comment period, the U.S. Department of the Interior (USDOI or DOI) will review the EIS and all comments received on this Final EIS.

The EIS is not a decision document. A Record of Decision (ROD) will be prepared if the decision is made to hold each lease, i.e., one for proposed EPA Lease Sale 225 and one for proposed EPA Lease Sale 226. The ROD will identify BOEM's preferred alternative for each lease sale, as well as the environmentally preferable alternative. The ROD will summarize the proposed action and the alternatives evaluated in this EIS, the conclusions of the impact analyses, and other information considered in reaching the decision. All relevant comments received on the Final EIS will be identified in the ROD.

A Proposed NOS will become available to the public 4-5 months prior to each proposed lease sale. If the decision by the Assistant Secretary of the Interior for Land and Minerals is to hold a proposed lease sale, a Final NOS will be published in its entirety in the *Federal Register* at least 30 days prior to the sale date, as required by the OCSLA.

Postlease Activities (Chapter 1.5)

Measures to minimize potential impacts are an integral part of the OCS Program. These measures are implemented through lease stipulations, operating regulations, Notices to Lessees and Operators (NTL's), and project-specific requirements or approval conditions. These measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, archaeological sites, air quality, oil-spill response planning, chemosynthetic communities, artificial reefs, operations in hydrogen sulfide prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features.

A geological and geophysical) permit must be obtained from BOEM prior to conducting off-lease geological or geophysical exploration or scientific research on unleased OCS lands or on lands under lease to a third party (30 CFR §§ 551.4 (a) and (b)). Geological investigations include various seafloor sampling techniques to determine the geochemical, geotechnical, or engineering properties of the sediments.

Formal exploration plans (EP's) and development and production plans (DPP's) (30 CFR §§ 550.211 and 550.241) with supporting information must be submitted for review and approval by BOEM before an operator may begin exploration, development, or production activities on any lease. Supporting environmental information, archaeological reports, biological reports (monitoring and/or live-bottom survey), and other environmental data determined necessary must be submitted with an OCS plan.

A Programmatic EA was completed to evaluate the potential effects of the deepwater technologies and operations (USDOI, MMS, 2000). The EP describes exploration activities, drilling rig or vessel, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information, and includes a proposed schedule of the exploration activities. Before any development operations can begin on a lease in a proposed lease sale area, a DPP must be submitted to BOEM for review and decision. A DPP describes the proposed development activities, drilling activities, platforms or other facilities, proposed production operations, environmental monitoring plans, and other relevant information, and it includes a proposed schedule of development and production activities.

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. New or unusual technologies may be identified by the operator in its EP, deepwater operations plan, and DPP or through BOEM's plan review processes. The operating procedures developed during the engineering, design, and manufacturing phases of the project, coupled with the results (recommended actions) from hazard analyses performed, will be used to develop the emergency action and curtailment plans. The lessee must use the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

Prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill. Besides the application process, the lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations.

A permanent abandonment includes the isolation of zones in the open wellbore, plugging of perforated intervals, plugging the annular space between casings (if they are open), setting a surface plug, and cutting and retrieving the casing at least 15 feet (ft) (5 meters [m]) below the mudline. This also must be addressed in the application.

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies, including DOI, the Department of Transportation (DOT), the U.S. Army Corps of Engineers (COE), the Federal Energy Regulatory Commission, and the USCG. Pipeline applications are usually submitted and reviewed separately from DOCD's. Pipeline applications may be for on-lease pipelines or rights-of-way for pipelines that cross other lessees' leases or unleased areas of the OCS. Pipeline permit applications submitted to the Bureau of Safety and Environmental Enforcement (BSEE) include the pipeline location drawing, profile drawing, safety schematic drawing, pipe design data, a shallow hazard survey report, and an archaeological report, if applicable. The BSEE evaluates the design, fabrication, installation, and maintenance of all OCS pipelines. Applications for pipeline decommissioning must also be submitted for BOEM review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert and/or to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging the ends and to minimize the likelihood that the decommissioned line will become an obstruction to other users of the OCS by filling it with water and burying the ends.

The BSEE will provide for both an annual scheduled inspection and a periodic unscheduled (unannounced) inspection of all oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation. The lessee is required to use the best available and safest drilling technology in order to enhance the evaluation of conditions of abnormal pressure and to minimize the potential for the well to flow or kick. Because blowout preventers (BOP's) are important for the safety of the drilling crew, as well as the rig and the wellbore itself, BOP's are regularly inspected, tested, and refurbished. The BSEE's responsibilities under the Oil Pollution Act of 1990 include spill prevention, review, and approval of oil-spill-response plans; inspection of oil-spill containment and cleanup equipment; and ensuring oil-spill financial responsibility for facilities in offshore waters located seaward of the coastline or in any portion of a bay that is connected to the sea either directly or through one or more other bays. The responsible party for covered offshore facilities must demonstrate oil-spill financial responsibility, as required by BOEM regulation 30 CFR part 553. Under 30 CFR § 250.1500 subpart O, BSEE has outlined well control and production safety training program requirements for lessees operating on the OCS.

Alternatives (Chapter 2)

Alternative A—The Proposed Action: This is BOEM's preferred alternative. This alternative would offer for lease all unleased blocks in the proposed EPA lease sale area for oil and gas operations (**Figure 2-1**). The proposed EPA lease sale area covers approximately 657,905 acres in the Gulf of Mexico's EPA, which includes those blocks previously included in the EPA Lease Sale 224 area and a triangular-shaped area south of this area bordered by the Central Planning Area boundary on the West and the Military Mission Line (86º 41′ W. longitude) on the East. The area is south of eastern Alabama and western Florida; the nearest point of land is 125 miles (201 kilometers) northwest in Louisiana. As of August 2013, approximately 465,200 ac of the proposed EPA lease sale area are currently unleased. The estimated amount of resources projected to be developed as a result of proposed EPA Lease Sales 225 and 226 is 0-0.071 billion barrels of oil and 0-0.162 trillion cubic feet of gas.

Alternative B—No Action: This is the cancellation of a proposed EPA lease sale. Any potential environmental impacts resulting from a proposed EPA lease sale would not occur or would be postponed. This is also analyzed in the Five-Year Program EIS on a nationwide programmatic level.

D.2. GUIDANCE AND STIPULATIONS FOR THE GULF OF MEXICO

BOEM's Topographic Features, Live Bottom (Pinnacle Trend), and Live Bottom (Low Relief) Stipulations were formulated over 20 years ago and were based on consultation with various Federal agencies and comments solicited from State, industry, environmental organizations, and academic representatives. These stipulations address conservation and protection of essential fish habitat/live-bottoms areas. The stipulations include exclusion of all oil and gas activity (structures, drilling, pipelines, production, etc.) on or near live-bottom areas (both high-relief and low-relief), mandatory shunting of drilling muds and cuttings near high-relief features, relocation of operations including pipelines away from essential fish habitat/live bottoms, and possible monitoring to assess the impact of the activity on the live bottoms. A continuous annual monitoring study has been ongoing at the East and West Flower Garden Banks since 1988.

Mitigating measures that are a standard part of the Bureau of Ocean Energy Management's OCS Program limit the size of explosive charges used for platform removal, require placing explosive charges at least 15 ft (5 m) below the mudline, establish No Activity and Modified Activity Zones around high-relief live bottoms, and require remote-sensing surveys to detect and avoid biologically sensitive areas such as low-relief live bottoms, pinnacles, and chemosynthetic communities.

In 2009, NTL 2009-G39 ("Biologically Sensitive Areas of the Gulf of Mexico") and NTL 2009-G40 ("Deepwater Benthic Communities") were produced; these now supersede the previous guidelines for these features found in NTL 2004-G05 and NTL 2000-G20, respectively. They offer guidance on the regulations at 30 CFR § 550.216(a), 30 CFR § 550.247(a), 30 CFR § 550.221(a), 30 CFR § 250.552(a), and 30 CFR § 550.282. These are information regulations for EP, DOCD's, and development and production plans and monitoring programs, plans, and report regulations. The NTL 2009-G39 changes the water depth applicability of NTL 2004-G05 from 400 m (1,312 ft) to 300 m (984 ft), makes minor changes to the list of affected OCS blocks, adds regulatory references, updates an NTL reference, makes minor administrative changes, and adds a guidance document statement. It still explains the Topographic Features, Live Bottom (Pinnacle Trend), and Live Bottom (Low Relief) Stipulations. The NTL 2009-G40 broadens the scope of the previous NTL 2000-G20 to cover all high-density deepwater benthic communities (not just high-density chemosynthetic communities), changes the definition of deep water from 400 m (1,312 ft) to 300 m (984 ft), and increases the separation distance from muds and cuttings discharge locations from 457 m (1,500 ft) to 610 m (2,000 ft).

D.3. HABITATS

Gulf of Mexico Essential Fish Habitat Program and Policies

Pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, Federal agencies are required to consult with NMFS on any action that may result in adverse effects to essential fish habitat (EFH). The NMFS published the final rule implementing the EFH provisions of the Magnuson-Stevens Fisheries Conservation and Management Act (50 CFR part 600) on January 17, 2002. Certain OCS activities authorized by BOEM may result in adverse effects to EFH, and therefore, require EFH consultation. The EFH is defined as "**waters**—aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; **substrate**—sediment, hard bottom, structures underlying the waters, and associated biological communities; **necessary**—the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and **spawning, breeding, feeding, or growth to maturity**—stages representing a species' full life cycle" (USDOC, NMFS, 2010).

In March 2000, this Agency consulted with NMFS's Southeast Regional Office in preparing an NMFS regional finding for the Gulf of Mexico OCS Region that allows BOEM to incorporate the EFH assessments into NEPA documents. BOEM consulted on a programmatic level, by letters of July 1999 and August 1999, to address EFH issues for certain BOEM Outer Continental Shelf activities (plans of exploration and production, pipeline rights-of-way, and platform removals).

As a result of the *Deepwater Horizon* explosion, oil spill, and response, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) requested reinitiation of the Endangered Species Act (ESA) consultation with both NMFS and FWS on July 30, 2010. The NMFS responded with a letter to BOEMRE on September 24, 2010. The EFH consultation was also addressed in NMFS's letter. A new EFH consultation will be initiated between BOEM's Gulf of Mexico OCS Region and NMFS's Southeast Region. This is an EFH assessment, which includes summaries of the EPA proposed actions, impacts, and relevant NTL's; and descriptions of managed species and EFH's. Based on the most recent and best available information at the time, BOEM will also continue to closely evaluate and assess risks to managed species and identified EFH in upcoming environmental compliance documentation under NEPA and other statutes. The EFH's that are covered in this EIS are water column, wetlands, seagrass communities/aquatic macrophytes, topographic features, live bottoms, *Sargassum*, chemosynthetic and nonchemosynthetic deepwater benthic communities, and soft bottom deepwater benthic communities. These habitats are described and the impacts from an EPA proposed action are summarized in this Appendix. Each EFH will have the corresponding chapters of this EIS in parentheses for reference. As a result of the *Deepwater Horizon* explosion, oil spill, and response, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) requested reinitiation of the Endangered Species Act (ESA) consultation with both NMFS and FWS on July 30, 2010. The NMFS responded with a letter to BOEMRE on September 24, 2010. The EFH consultation was also addressed in NMFS's letter. A new EFH consultation has been initiated between BOEM's Gulf of Mexico OCS Region and NMFS's Southeast Region. This is an EFH assessment, which includes summaries of the EPA proposed actions, impacts, and relevant NTL's; and descriptions of managed species and EFH's. Based on the most recent and best available information at the time, BOEM will also continue to closely evaluate and assess risks to managed species and identified EFH in upcoming environmental compliance documentation under NEPA and other statutes. The EFH's that are covered in this EIS are water column, wetlands, seagrass communities/aquatic macrophytes, topographic features, live bottoms, *Sargassum*, chemosynthetic and nonchemosynthetic deepwater benthic communities, and soft bottom deepwater benthic communities. These habitats are described and the impacts from an EPA proposed action are summarized in this Appendix. Each EFH will have the corresponding chapters of this EIS in parentheses for reference.

Water Column (Chapters 4.1.1.2.1.1. and 4.1.1.2.2.1)

Over 150 rivers empty out of North America into the Gulf (Gore, 1992, page 127). The rivers emptying into the Gulf bring freshwater and sediment into coastal waters (Gore, 1992, pages 127-131), which affects the water quality of these waters. The water cycle may introduce chemical and physical factors that alter the condition of the natural water (such as the addition of waterborne pollutants or the addition of warmer water into the Gulf). The leading source of contaminants that impair coastal water quality is urban runoff; which includes suspended solids, heavy metals and pesticides, oil and grease, and nutrients. Other pollutant source categories include agricultural runoff, municipal point sources, industrial sources, hydromodification (e.g., dredging), and vessel sources (e.g., shipping, fishing, and recreational boating). The zone of hypoxia on the Louisiana-Texas shelf occurs seasonally and is affected by the timing of the Mississippi and Atchafalaya Rivers' discharges carrying nutrients to the surface waters. The hypoxic conditions last until local wind-driven circulation mixes the water again. Of those with sufficient data in the EPA, Suwannee River and Choctawhatchee Bay had low eutrophic conditions; Pensacola Bay had moderately low eutrophic conditions; and Apalachicola Bay, Florida Bay, and Charlotte Harbor had moderate eutrophic conditions. However, at the time of the assessment, conditions were expected to worsen in the future at Charlotte Harbor. Rookery Bay, Sarasota Bay, and Tampa Bay had moderately high eutrophic conditions, while North Ten Thousand Islands and Perdido Bay had high eutrophic conditions. The confidence of the eutrophication assessments varied.

The water offshore of the Gulf's coasts can be divided into two regions: shallow <1,000 ft (305 m) and deep water ≥1,000 ft (305 m). Waters on the continental shelf at 0-200 m (0-656 ft) and on the slope at 200-2,000 m (656-6,562 ft) are heavily influenced by the Mississippi and Atchafalaya Rivers. In the Gulf of Mexico, pH ranges from approximately 8.1 to 8.3 at the surface (Gore, 1992, page 87), salinity of the Gulf is generally 36 parts per thousand, and surface temperatures range from 29 ºC (84 ºF) to 19 ºC (65 ºF) (Gore, 1992, page 79). Offshore waters, especially deeper waters, are more directly affected by natural seeps that are located in offshore waters of the Gulf of Mexico. Hydrocarbons enter the Gulf of Mexico through natural seeps in the Gulf of Mexico at a rate of approximately 980,392 barrels (bbl) per year (a range of approximately 560,224-1,400,560 bbl per year) (NRC, 2003, page 191).

Gulf Stream

The Loop Current and its associated eddies create a dynamic zone with strong divergences and convergences that concentrate and transports plankton (this includes larvae from both oceanic and continental shelf species).

Estuarine

Wetlands (Chapters 4.1.1.4.1)

In general, coastal wetland habitats occur as bands around waterways. They are broad expanses of saline, brackish, and freshwater marshes; mud and sand flats; cypress-tupelo and mangrove swamps; and bottomland hardwood forests. Saline and brackish habitats support sharply delineated and segregated stands of single plant species. Fresh and low-salinity environments support more diverse and mixed communities of plants. High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. These wetland corridors also function as floodwater retention and purification areas as well as sites for local aquifer recharge. Different wetland habitats include the Laguna Madre (Texas), the Chenier Plain (Louisiana), the Mississippi River Delta Complex (Louisiana), Pascagoula River Delta and Mississippi Sound (Mississippi/Alabama), and the Big Bend (Florida). These are important areas for many estuarine dependent species.

Seagrass Communities/Aquatic Macrophytes (Chapter 4.1.1.5.1)

Submerged vegetation 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). Seagrasses and freshwater submerged aquatic vegetation provide important nursery and permanent habitat for sunfish, killifish, immature shrimp, crabs, drum, trout, flounder, and several other nekton species, and 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). These habitats are found in some capacity throughout the Gulf.

Structural Habitats

Oysters

Oysters are unique in that they are a substrate and a fisheries species. They provide hard substrate with complex structure for inshore species, including other oysters (all structure provides hiding places/refuge). They are also an important prey species and are discussed later in this Appendix. In the coastal areas off the United States, the oyster reefs in the Gulf of Mexico were evaluated as being in fair condition (Beck et al., 2001).

Live Bottoms (Pinnacle Trend [Chapter 4.1.1.6.1.1] and Low Relief [Chapter 4.1.1.6.2.1])

The northeastern portion of the CPA exhibits a region of high topographic relief known as the "Pinnacle Trend" at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon. The Pinnacle Trend spreads over a 103 x 26 km area (64 x 16 mi) in water depths of 60-200 m (200-650 ft) (**Figure 4-4**). High-relief features consist of pinnacles, flat-top reefs, reef-like mounds, patch reefs, and isobath-parallel ridges. Low-relief features include fields of small seafloor mounds that rise only a meter or two from the seafloor but provide hard surfaces for encrusting and attached epifauna. Though these are not in the EPA, there is the possibility of an accidental event impacting these areas.

Low-relief, hard-bottom features are located on the inner and middle Mississippi-Alabama shelf. These features include isolated low-relief, reef-like structures; rubble fields; low-relief flat rocks (e.g., 6 m long and 60 cm thick [20 ft long and 2 ft thick]); limestone ledges (e.g., 4 m [13 ft] high); rocky outcrops off Mobile Bay (18- to 40-m [59- to 131-ft] depth range; 5 m wide and 2 m high [16 ft wide and 7 ft high]); and clustered reefs (e.g., tens of meters across and 3 m [10 ft] high) (Schroeder et al., 1988; Schroeder, 2000). Hard-bottom features on the Mississippi-Alabama-Florida Shelf (MAFLA) typically provide reef habitat for tropical organisms, including sessile epifauna (soft corals, nonreef-building hard corals, sponges, bryozoans, crinoids) and fish; these areas are typically of low relief (<1 m; 3 ft) (Thompson et al., 1999). Hard-bottom areas include De Soto Canyon, Florida Middle Grounds, Pulley Ridge, Steamboat Lumps, Madison Swanson, and the Sticky Grounds. Other low-relief live bottoms include seagrass communities, and these are covered in **Chapter 4.1.1.5** of this EIS and under the heading "Seagrass Communities/Aquatic Macrophytes" in this Appendix. The closest hard bottom to the EPA proposed action area is approximately 130 km (80 mi) away.

Topographic Features (Chapters 4.1.1.7.1)

Details for the protection and avoidance of biologically sensitive features and areas are described in this Agency's NTL 2009-G39. The Biological Stipulation Map Package (http://www.boem.gov/Regulations/Notices-To-Lessees/Notices-to-Lessees-and-Operators.aspx) includes drawings of each bank with associated protection zones. Topographic features are hard-bottom habitats and are rare compared with the ubiquitous soft bottoms in the Gulf (Parker et al., 1983). They are typically upthrusts of rock due to uplift (salt diapirs) by underlying layers of salt deep under the seafloor. Some others, such as the South Texas Banks, are relic coral reefs left over from the last sea-level low stand (about 10,000 years ago). These topographic highs, or subsea banks, provide an island of hard substrate in a virtual ocean of soft bottoms. **Figure 4-5** depicts the location of protected topographic features in the Gulf. Though these features are not located in the EPA, BOEM acknowledges there is the possibility of an accidental event impacting these areas. However, the closest known topographic features to the EPA proposed action area is approximately 250 km (155 mi) away.

Sargassum *Communities (Chapters 4.1.1.8.1)*

Pelagic *Sargassum* algae is one of the most ecologically important brown algal genera found in the pelagic environment of tropical and subtropical regions of the world. This algae is ubiquitous in surface waters throughout the Gulf of Mexico. The pelagic complex in the Gulf is mainly comprised of *S. natans* and *S. fluitans* (Stoner, 1983; Lee and Moser, 1998; Littler and Littler, 2000). Both species of macrophytes (aquatic plants) are hyponuestonic (living immediately below the surface) and fully adapted to a pelagic existence (Lee and Moser, 1998). *Sargassum* serves as nurseries, sanctuaries, and forage grounds for both commercially and recreationally exploited species.

Benthic Habitats and Sediment/Water Interface

Chemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.9.1)

These communities use a carbon source independent of photosynthesis and the sun-dependent photosynthetic food chain that supports all other life on earth. Although the process of chemosynthesis is entirely microbial, chemosynthetic bacteria can support thriving assemblages of higher organisms. This is accomplished through symbiotic relationships in which the chemosynthetic bacteria live within the tissues of tube worms and bivalves and provide a food source for their hosts. At least 69 communities are now known to exist in the Gulf.

Nonchemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.10.1)

Deepwater corals are relatively rare examples of deepwater communities that would not be expected considering the fact that the vast majority of the deep Gulf continental slope is made up of soft silt and clay sediments. Hermatypic (reef-building) corals contain photosynthetic algae and cannot live in deepwater environments; however, many ahermatypic corals can live on suitable substrates (hardgrounds) in these environments. Scleractinian corals are recognized in deepwater habitats, but there is little information regarding their distribution or abundance in the Gulf (USDOI, MMS, 2000, page IV-14). Scleractinian corals may occupy isolated hard-bottom habitats but usually occur in association with high-density chemosynthetic communities that often are situated on carbonate hardgrounds.

Soft Bottom Benthic Communities (Chapter 4.1.1.11.1)

The seafloor on the continental shelf in the Gulf of Mexico consists primarily of muddy to sandy sediments. These soft bottom communities consist primarily of sand/shell and are inhabited by different animals that may be classified as infauna and epifauna. These animals modify their habitats; also, some fishes modify these bottoms by burrowing.

Habitat Areas of Particular Concern

The Habitat Areas of Particular Concern (HAPC's) are localized areas of EFH that are either ecologically important, sensitive, stressed, or a rare area as compared with the rest of a species' EFH geological range. The HAPC's, as designated by the Gulf of Mexico Fishery Management Council (GMFMC), are the East and West Flower Garden Banks, Stetson Bank, Rankin Bank, Bright Bank, 29 Fathom Bank, 28 Fathom Bank, MacNeil Bank, Geyer Bank, McGrail Bank, Sonnier Banks, Alderdice Bank, and Jakkula Bank); in Florida (EPA), they are Madison Swanson, Florida Middle Grounds, Pulley Ridge, and Tortugas Ecological Reserves. The currently listed threatened species (possibly updated to endangered) of elkhorn and staghorn coral are found in patch reefs off the Florida Keys and Florida reef tract, which are one of four NMFS-designated critical habitats for these corals (GMFMC, 2005; USDOC, NOAA, 2011). The NMFS has a poster outlining many of these banks, and it can be found at http://sero.nmfs.noaa.gov/hcd/pdfs/efhdocs/gom_efhhapc_poster.pdf.

Manmade Structures

While these are not identified or described by NMFS as EFH, manmade structures serve as important habitat for many species. When manmade reefs are constructed, they provide new primary hard substrate similar in function to newly exposed hard bottom, with the additional benefit of substrate extending from the bottom to the surface. Reef structures of high profile seem to yield generally higher densities of managed and nonmanaged pelagic and demersal species than a more widespread, lower profile natural hard bottom or reef (South Atlantic Fishery Management Council, 1998). Wilson et al. (2003) reported fish densities as much as 1,000 times larger on platforms compared with surrounding mud bottom habitats and even equal to or greater than natural reef habitats such as the Flower Garden Banks. The benefits of artificial reefs created by the installation of energy production platform structures are well documented in Gulf waters off the coast of Texas and Louisiana. More than 400 oil and gas platforms are also used as artificial reefs after they are decommissioned. Jetties also provide hard substrate for intertidal species and rigs also create artificial hard substrate habitat for offshore species.

D.4. FISHERIES (CHAPTERS 4.1.1.17, 4.1.1.18, AND 4.1.1.19)

The Gulf is identified as EFH for species managed by the GMFMC and is covered in the Shrimp Fishery Management Plan (FMP), Red Drum FMP, Reef Fish FMP, Spiny Lobster FMP, Coral and Coral Reef FMP, and Coastal Migratory Pelagic FMP. The highly migratory species managed by NMFS (these species continue to have EFH designations extending in some cases to the Exclusive Economic Zone) also have EFH identified in the Gulf. Many of these species are of commercial importance and all of them spend a portion of their life cycle within the waters of the Gulf. The NMFS lists the species, EFH categories and designations, and HAPC in their *Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies; Gulf of Mexico Region* (USDOC, NMFS, 2010). The following is summarized from the Gulf of Mexico Fishery Management Council's *Final Environmental Impact Statement; Generic Essential Fish Habitat Amendment to the Following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf of Mexico, Stone Crab Fishery of the Gulf of Mexico, Coral and Coral Reefs of the Gulf of Mexico, Spiny Lobster in the Gulf of Mexico and South Atlantic, Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic* (GMFMC, 2004) and the *Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat* (USDOC, NMFS, 2009). For the full list of species and their scientific names, refer to **Table D-1**.

Red Drum

Red drum utilize estuaries from Vermilion Bay, Louisiana, to eastern Mobile Bay, Alabama, to 25 fathoms (46 m; 150 ft) in Florida and between Crystal River to Naples, Florida, at 5-10 fathoms (9-18 m; 30-60 ft) and Cape Sable, Florida, to the boundary of Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council. Red drum occur all over the Gulf from the estuaries to 40 m (131 ft) offshore, and they can tolerate wide salinity ranges. Red drum eggs are found nearshore, and larvae are in estuaries in temperatures of 25° C (77° F), during the later summer and early fall. Larvae feed on copepods. Early juveniles utilize nearshore estuarine areas like bays in the early winter and eat a variety of prey. Adults are found from the estuaries to the continental shelf in the fall and are omnivores. Spawning occurs nearshore in the deeper waters by mouths of bays and inlets and the Gulf side of barrier islands in the fall.

Reef Fish

Reef fish utilize estuaries associated with the Gulf, occupy pelagic and benthic portions of the Gulf, and use different topographic features on the continental shelf with high relief and some soft bottoms (**Table D-2**). Different species and different life history stages use different parts of the Gulf.

Coastal Migratory Species

Coastal migratory species generally utilize estuaries. The habitat locations for these species can be found in **Table D-3**.

Shrimp

Shrimp generally spawn offshore and have demersal eggs and pelagic larvae that eat algae and zooplankton (**Table D-4**). Their post-larvae are found in estuaries and become benthic. The juveniles are in estuaries, are omnivores, and eventually emigrate offshore.

Spiny Lobster

Spiny lobsters are found offshore, associated with coral reefs and seagrass beds. Their larvae eat plankton and, when they move from offshore to inshore by bays and seagrass, they stop feeding. Juveniles utilize nearshore bays with macroalgae, sponges, and corals; they feed on invertebrates. Adults are found offshore associated with reefs, rocky habitat, and hard bottom, and they spawn offshore in reef fringes. Adults can be found in seagrass beds within bays and feed on invertebrates.

Corals

Coral larvae are planktonic. Corals are broadcast spawners, and the primary locations of reed building are the Flower Garden Banks, Florida Middle Grounds, and the Dry Tortugas.

Highly Migratory Species

Highly Migratory Species' productivity varies with the Loop Current. General productivity in the Gulf is in different areas with different habitats; the highest fish resources are found in the Mississippi River Delta, Florida Big Bend, Florida Middle Grounds, mid- and outer shelf, and De Soto Canyon (because it has upwelling). Highly Migratory Species occupy a range of habitats: estuaries, coastal, neritic, and offshore pelagic environments. **Tables D-5 and D-6** provide descriptions of where these species could be found in the Gulf of Mexico. In many of the statements, the states are used to help visualize approximately where in the Gulf the species could occur. The following information can be found in detail in *Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat* (USDOC, NMFS (2009). The NMFS has designated a vast area of the western Gulf of Mexico for Atlantic bluefin tuna as a HAPC; this species is found in both the Gulf of Mexico and the Atlantic Ocean (USDOC, NMFS, 2009). Smalltail shark, bigeye sixgill shark, sevengill shark, and sixgill shark do not have an EFH identified due to insufficient data.

Other Species of Importance

Mullets use coastal waters, estuaries, and rivers; they have wide salinity and depth (1-120 m; 3-393 ft) range. Their eggs are planktonic and are found offshore. Larvae are pelagic and migrate inshore by entering through estuaries, and they feed on zooplankton. Juveniles utilize estuaries and are found in the mud and sand, and they feed on detritus and algae. Adults are found in estuaries and rivers over mud and sand bottoms and with vegetation. They spawn during the fall and winter in offshore in large schools and return to the estuary after they spawn.

Gulf menhaden are estuarine dependent, pelagic, and schooling planktivores that occur at depth from 1-140 m (3-459 ft). Eggs are pelagic and are found both inshore and offshore. Larvae are passively transported into estuaries and associate with lower salinities. Juveniles are found in nonvegetated areas and move to more saline bays with size. Adults are found in nearshore waters in bays (<18 m; 59 ft) and spawn over the shelf in the fall and winter.

Blue crabs are found all over Gulf depending on the life history stage. Eggs are attached to females that occur in high salinity waters by barrier islands or bay mouths. Larvae (zoeae) are pelagic and are carried offshore to develop over the shelf. Post-larvae (megalope) migrate to estuaries and settle in vegetation and shoreline habitat; they are omnivores. Juveniles utilize vegetated habitats with mud and sand bottoms, and they have a wide salinity range. Adults are found in the same areas as juveniles, but females are generally found in higher salinities.

Oysters are found in inshore waters. Eggs sink and hatch. Larvae are free swimming until their foot forms and then they settle to the bottom on hard substrate; they are planktivorous. The oyster life cycle is all dependent on salinity cues. Adults grow attached to the substrate and are filter feeders and broadcast spawners. They release eggs and sperm during the spring to the fall in warm, high-salinity waters (>10 practical salinity units).

D.5. IMPACTS OF ROUTINE OPERATIONS

Routine operations continue during the life of a lease, and different activities can have different effects on EFH. Generally, the activities would start with seismic surveys, then an exploration well and then delineation wells to find and help define the amount of resource or the extent of the reservoir (**Chapter 3.1.1.2**). Development wells are then drilled from movable structures, fixed bottom-supported structures, floating vertically moored structures, floating production facilities, and drillships (**Chapter 3.1.1.3.1**). Any drilling will cause some sort of bottom area disturbance (**Chapter 3.1.1.3.2.1**) and sediment displacement (**Chapter 3.1.1.3.2.2**). Most exploration drilling, platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, topside structures, or support vessels in place. Anchors disturb the seafloor and sediments in the area where dropped or emplaced (**Chapter 3.1.1.3.3.1**). Discharges are drilling muds and cuttings (**Chapter 3.1.1.4.1**), and produced waters (**Chapter 3.1.1.4.2**) will occur with production and development but they are highly regulated by USEPA. In order to move the vast amount of oil over the years, a mature pipeline network exists in the Gulf to transport oil and gas production from the OCS to shore (**Chapter 3.1.1.8.1**). Once a lease has expired, the lessee must sever bottom-founded structures and their related components at least 5 m (15 ft) below the mudline to ensure that nothing would be exposed that could interfere with future lessees and other activities in the area (**Chapter 3.1.1.10**). All of the routine operations are not all offshore. There are also coastal routine operations that can affect EFH, which include the following: service bases; gas processing plants; coastal pipelines; navigation channels; and disposal facilities for operations (discharge and wastewater) (**Chapters 3.1.2.1.1, 3.1.2.1.4.2**, **3.1.2.1.6**, **3.1.2.1.8, 3.1.2.1.9, and 3.1.2.2**, respectively).

Water Column (Chapters 4.1.1.2.1.2 and 4.1.1.2.2.2)

The primary impacting sources to water quality in coastal waters are point-source and storm-water discharges from support facilities, vessel discharges, and nonpoint-source runoff. These activities are not only highly regulated but also localized and temporary in nature. During exploration activities, the primary impacting sources to offshore water quality are discharges of drilling fluids and cuttings. During platform and pipeline installation and removal activities, the primary impacting sources to water quality are sediment disturbance and temporarily increased turbidity. Impacting discharges during production activities are produced water and service-vessel discharges, which might include water with an oil concentration of approximately 15 parts per million as established by regulatory standards. The USEPA and USCG's regulations are in place to limit the toxicity of the ingredients, the levels of incidental contaminants in these discharges, and in some cases the discharge rates and discharge locations. Any disturbance of the seafloor would increase turbidity in the surrounding water, but the increased turbidity should be temporary and restricted to the area near the disturbance. There are multiple Federal regulations and permit requirements that would decrease the magnitude of the impacts of these activities.

Wetlands (Chapter 4.1.1.4.2)

Overall, the impacts to wetlands from routine activities associated with an EPA proposed action are not expected to adversely alter barrier beach configurations much beyond existing, ongoing impacts in localized areas. This is because of the small amount of dredging, small probability of pipeline landfall, and no new onshore facilities expected as part of an EPA proposed action. If any such activities should occur, multiple Federal and State regulations would ensure decreased impacts to coastal habitats.

Seagrass Communities/Aquatic Macrophytes (Chapter 4.1.1.5.2)

Routine OCS activities in the EPA that may impact seagrasses include maintenance dredging, vessel traffic, and pipeline landfalls. These activities are not expected to significantly increase in occurrence and range in the near future. If they do occur, these activities should have minor effects on submerged vegetation. This is because of Federal and State requirements and implemented programs, along with the beneficial effects of natural flushing (e.g., from winds and currents). Any potential effects on submerged vegetation from routine activities in the EPA are expected to be localized and not significantly adverse.

Live Bottoms (Pinnacle Trend [Chapter 4.1.1.6.1.2] and Low Relief [Chapter 4.1.1.6.2.2])

Oil and gas operations discharge drilling muds and cuttings generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings in the Pinnacle Trend area would not greatly impact the biota of the live bottoms because the biota surrounding the pinnacle features are adapted to the turbid (nepheloid) conditions and high sedimentation rates associated with the outflow of the Mississippi River (Gittings et al., 1992). The pinnacles themselves are coated with a veneer of sediment. The toxicity of the produced waters has the potential to adversely impact the live-bottom organisms of the Pinnacle Trend. However, based on the localized impacts of routine oil and gas activities, the distance of the Pinnacle Trend from the sale area, and the depth of the sale area in relation to the depth where Pinnacle features are found, no impacts from routine events are anticipated to occur to Pinnacle features in the CPA as a result of the proposed EPA activity.

The effects from routine operations would be similar to hard, low-relief live bottoms as they are to the Pinnacle features. The toxicity of produced waters has the potential to adversely impact the live-bottom organisms. However, the closest Live Bottom Stipulation block is approximately 70 nmi (130 km; 80 mi) from the proposed sale area, which eliminates the potential effects of routine impacts that could affect live-bottom, low-relief features, including impacts from anchoring, infrastructure emplacement, drilling-effluent and produced-water discharges, and infrastructure removal. Because the greatest impacts of routine oil and gas activity are reported close to the well and because discharge of drilling muds, cuttings, and produced waters is strictly regulated by USEPA's National Pollutant Discharge and Elimination System (NPDES) permits, routine discharges will not reach the live bottom features. In addition, BSEE's regulations protect live bottoms from structure removal by reducing shock impact.

Topographic Features (Chapter 4.1.1.7.2)

The Topographic Features Stipulation would prevent most of the potential impacts on topographic features from bottom-disturbing activities (structure removal and emplacement) and operational discharges associated with an EPA proposed action. The closest topographic feature is approximately 250 km (150 mi) from the proposed sale area, which eliminates the potential effects of routine impacts that could affect topographic features. Because the greatest impacts of routine oil and gas activity are reported close to the well and because discharge of drilling muds, cuttings, and produced waters is strictly regulated by NPDES permits, routine discharges will not reach the topographic features. In addition, BSEE's regulations protect topographic features from structure removal by reducing shock impact.

Sargassum Communities (Chapter 4.1.1.8.2)

All types of discharges, including drill muds and cuttings, produced water, and operational discharges (e.g., deck runoff, bilge water, and sanitary effluent), would contact a small portion of the *Sargassum* algae. However, the quantity and volume of these discharges within the proposed sale area is relatively small compared with the pelagic waters of the EPA. Therefore, although discharges would contact *Sargassum*, they would only contact a very small portion of the *Sargassum* population. Likewise, impingement effects by service vessels and working platforms and drillships would contact only a very small portion of the *Sargassum* population. The impacts to *Sargassum* that are associated with an EPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole. The *Sargassum* community occupies pelagic waters with generally high water quality and would be resilient to the minor effects predicted. It has a yearly cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community.

Chemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.9.2)

Chemosynthetic communities are susceptible to physical impacts from anchoring, structure emplacement, pipeline installation, structure removal, and drilling discharges. The guidance described in NTL 2009-G40 greatly reduces the risk of these physical impacts by requiring the avoidance of potential chemosynthetic communities. Routine operations of an EPA proposed action are expected to cause no damage to the ecological function or biological productivity of chemosynthetic communities. Widely scattered, high-density chemosynthetic communities would not be expected to experience impacts from oil and gas activities in deep water because the impacts would be limited by standard BOEM protections in place as described in NTL 2009-G40.

Nonchemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.10.2)

Some impact to deepwater benthic communities from drilling and production activities would occur as a result of physical impacts and drilling discharges regardless of their locations. However, recolonization of populations from widespread neighboring soft-bottom substrate would be expected over a relatively short period of time for all size ranges of organisms. Widely scattered, deep live bottoms would not be expected to experience impacts from routine oil and gas activities in deep water because the impacts would be limited by standard BOEM protections in place as described in NTL 2009-G40.

Soft Bottom Benthic Communities (Chapters 4.1.1.11.2)

Although localized impacts to comparatively small areas of the soft bottom benthic communities would occur, the impacts would be on a relatively small area of the seafloor compared with the overall area of the seafloor (384,567 km^2; 148,482 mi^2). Infauna may be crushed by anchors or pipelines laid upon the seafloor. However, the greatest impact is the alteration of benthic communities as a result of smothering, chemical toxicity, and substrate change. Communities that are smothered by cuttings repopulate, and populations that are eliminated as a result of sediment toxicity or organic enrichment would be taken over by more tolerant species. The community alterations are a shift in species dominance (Montagna and Harper, 1996). These localized impacts generally occur within a few hundred meters of platforms, and the greatest impacts are seen close to the platform. These repopulated habitats within the Gulf are probably not different from the early successional communities that predominate throughout areas of the Gulf that are frequently disturbed (Gaston et al., 1998; Diaz and Solow, 1999; Rabalais et al., 2002). Benthic communities farther from a well would not be impacted by routine oil and gas activities.

Fish Resources (Chapters 4.1.1.17.2)

Routine activities such as pipeline trenching and OCS discharge of drilling muds and produced water could affect fish resources. It is expected that any possible coastal and marine environmental degradation from routine activities associated with an EPA proposed action is expected to cause a nondetectable decrease in fish resources. This is because of regulations, mitigations, and the fact that Gulf of Mexico fish stocks have retained both diversity and biomass throughout the years of offshore development; an EPA proposed action is expected to result in a minimal decrease in fish resources and/or standing stocks.

D.6. IMPACTS OF ACCIDENTAL EVENTS

Offshore oil spills and their probabilities are presented in **Chapter 3.2.1.4** for a spill ≥1,000 bbl and in **Chapter 3.2.1.5** for a spill <1,000 bbl. Coastal spills are analyzed in **Chapter 3.2.1.6**, and the response activities for the spills are discussed in detail in **Chapter 3.2.1.8**. This is a summary of the effects of these spills on EFH. Although a catastrophic event is a low-probability event and is neither reasonably foreseeable nor reasonably certain to occur, there is also a summary of the potential effects of a catastrophic spill on each EFH in **Appendix B**.

Water Column (Chapters 4.1.1.2.1.3 and 4.1.1.2.2.3)

Accidental events associated with an EPA proposed action that could impact coastal and offshore water quality include spills of oil and refined hydrocarbons, releases of natural gas and condensate, usage of chemical dispersants in oil-spill response, and spills of chemicals or drilling fluids. The loss of well control, pipeline failures, collisions, or other malfunctions could also result in such spills. Spills from collisions are not expected to be significant because collisions occur infrequently. Overall, loss of well control events and blowouts are rare events and of short duration, so potential impacts to offshore water quality are not expected to be significant except in the rare case of a catastrophic event (**Appendix B**). Although response efforts may decrease the amount of oil in the environment, the response efforts may also impact the environment through, for example, increased vessel traffic, hydromodification, and application of dispersants. Natural degradation processes would also decrease the amount of spilled oil over time. For coastal spills, two additional factors that must be considered are the shallowness of the area and the proximity of the spill to shore. Over time, natural processes can physically, chemically, and biologically degrade oil. Chemicals used in the oil and gas industry are not a significant risk in the event of a spill because they are either nontoxic, used in minor quantities, or are only used on a noncontinuous basis. Although there is the potential for accidental events, an EPA proposed action would not significantly change the water quality of the Gulf of Mexico over a large spatial or temporal scale outside of a catastrophic event.

Wetlands (Chapter 4.1.1.4.3)

Due to the proximity of inshore spills to wetlands and coastal habitats, inshore spills pose the greatest threat. Louisiana is the only state with a probability of an offshore spill contacting State waters. Fringe wetlands in the northern Gulf of Mexico are in moderate- to high-energy environments; therefore, sediment transport and tidal stirring should reduce the chances for oil persisting in the event that these areas are oiled. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment, chemical treatments, and personnel used to clean up can generate the greatest impacts to the area. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. Overall, impacts to wetland habitats from an oil spill associated with activities related to an EPA proposed action would be expected to be low and temporary. This is because of the dynamic nature of the system, State and COE permit regulations, and specific cleanup techniques. Coastal spills, which are the most likely to affect wetlands, would be expected to be localized and smaller in scale and to have a quick response so the amount of wetlands affected would not be expected to be significant.

Seagrass Communities/Aquatic Macrophytes (Chapter 4.1.1.5.3)

The greatest threat to inland, submerged vegetation communities would be from an inland spill resulting from a vessel accident or pipeline rupture, but the size of these types of spills is small and the duration short. The floating nature of nondispersed crude oil, the regional microtidal range, dynamic climate with mild temperatures, and the amount of microorganisms that consume oil would alleviate prolonged effects on submerged vegetation communities. Also, safety and spill-prevention technologies continue to improve and will decrease detrimental effects to submerged vegetation from an EPA proposed action.

Live Bottoms (Pinnacle Trend [Chapter 4.1.1.6.1.3] and Low Relief [Chapter 4.1.1.6.2.3])

Disturbances resulting from an EPA proposed action, including oil spills and blowouts, have the potential to disrupt and alter the environmental, recreational, and aesthetic values of the live-bottom habitats. Live-bottom (Pinnacle Trend) features represent a small fraction of the continental shelf area. The small portion of the seafloor covered by these features, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to the Pinnacle Trend features. The depth below the sea surface to which the Pinnacle features rise (40 m [130 ft] or more below the sea surface) helps to protect them from surface oil spills because disturbance of the sea surface by storms can mix surface oil into the water column, but the effects are generally limited to the upper 10 m (33 ft). In areas with known live bottoms, the Live Bottom (Pinnacle Trend) and Live Bottom (Low Relief) Stipulations prevent most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of live bottoms. However, because the proposed EPA lease sale area is greater than 120 km (70 mi) from the closest known Live Bottom Stipulation block, the stipulation will not be applied to a lease. Because of the distance of an EPA proposed action from the features, only large spills have the potential to reach the live-bottom (low-relief) features. Also, operations outside the proposed buffer zones around sensitive habitats (including blowouts and oil spills) may affect the different live-bottom features.

A subsurface spill or plume may impact sessile biota of live-bottom features. Oil or dispersed oil may cause sublethal impacts to benthic organisms if a plume reaches these features. Sedimented oil or sedimentation as a result of a blowout may impact benthic organisms. Impacts may include loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success. Because of the distance from live bottoms, sedimented oil should be well dispersed, resulting in a light layer of deposition that would be easily removed by the organism and have low toxicity.

Topographic Features (Chapter 4.1.1.7.3)

On blocks with topographic features, the Topographic Features Stipulation may be implemented by BOEM to assist in preventing most of the potential impacts on topographic feature communities from blowouts, surface, and subsurface oil spills and the associated effects by increasing the distance of such events from the topographic features. However, because there are no blocks subject to the Topographic Features Stipulation in the proposed EPA lease sale area and because the proposed EPA lease sale area is greater than 250 km (155 mi) from the closest topographic feature, the stipulation will not be applied to a lease. Because of the distance of an EPA proposed action from the features, only large spills have the potential to reach the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal and impacts would be at the community level. Any turbidity, sedimentation, and oil adsorbed to sediments would also be at low concentrations by the time the topographic features were reached, also resulting in sublethal impacts. Impacts from an oil spill on topographic features are also lessened by the distance of the spill, the depth, and the currents that surround the topographic features.

Sargassum Communities (Chapter 4.1.1.8.3)

Pelagic *Sargassum* algae occur seasonally as a patchy resource in almost every part of the northern Gulf, resulting in a wide distribution over a very large area. Considering its ubiquitous distribution and occurrence in the upper water column near the sea surface, potential accidental spills from oil and gas operations would be expected to contact localized portions of the *Sargassum* community. All types of spills (including surface oil and fuel spills), underwater well blowouts, and chemical spills would contact *Sargassum* algae. The quantity and volume of most of these spills would be relatively small compared with the pelagic waters of the Gulf of Mexico. Therefore, most spills would only contact a very small portion of the *Sargassum* population. The impacts to *Sargassum* that are associated with an EPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community unless a catastrophic spill occurs. In the case of a very large spill, the *Sargassum* algae community could suffer severe impacts to a sizable portion of the population in the northern Gulf. The *Sargassum* community lives in pelagic waters with generally high water quality and is expected to show good resilience to the predicted effects of spills. It has a yearly growth cycle that promotes quick recovery from impacts and that would be expected restore typical population levels in 1-2 growing seasons. Because of the patchy and ephemeral nature of *Sargassum*, accidental impacts associated with an EPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole.

Chemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.9.3)

The most likely threat to chemosynthetic communities is physical disturbance of the seafloor, which could destroy the organisms of these communities. The possibility of oil from a surface spill reaching a depth of 300 m (984 ft) or greater in any measurable concentration is very small. Subsea oil plumes resulting from high-pressure subsea oil releases and/or the application of chemical dispersants have the potential to negatively affect chemosynthetic communities. If oil is ejected under high pressure or if dispersants are applied to an oil spill, oil would mix into the water column, be carried by underwater currents, and could eventually contact the seafloor where it may impact patches of chemosynthetic community habitat in its path.

Most accidental events expected to be associated with an EPA proposed action would result in only minimal impacts to chemosynthetic communities with adherence to the biological stipulation and the guidelines described in NTL 2009-G40. One exception would be in the case of a catastrophic spill combined with the application of dispersant, producing the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. The possible impacts, however, will be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect.

Nonchemosynthetic Deepwater Benthic Communities (Chapter 4.1.1.10.3)

The most likely threat to nonchemosynthetic communities is physical disturbance of the seafloor, which could destroy the organisms of these communities. The possibility of oil from a surface spill reaching a depth of 300 m (984 ft) or greater in any measurable concentration is very small. Subsea oil plumes resulting from high-pressure subsea oil releases and/or the application of chemical dispersants have the potential to negatively affect nonchemosynthetic communities. If oil is ejected under high pressure or if dispersants are applied to an oil spill, oil would mix into the water column, be carried by underwater currents, and could eventually contact the seafloor where it may impact patches of nonchemosynthetic community habitat in its path.

Accidental events associated with an EPA proposed action would result in only minimal impacts to nonchemosynthetic communities with adherence to the biological stipulation and the guidelines described in NTL 2009-G40. One exception would be in the case of a catastrophic spill combined with the application of dispersant, producing the potential to cause devastating effects on local patches of habitat in the path of subsea plumes where they physically contact the seafloor. The possible impacts, however, will be localized due to the directional movement of oil plumes by the water currents and because the sensitive habitats have a scattered, patchy distribution. Oil plumes that remain in the water column for longer periods would disperse and decay, having only minimal effect.

Soft Bottom Benthic Communities (Chapter 4.1.1.11.3)

Because of the small amount of proportional space that OCS activities occupy on the seafloor, only a small portion of the seafloor of the Gulf would experience lethal impacts as a result of blowouts, surface and subsurface oil spills, and the associated effects. The greatest impacts would be closest to the spill site, and impacts would decrease with distance from the spill. Contact with spilled oil at a distance from the spill would likely cause sublethal to immeasurable effects to benthic organisms because the distance would prevent contact with concentrated oil. Oil from a subsurface spill that reaches benthic communities would be primarily sublethal and impacts would be at the local community level. Any sedimentation, sedimented oil, and oil from a subsurface spill that reaches benthic communities would be at low concentrations by the time it reached the benthic communities and be primarily sublethal so impacts would be at the local community level. Also, any local communities that are lost would be repopulated fairly rapidly (Neff, 2005). Although an oil spill may have some detrimental impacts, especially closest to the occurrence of the spill, the impacts may be no greater than natural biological fluctuations (Clark, 1982), and impacts would be to an extremely small portion of the overall Gulf of Mexico.

Fish Resources (Chapter 4.1.1.17.3)

Accidental events that could impact fish resources include blowouts and oil or chemical spills. Because subsurface blowouts, although a highly unlikely occurrence, suspend large amounts of sediment, they have the potential to adversely affect fish resources in the immediate area of the blowout. If oil spills due to an EPA proposed action were to occur in open waters of the OCS proximate to mobile adult fish, the effects would likely be nonfatal and the extent of damage would be reduced because adult fish have the ability to move away from a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. Fish populations may be impacted by an oil spill but they would be primarily affected if the oil reaches the shelf and estuarine areas because these are the most productive areas, but the probability of a spill in these areas is low. The fish populations of the Gulf of Mexico have repeatedly proven to be resilient to large, annually occurring areas of anoxia, major hurricanes, and oil spills. An EPA proposed action is not expected to significantly affect fish populations in the Gulf of Mexico.

D.7. IMPACTS OF A CATASTROPHIC SPILL EVENT (APPENDIX B)

Though not reasonably foreseeable as a result of an EPA proposed action, BOEM did consider potential impacts from a low-probability catastrophic oil spill event in **Appendix B**, and the results are summarized here, for reference in relation to EFH consultation.

Water Column

During the initial phase of a catastrophic blowout, water quality impacts include disturbance of sediments and the release and suspension of oil and natural gas (methane) into the water column. Some sediment could travel several kilometers, depending on particle size and subsea current patterns. In the deep Gulf, surficial sediments are mostly composed of silt and clay and, if resuspended, could stay in the water column for several hours to even days. 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). Dispersed hydrocarbons may adsorb onto marine detritus (marine snow) or may be mixed with drilling mud and deposited near the source. A catastrophic blowout also 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. 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 (e.g., increased vessel traffic and the addition of dispersants and methanol to the marine environment). The temporary decrease in oxygen content has been attributed to microbial degradation of the oil. Over time, as the oil continues to be degraded and diffuses, hypoxia becomes less of a concern.

Methane may stay in the marine environment for long periods of time (Patin, 1999, page 237), and methane diffusing through the water column would likely be oxidized in the aerobic zone and would rarely reach the air-water interface (Mechalas, 1974, page 23). Methane and other natural gas constituents are carbon sources, and their introduction into the marine environment could also result in reducing the dissolved oxygen levels due to microbial degradation of the methane, potentially creating hypoxic or "dead" zones. These areas also decrease in time as methane/natural gas constituents degrade.

Wetlands

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 good chance of survival. This is true even if aboveground die-off of marsh vegetation occurs (Lin et al., 2002). However, if reoiling occurs and the new shoots are killed, then the marsh plants may not have enough stored energy to produce a second round of new shoots. Due to the distance of deep water from shore, the possibility of a spill from a deepwater blowout reaching coastal wetlands with the toxicity to significantly impact the coastal wetlands is low. This is because of the response procedures implemented during a catastrophic spill. If the duration is long and the magnitude is great, then 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.

Seagrass Communities/Aquatic Macrophytes

If coastal waters, bays, and estuaries accrue oil, there is an assumption that there would be a decrease in local submerged vegetation cover and negative community impacts. Depending on the species and environmental factors, seagrasses may exhibit minimal impacts from a spill; however, the communities within the beds could accrue greater negative outcomes (Jackson et al., 1989; Taylor et al., 2006). Community effects could range from either direct mortality due to smothering or indirect mortality from loss of food sources and loss of habitat due to a decrease in ecological performance of the entire system (Zieman et al., 1984).

Hard Bottoms (Topographic Features and Live Bottoms/Low Relief)

Impacts that occur to hard-bottom shelf habitats 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). If the blowout were to occur beneath the seabed, suspension and subsequent deposition of disturbed sediment may smother localized areas of benthic and live-bottom communities. This could possibly include organisms within No Activity Zones or other hard-bottom substrate. Sediment from a blowout, if it occurred nearby, may have a reduced impact on these communities compared with an open-water reef community. This is because these hard-bottom organisms are more tolerant of suspended sediment (Gittings et al., 1992). The habitats beneath the rig may be permanently lost; however, the rig itself may become an artificial reef upon which epibenthic organisms may settle. The surrounding benthic communities that were smothered by sediment would repopulate from nearby stocks through spawning recruitment and immigration. Low-level exposures of corals to oil from a subsea plume may result in chronic or temporary impacts. Corals exposed to subsea oil plumes may incorporate petroleum hydrocarbons into their tissue. Reductions in feeding and photosynthesis are some impacts that may occur to coral exposed to dispersed oil. Dispersed oil does appear to be more toxic to coral species than oil or dispersant alone. Both hard and soft corals have the ability to produce mucus. Mucus production has been shown to increase when corals are exposed to crude oil, and this mucus can protect the organisms from oil (Mitchell and Chet, 1975; Ducklow and Mitchell, 1979). Vessel anchorage and decontamination stations set up during response efforts may also break or kill hard-bottom features.

Sargassum Communities

Free-floating patches of *Sargassum* and spilled oil tend to accumulate in convergence zones. Many species, including fish and invertebrates, use *Sargassum* for food and cover (Dooley, 1972; Stoner, 1983; Coston-Clements et al., 1991). Burn operations sometime occur in areas with high cover of *Sargassum* because of the associated aggregated oil (Unified Incident Command, 2010). This is because oceanographic processes that concentrate *Sargassum* into mats and rafts would also concentrate toxic substances within those flotsam. Therefore, it may be assumed that *Sargassum* would be found in areas where oil, dispersants, and other chemicals have accumulated following a catastrophic spill. This accumulation in the *Sargassum* creates a toxic environment for associated species, especially those that use the *Sargassum* as refuge for larvae or other developmental stages (Unified Incident Command, 2010).

Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities

There is a possibility that a well could be drilled close enough for a chemosynthetic or nonchemosynthetic community to be damaged in the event of a catastrophic blowout. Blowouts at points above the seafloor (in the riser or on the drill platform) would likely have little immediate effect on deepwater seafloor communities unless the structure sinks and physically impacts the seafloor. Many invertebrates associated with chemosynthetic or nonchemosynthetic communities, particularly the crustaceans, would likely be more susceptible to damage from oil exposure. 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.

Soft Bottom Benthic Communities

When soft bottom infaunal communities are physically impacted by a blowout (either lost to the crater formation or smothered by sediment), recolonization by populations from neighboring soft-bottom substrate is expected within a relatively short period of time. This is in a matter of days for bacteria and probably less than 1 year for most macrofauna and megafauna species. Recolonization could take longer for areas affected by direct contact of concentrated oil. A slow recovery rate will result in a community with reduced biological diversity and possibly a lesser food value for predatory species, which would decrease the value of the soft bottom community as EFH. Many of the organisms on soft bottoms live within the sediment and have the ability to migrate upward in response to burial by sedimentation. Continued localized disturbance of soft bottom communities may occur during oil-spill-response efforts. Anchors used to set booms to contain oil or vessel anchors in decontamination zones may affect infaunal communities in the response activity zone. Any decontamination activities, such as cleaning vessel hulls of oil, may also contaminate the sediments of the decontamination zone, as some oil may settle to the seabed, impacting the underlying benthic community. Therefore, the soft bottom that is expected to suffer greatest effects would be soft bottoms in the immediate vicinity of a seafloor blowout in which some oil is mixed into the sediment.

Fish Resources

Accidental events that could impact fish resources and EFH include blowouts and oil or chemical spills. Because subsurface blowouts, although a highly unlikely occurrence, suspend large amounts of sediment, they have the potential to adversely affect fish resources in the immediate area of the blowout. Also, any accidental event that could affect water quality or sensitive habitats has the potential to affect fish resources. If oil spills due to an EPA proposed action were to occur in open waters of the OCS proximate to mobile adult finfish, the effects would likely be nonfatal and the extent of damage would be reduced because adult fish have the ability to move away from a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent hydrocarbon compounds. Benthic EFH's would have decreased effects from oil spills because of the depths many occupy and because of the distance these low probability spills would occur from benthic habitats (due to stipulations, NTL's, etc.).

D.8. CUMULATIVE IMPACTS

The OCS Program (**Chapter 3.3.1**) along with State oil and gas activities (**Chapter 3.3.2**) and other offshore activities including dredging and artificial reefs (**Chapters 3.3.3.1 and 3.3.3.5**) will continue to affect offshore EFH. Coastal cumulative effects on EFH include submerged wetlands, river development and flood controls, and dredging events (**Chapters 3.3.4**), and these will affect EFH. Natural disturbances (**Chapter 3.3.5**) such as tropical cyclones will continue to be a presence and affect EFH as well.

Water Column (Chapters 4.1.1.2.1.4 and 4.1.1.2.2.4)

Water quality in coastal and offshore waters would be impacted by sediment disturbance and suspension (i.e., turbidity), vessel discharges, erosion, runoff from nonpoint-source pollutants (including river inflows), seasonal influences, and accidental events. Natural seeps and discharges from exploration and production activities are other potential impacting factors to offshore waters. The effects on water quality resulting from an EPA proposed action are a small addition to the cumulative impacts (other Federal agencies, States, private vessels, increases in human population, and natural events or processes) on the waters of the Gulf. Increased turbidity and discharge from an EPA proposed action would be temporary in nature and minimized by Federal permit regulations and mitigation. Since a catastrophic accident is considered rare and not expected to occur in coastal waters, the impact of accidental spills is expected to be small. In offshore waters, degradation processes in both surface and subsurface waters would decrease the amount of spilled oil over time through natural processes that can physically, chemically, and biologically degrade oil (NRC, 2003). The effect on coastal water quality from smaller accidental spills is expected to be minimal relative to the cumulative inputs of hydrocarbons from other sources. The incremental contribution of the routine activities and accidental events associated with an EPA proposed action to the cumulative impacts on coastal and offshore water quality is not expected to be significant as long as all regulations are followed.

Wetlands (Chapter 4.1.1.4.4)

Wetlands are most vulnerable to inshore or nearshore oil spills, but such spills are generally localized events. Spill sources include vessel collisions, pipeline breaks, and shore-based transfer, refining, and production facilities. There is a reduced risk of spills contacting wetlands because of the distance of offshore facilities to wetland sites, beach and barrier island topography (although locally reduced post-Hurricanes Katrina and Rita), and product transportation through existing pipelines or pipeline corridors. If oil reaches wetlands, only light localized impacts to inland wetlands would occur.

While landloss will continue from subsidence and saltwater intrusion, the State of Louisiana and COE have implemented freshwater diversion projects to minimize the effect of this saltwater-induced landloss. This would cause a change in the type of EFH (i.e., wetlands to open water). An EPA proposed action would not require any channel maintenance; therefore, no additional wetland loss would result from dredged material disposal. If dredged-material disposal is required, it would likely be beneficially used for marsh creation. Though existing pipeline channels are estimated to continue to erode wetlands, estimates do not take into account the current regulatory programs, and modern construction techniques and COE mitigations. Because of modern construction techniques and mitigation measures, there would be zero to negligible impacts on wetland habitats as a result of an EPA proposed action.

The disposal of OCS wastes and drilling by-products would be delivered to existing facilities. Because of existing capacity, no additional expansion into wetland areas is expected. Development pressures in the coastal regions of Texas, Louisiana, Mississippi, Alabama, and Florida have caused the destruction of large areas of wetlands. In coastal Louisiana, the most destructive developments have been the inland oil and gas industry projects, which have resulted in the dredging of huge numbers of access channels. Agricultural, residential, and commercial developments have caused the most destruction of wetlands in Mississippi, Alabama, and Florida. In Texas and Florida, recreational and tourist developments have been particularly destructive. These trends are expected to continue.

The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and have shifted the coastal area from a condition of net land building to one of net landloss. The incremental contribution of an EPA proposed action to the cumulative impacts on coastal wetlands is expected to be small.

Seagrass Communities/Aquatic Macrophytes (Chapter 4.1.1.5.4)

Dredging generates the greatest overall risk to submerged vegetation, while naturally occurring hurricanes cause direct damage to beds. The Federal and State permit mitigation policies that are currently in place, the small probability of an oil spill, and the natural flow regimes of coastal waters are not expected to change in the near future. These activities further reduce the incremental contribution of stress from an EPA proposed action on submerged vegetation.

Live Bottoms (Pinnacle Trend [Chapter 4.1.1.6.1.4] and Low Relief [Chapter 4.1.1.6.2.4])

Non-OCS activities that may occur in the vicinity of the pinnacle and hard-bottom, low-relief communities include recreational boating and fishing, import tankering, fishing and trawling, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause damage to the live-bottom communities. Ships using fairways in the vicinity of communities anchor in the general area of live bottoms on occasion, and numerous fishermen take advantage of the resources of regional bottoms. These activities could lead to instances of severe and permanent physical damage to individual formations. During severe storms, such as hurricanes, large waves may reach deep enough to stir bottom sediments (Brooks, 1991; CSA, 1992). Because of the depth of the Pinnacle Trend area, these forces are not expected to be strong enough to cause direct physical damage to organisms living on those reefs. Yearly hypoxic events may affect portions of live-bottom benthic populations in the northeastern part of the CPA (Rabalais et al., 2002).

Possible impacts from OCS oil and gas routine operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills, or blowouts associated with OCS activities can cause damage to pinnacle communities. Long-term OCS activities are not expected to adversely impact the live-bottom environment because these impact-producing factors are restrained by the continued implementation of the lease stipulation and site-specific mitigations. The inclusion of the Live Bottom (Pinnacle Trend) and Live Bottom (Low Relief) Stipulations would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live bottoms are judged to be infrequent because of the small number of operations in the vicinity of pinnacles and other hard, live bottoms and the distance of these operations from the habitats. The impact to the live/hard-bottom resource as a whole is expected to be minimal because of primarily localized impacts. Potential impacts from discharges would be further reduced by USEPA discharge regulations and permits restrictions.

The incremental contribution of an EPA proposed action to the cumulative impact is expected to be minimal, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Pinnacle Trend) and Live Bottom (Low Relief) Stipulations, the fact that BOEM is not currently offering the low-relief habitats for lease, and the distance of live-bottom habitats from the source of OCS-related impacts.

Topographic Features (Chapter 4.1.1.7.4)

Activities causing mechanical disturbance represent the greatest threat to the topographic features. Potential OCS-related impacts include the anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal. However, because there are no Topographic Feature Stipulation blocks in the proposed lease sale area and because the proposed lease sale area is >250 km (155 mi) from the closest topographic feature, little impact would be incurred by the biota of the topographic features with an EPA proposed action. The USEPA discharge regulations and permits would further reduce any discharge-related impacts.

If a subsea oil plume is formed, it could contact the habitats of a topographic feature; this contact may be restricted to the lower, less sensitive levels of the banks and/or may be swept around the banks with the prevailing water currents. The farther the oil source is from the bank, the more dilute and degraded the oil would be when it reaches the vicinity of the topographic features.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The majority of oil released below the sea surface rises and should not physically contact organisms on topographic features because of the distance of the proposed lease sale area to a topographic feature. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, it would be physically or chemically dispersed to low concentrations by the time it reached the feature, and the effects would be primarily sublethal. In the very unlikely event that oil from a subsurface spill reached an area containing hermatypic coral cover in lethal concentrations, the recovery could take in excess of 10 years (Fucik et al., 1984). Finally, in the unlikely event a freighter, tanker, or other oceangoing vessel related to OCS Program activities or non-OCS-related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo, recovery could take years to decades, depending on the extent of the damage. Because these events are rare in occurrence, the potential of impacts from these events is considered low.

Non-OCS activities could mechanically disrupt the bottom (such as anchoring and treasure-hunting activities). Natural events such as hurricanes or the collapse of the tops of the topographic features (through dissolution of the underlying salt structure) could cause severe impacts. The collapsing of topographic features is unlikely and would impact a single feature. Impacts from scuba diving, fishing, ocean dumping, and discharges or spills from tankering of imported oil could have detrimental effects on topographic features.

Overall, the incremental contribution of an EPA proposed action to the cumulative impact is negligible because of the implementation of the proposed Topographic Features Stipulation, which would limit mechanical impacts and operational discharges.

Sargassum Communities (Chapter 4.1.1.8.4)

Because of the ephemeral nature of *Sargassum* communities, many activities associated with an EPA proposed action would have a localized and short-term effect. There is also a low probability that a catastrophic spill would occur with an EPA proposed action. The incremental contribution of an EPA proposed action to the overall cumulative impacts on *Sargassum* communities that would result from the OCS Program, environmental factors, and non-OCS-related user group activities are expected to be minimal.

Chemosynthetic and Nonchemosynthetic Deepwater Benthic Communities (Chapters 4.1.1.9.4 and 4.1.1.10.4)

Cumulative impacts to deepwater communities in the Gulf from sources other than OCS activities are considered negligible. The most serious, impact-producing factor threatening chemosynthetic and nonchemosynthetic communities is physical disturbance of the seafloor, including activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. These could destroy the organisms of these communities. Possible catastrophic oil spills due to seafloor blowouts have the potential to devastate localized deepwater benthic habitats. However, these events are rare and would only affect a small portion of the sensitive benthic habitat in the Gulf. Guidance provided in NTL 2009-G40 describes required surveys and avoidance prior to drilling or pipeline installation and would greatly reduce risk. Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths where deepwater benthic communities occur (>300 m; 984 ft) and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes. Regionwide and even global impacts from CO_2 build-up and proposed methods to sequester carbon in the deep sea (e.g., ocean fertilization) are not expected to have major impacts to deepwater habitats in the near future.

The proposed activities considered under the cumulative scenario are expected to cause no damage to the ecological function or biological productivity of widespread, low-density deepwater communities. The rarer, widely scattered, high-density communities could experience isolated minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years, but even minor impacts are not expected. There is evidence that substantial impacts on these communities could permanently prevent reestablishment. Other sublethal impacts include possible incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. Adverse impacts from an EPA proposed action would be limited but not completely eliminated by adherence to the guidelines described in NTL 2009-G40.

Soft Bottom Benthic Communities (Chapter 4.1.1.11.4)

Non-OCS activities that may occur on soft bottom benthic substrate include recreational boating and fishing, import tankering, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions. These activities could cause temporary damage to soft bottom communities. Ships and fishermen anchoring on soft bottoms may crush and smother underlying organisms. Damage resulting from commercial fishing, especially bottom trawling, may have a severe impact on soft bottom benthic communities. Oil spills from non-OCS import tankering or other activity may result in oiled benthic communities that will only repopulate once the concentration of oil in the sediment has decreased. During severe storms, large waves may stir bottom sediments, which cause scouring, remobilization of contaminants in the sediment, abrasion and clogging of gills as a result of turbidity, uprooting benthic organisms from the sediment, and an overall result in decreased species diversity (Dobbs and Vozarik, 1983; Engle et al., 2008).

Impacts from routine activities of OCS oil and gas operations include anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, and discharges of produced waters. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to infaunal communities. Long-term OCS activities are not expected to adversely impact the entire soft-bottom environment because the local impacted areas are extremely small compared with the entire seafloor of the Gulf of Mexico. The USEPA's general NPDES permit restrictions on the discharge of produced water would help to limit the impacts on benthic communities (Smith, 1994).

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals may have local devastating impacts but the cumulative effect on the overall seafloor and infaunal communities on the Gulf would be very small. Soft bottom benthic communities are ubiquitous throughout and often remain in an early successional stage due to natural fluctuation, and therefore, the activities of OCS production of oil and gas would not cause additional severe cumulative impacts.

The incremental contribution of an EPA proposed action to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts, however, are small compared with the overall size and ubiquitous composition of the soft bottom benthic communities in the Gulf of Mexico.

Fish Resources (Chapters 4.1.1.17.4)

The OCS factors potentially impacting fish resources in the Gulf of Mexico are federally regulated or mitigated and small. There are many anthropogenic factors that are regulated by Federal and State agencies, and natural factors that cannot be regulated. Also to be considered is the variability in Gulf fish populations due to natural factors such as spawning success and juvenile survival. Overall, the incremental contribution of the OCS effects to fish populations is small.

Overfishing (including bycatch) has contributed in a large way to some populations of Gulf fish. The Magnuson-Stevens Fishery Conservation and Management Act and its amendments address sustainable fisheries and set guidelines for protecting marine resources and habitat from fishing- and nonfishing-related activities. Limits on catch and fishing seasons are set by the GMFMC. State agencies regulate inshore fishing seasons and limits.

Naturally occurring tropical cyclones can cause damage to various EFH. These can be onshore as with wetland loss and offshore with damaged topographic features. These storms are a continual part of the Gulf of Mexico climate.

All of these events and activities cause some sort of effect on the different EFH and fish resources. Many anthropogenic inputs, including an EPA proposed action, are now monitored, regulated, and mitigated by the permitting agency or State. These efforts will continue in the future, and the restoration of habitats could increase with better technologies. While EFH and fish resources are impacted by these many factors, an EPA proposed action would add a minimal amount to the overall cumulative effects.

D.9. OVERALL GENERAL CONCLUSIONS

Water Column

The primary impacting sources to water quality in coastal waters are point-source and storm-water discharges from support facilities, vessel discharges, and nonpoint-source runoff. There are multiple Federal regulations and permit requirements that would decrease the magnitude of the impacts of these activities. Accidental events associated with an EPA proposed action that could impact coastal and offshore water quality include spills of oil and refined hydrocarbons, releases of natural gas and condensate, usage of chemical dispersants in oil-spill response, and spills of chemicals or drilling fluids. Response efforts along with natural degradation processes also decrease the amount of spilled oil over time. The effects on water quality resulting from an EPA proposed action are a small addition to the cumulative impacts (i.e., other Federal agencies, States, private vessels, increases in human population, and natural events or processes) on the waters of the Gulf of Mexico.

Wetlands and Seagrass Communities/Aquatic Macrophytes

A loss of wetlands and associated biological resources (including submerged grass beds) could occur if these vegetated habitats are permanently lost because of impacts caused by dredging and construction activities that displace existing wetlands or from oil spills severe enough to cause permanent die-back of vegetation and conversion to open water. Construction and emplacement of onshore pipelines in coastal wetlands displace coastal wetlands in disturbed areas that are then subject to indirect impacts like saltwater intrusion or erosion of the marsh soils along navigation channels and canals. Ongoing natural and anthropogenic processes in the coastal zone, only one of which is OCS-related activity, can result in direct and indirect loss of wetlands. Natural losses as a consequence of the coastal area becoming hydrologically isolated from the Mississippi River that built it, sea-level rise, and subsidence of the delta platform in absence of new sediment added to the delta plain appear to be much more dominant processes impacting coastal wetlands. These losses would actually be changes in EFH from flooded vegetated habitat to open-water habitats.

Sargassum Communities

The impacts to *Sargassum* that are associated with an EPA proposed action are expected to have only minor effects to a small portion of the *Sargassum* community as a whole. The *Sargassum* community occupies pelagic waters with generally high water quality and would be resilient to the minor effects predicted. It has a yearly cycle that promotes quick recovery from impacts. No measurable impacts are expected to the overall population of the *Sargassum* community.

Live Bottoms and Topographic Features

Oil and gas operations that discharge drilling muds and cuttings generate turbidity, potentially smothering benthos near the drill sites. Because the greatest impacts of routine oil and gas activity are reported close to the well and because the discharge of drilling muds, cuttings, and produced waters is strictly regulated by USEPA’s National Pollutant Discharge and Elimination System (NPDES) permits, routine discharges will not reach the benthic features. Because of the distance of an EPA proposed action from live bottoms and topographic features, sedimented oil should be well dispersed, resulting in a light layer of deposition that would be easily removed by the organism and would have low toxicity. Overall, the incremental contribution of an EPA proposed action to the cumulative impact is negligible because of the distance of these features from an EPA proposed action (>250 km [155 mi] away).

Deepwater Benthic Habitats

Widely scattered, high-density chemosynthetic communities and nonchemosynthetic communities would not be expected to experience impacts from oil and gas activities in deep water because the impacts would be limited by standard BOEM protections in place as described in NTL 2009-G40. The proposed activities considered under the cumulative scenario are expected to cause no damage to the ecological function or biological productivity of widespread, low-density deepwater communities.

Although localized impacts to comparatively small areas of the soft bottom benthic communities would occur, the impacts would be on a relatively small area of the seafloor compared with the overall area of the seafloor (384,567 km^2; 148,482 mi^2). The greatest impact is the alteration of benthic communities as a result of smothering, chemical toxicity, and substrate change. Although an oil spill may have some detrimental impacts, especially closest to the occurrence of the spill, the impacts may be no greater than natural biological fluctuations (Clark, 1982), and impacts would be to an extremely small portion of the overall Gulf of Mexico. The incremental contribution of an EPA proposed action to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts, however, are small compared with the overall size and ubiquitous composition of the soft bottom benthic communities in the Gulf of Mexico.

Fish Resources and Commercial Fisheries

The largest impacts to these resources from an EPA proposed action would be the irreversible loss of fish and coral resources, including commercial and recreational species, are caused by structure removal using explosives. Fish in proximity to an underwater explosion can be killed. Without the structure to serve as habitat area, sessile, attached invertebrates and the fish that live among them are absent. Structure removal eliminates these special and local habitats and the organisms living there, including such valuable species as red snapper. Continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures. However, when compared with the other EFH in the Gulf, these structures are a small amount of habitat.

D.10. REFERENCES CITED

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Table D-1

Managed Species in the Gulf of Mexico

Red Drum Fishery
red drum (*Sciaenops ocellatus*)

Reef Fish Fishery
blackfin snapper (*Lutjanus buccanella*)
cubera snapper (*Lutjanus cyanopterus*)
gray snapper (*Lutjanus griseus*)
lane snapper (*Lutjanus synagris*)
mutton snapper (*Lutjanus analis*)
queen snapper (*Etelis oculatus*)
red snapper (*Lutjanus campechanus*)
silk snapper (*Lutjanus vivanus*)
vermilion snapper (*Rhomboplites aurorubens*)
yellowtail snapper (*Ocyurus chrysurus*)
wenchman (*Pristipomoides aquilonaris*)

black grouper (*Mycteroperca bonaci*)
gag (*Mycteroperca microlepis*)
Nassau grouper (*Epinephelus striatus*)
red grouper (*Epinephelus morio*)
scamp (*Mycteroperca phenax*)
speckled hind (*Epinephelus drummondhayi*)
snowy grouper (*Epinephelus niveatus*)
yellowedge grouper (*Epinephelus flavolimbatus*)
yellowfin grouper (*Mycteroperca venenosa*)
yellowmouth grouper (*Mycteroperca interstitialis*)

greater amberjack (*Seriola dumerili*)
lesser amberjack (*Seriola fasciata*)
almaco jack (*Seriola rivoliana*)
banded rudderfish (*Seriola zonata*)

gray triggerfish (*Balistes capriscus*)

goldface tilefish (*Caulolatilus chrysops*)
tilefish (*Lopholatilus chamaeleonticeps*)
hogfish (*Lachnolaimus maximus*)

Coastal Migratory Pelagic Fishes
cobia (*Rachycentron canadum*)
king mackerel (*Scomberomorus cavalla*)
Spanish mackerel (*Scomberomorus maculatus*)

Corals
Class Hydrozoa (stinging and hydrocorals)
Class Anthozoa (sea fans, whips, precious coral, sea pen, stony corals)

Shrimp Fishery
brown shrimp (*Farfantepenaeus aztecus*)
pink shrimp (*Farfantepenaeus duorarum*)
royal red shrimp (*Pleoticus robustus*)
white shrimp (*Litopenaeus setiferus*)

Spiny Lobster Fishery
spiny lobsters (*Panulirus argus*)

Highly Migratory Species
albacore (*Thunnus alalunga*)
Atlantic bluefin tuna (*Thunnus thynnus*)
Atlantic bigeye tuna (*Thunnus obesus*)
Atlantic yellowfin tuna (*Thunnus albacares*)
skipjack (*Katsuwonus pelamis*)

swordfish (*Xiphias gladius*)

blue marlin (*Makaira nigricans*)
sailfish (*Istiophorus platypterus*)
white marlin (*Tetrapturus albidus*)
longbill spearfish (*Tetrapturus pfluegeri*)

basking shark (*Cetorhinus maximus*)
great hammerhead (*Sphyrna mokarran*)
scalloped hammerhead (*Sphyrna lewini*)
smooth hammerhead (*Sphyrna zygaena*)
white shark (*Carcharodon carcharias*)
nurse chark (*Ginglymostoma cirratum*)
bignose shark (*Carcharhinus altimus*)
blacktip shark (*Carcharhinus limbatus*)
bull shark (*Carcharhinus leucas*)
Caribbean reef shark (*Carcharhinus perezi*)
dusky shark (*Carcharhinus obscurus*)
Galapagos shark (*Carcharhinus galapagensis*)
lemon shark (*Negaprion brevirostris*)
narrowtooth shark (*Carcharhinus brachyurus*)
night shark (*Carcharhinus signatus*)
sandbar shark (*Carcharhinus plumbeus*)

Table D-1. Managed Species in the Gulf of Mexico (continued).

Highly Migratory Species (continued)	**Highly Migratory Species (continued)**
silky shark (*Carcharhinus falciformis*)	finetooth shark (*Carcharhinus isodon*)
spinner shark (*Carcharhinus brevipinna*)	smalltail shark (*Carcharhinus porosus*)
tiger shark (*Galeocerdo cuvieri*)	bigeye sixgill shark (*Hexanchus vitulus*)
bigeye sand shark (*Odontaspis noronhai*)	sevengill shark (*Heptranchias perlo*)
sand tiger shark (*Odontaspis taurus*)	sixgill shark (*Heptranchias griseus*)
whale shark (*Rhinocodon typus*)	longfin mako shark (*Isurus paucus*)
Atlantic angel shark (*Squatina dumerili*)	shortfin mako shark (*Isurus oxyrinchus*)
bonnethead shark (*Sphyrna tiburo*)	blue shark (*Prionace glauca*)
Atlantic sharpnose (*Rhinocodon terraenovae*)	oceanic whitetip shark (*Carcharhinus longimanu*)
blacknose shark (*Carcharhinus acronotus*)	bigeye thresher shark (*Alopias superciliosus*)
Caribbean sharpnose shark (*Rhinocodon porosus*)	common thresher shark (*Alopias vulpinus*)

Sources: GMFMC, 2004.
USDOC, NMFS, 2010.

Table D-2

Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Grey trigger	Sand bottoms near reef habitats in the spring and summer seasons		Upper water column in spring and summer seasons	Upper water column associated with *Sargassum* and eat from *Sargassum*	Continental shelf waters (>10 m; 33 ft), reefs in the late spring and summer, and eat invertebrates
Greater amberjack	Gulfwide	Gulfwide	Offshore in the summer	Gulfwide with floating structures (*Sargassum*) in the late summer and fall and feed on invertebrates	Gulfwide near the structured habitat, eat invertebrates and fishes, and spawn in the spring and summer offshore
Lesser amberjack	Gulfwide	Gulfwide		Gulfwide; associated with floating structures (*Sargassum*) in the late summer and fall and feed on invertebrates	Gulfwide; near the bottom, associated with structures, feed on squid, and spawn in spring and fall
Almaco jack	Gulfwide	Gulfwide		Gulfwide; associated with floating structures (*Sargassum*) and barrier islands in the late summer and fall, and feed on invertebrates	Southern Gulf, offshore associated with platforms, prey on fishes, and spawning is hypothesized to be spring and fall
Banded rudderfish		Gulf Stream every other month (starting with January)		Offshore, associated with floating structures (*Sargassum*), year round	Coastal waters over the continental shelf, both pelagic and epibenthic; feed on fish and shrimp, and spawn year round offshore
Hogfish				Seagrass beds of Florida Bay and eat invertebrates	Coral reefs and rocky flats, and eat mollusks

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Queen snapper	Offshore	Offshore			Deep water in southern Gulf (>100 m; 328 ft) in rocky bottoms; eat fish, crustaceans, and squid; and spawn in March and August in St. Lucia
Mutton snapper	Shallow continental shelf waters	Shallow continental shelf waters		Seagrasses during the summer	Seagrass or reefs, year round, eat nekton, and spawn in south Florida at drop offs near coral reefs in late springs
Blackfin snapper	Continental shelf year round			Shallow waters with hard substrate (12-40 m; 39-131 ft) by the Virgin Islands in spring	Continental shelf edge, eat nekton, and spawn year round
Red snapper	Offshore in the summer and fall	Continental shelf waters in summer and fall, and eat rotifers and algae		Continental shelf associated with structures and feed on zooplankton and shrimp	Hard and irregular bottoms, eat nekton, and spawn offshore away from coral reefs in sand bottoms with low relief in summer and fall
Cubera snapper	Near coral reefs and wrecks of medium depth (80 m; 262 ft) in the summer			Shallow vegetated waters in estuaries near streams and rivers wide salinity ranges	Southern Gulf near reefs and mangroves, in wide salinity ranges, eat nekton, and spawn in the Florida Keys at approximately 80 m (262 ft)
Gray snapper	High salinity continental shelf waters near coral reefs in the summer	High salinity continental shelf waters near coral reefs in the summer and eat zooplankton	Move to estuaries with vegetation (seagrass), wide salinity and temperature ranges, and eat copepods and amphipods	Feed on crustaceans	Onshore and offshore, eat nekton, and spawn offshore near reefs in summer

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Lane snapper	Continental shelf and offshore in the summer			Low salinity inshore grasses, coral reefs, and soft bottoms (0-20m; 0-65 ft), and eat small invertebrates	High salinity offshore waters in sand bottoms with structure; wide depth range of 4-130 m (13-426 ft); eat nekton, annelids, and algae; spawning peak offshore in midsummer
Silk snapper	Shallow water year round and eat nekton	Shallow water year round and eat nekton		Shallow water year round and eat nekton	Edge of the continental shelf (90-140 m; 295-459 ft), ascend at night, feed on nekton, and spawn year round (more so in the late summer)
Yellowtail snapper	Found in February and October	Shallow water with vegetation and structure and feed on zooplankton		Nearshore with vegetation and move to shallow coral reefs with age	Semipelagic and use deeper coral reefs (50 m; 164 ft), feed on nekton, and spawn away from shore with peaks in February-April and September-October
Vermilion snapper				Coral reefs and rocky bottoms (20-200 m; 65-656 ft), spawn offshore in spring-summer	Coral reefs and rocky bottoms (20-200 m; 65-656 ft), and spawn offshore in spring-summer
Wenchman	Continental shelf waters, warmer months	Continental shelf waters, warmer months			Hard bottoms of the mid- to outer shelf (80-200 m; 262-656 ft), feed on small fish, and spawn in burrows and cervices in summer and fall

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Blueline and goldface tilefishes	Pelagic and occur offshore	Pelagic and occur offshore		Pelagic and occur offshore	Continental shelf edge and upper slope (91-150 m; 298-492 ft) associated with irregular bottoms, feed on benthic invertebrates and some fish, and spawn in burrows and crevices in summer and fall
Tilefish	Pelagic and occur on the near shelf edge in the spring and summer	Pelagic and occur on the near shelf edge in the spring and summer			Outer continental shelf (>250 m; 820 ft), feed on crustaceans, burrow in clay, and spawn spring to fall
Speckled hind	Pelagic and occur offshore	Pelagic and occur offshore		Shallow waters	Hard bottoms/ rocky reefs commonly at 60-120 m (196-393 ft); they are the apex predator of the mid-shelf coral reef and spawn at continental shelf edge in spring and late summer
Yellowedge grouper	Pelagic and occur offshore	Pelagic and occur offshore		Shallow waters with rocky bottom habitats	Outer continental shelf (>180 m; 590 ft) with high relief, hard-bottom habitats; feed on nekton; and spawn in the spring and summer

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Goliath grouper (protected)	Pelagic and occur offshore in the late summer and early fall	Pelagic and occur offshore in the late summer and early fall		High salinity (>25 psu) estuaries and bays, and feed on crustaceans and vegetation	Near jetties, coral reefs, and crevices at 2-55 m (6-180 ft); feed on crustaceans; and spawn from summer to winter with peaks in the late summer offshore in structures or patchy reefs
Red grouper	Pelagic and occur offshore over the continental shelf, and feed on zooplankton	Pelagic and occur offshore over the continental shelf, and feed on zooplankton		Inshore by seagrass and rock formation, have wide salinity range, feed on crustaceans, and move into deeper waters with size	Continental shelf near live bottoms and crevices (3-190 m; 9-623 ft), feed on nekton, and spawn offshore as protogynous hermaphrodites in late the winter and spring
Marbled grouper (insufficient information to identify EFH)					
Snowy grouper	Pelagic and occur offshore	Pelagic and occur offshore		Benthic and found inshore associated with shallow reefs, feed on nekton, and move offshore with size	Deep water (100-200 m; 328-656 ft) with high-relief rocky bottoms, feed on nekton, and spawn in spring and summer
Nassau grouper (protected)	Not offshore but are in highly saline waters in the winter	Not offshore but are in highly saline waters in the winter, and start feeding on other larvae		Saline, shallow, vegetated waters or associated with reefs in similar waters, move offshore with size, and start feeding on fishes	Associated with reeds and crevices, feed on nekton, and spawn in the winter at full moon over soft corals, sponges, and sand

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Black grouper	Pelagic and occur offshore	Pelagic and occur offshore		Inshore to estuaries with seagrass, rocky bottoms, or coral reefs, eat crustaceans, and move to deeper water with size	Deeper (>20 m; 65 ft) waters than the other life history stages over rocky bottoms and coral reefs (mid to high relief), feed on fish, and spawn in May near the Florida Keys
Yellowmouth grouper	Pelagic and occur offshore	Pelagic and occur offshore		Shallow waters with mangroves (e.g., lagoons) and feed on fishes	Inshore in water depths <100 m (328 ft) over rocky bottom and corals, feed on nekton, and spawn in spring and summer
Gag	Pelagic and occur in the winter to spring	Pelagic and occur in the winter to spring, shallow (<5 m; 16 ft) estuaries associated with grass beds or oysters, eat crustaceans then nekton, and then recruit to offshore hard bottoms in the fall			In water depths of 20-100 m (65-326 ft) associated with hard bottoms that have some relief, feed on nekton, and spawn offshore shelf edge break in the winter but peaking in the spring
Scamp	Pelagic and occur offshore in the spring	Pelagic and occur offshore in the spring		Inshore associated with hard bottoms	Continental shelf associated with high-relief hard bottoms that have complex structure, feed on nekton, and spawn at the continental shelf edge (60-100 m; 196-328 ft) in complex habitat from early spring to summer

Table D-2. Described Essential Fish Habitat Locations for Reef Fish in the Gulf of Mexico (continued).

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Yellowfin grouper				Seagrass beds then move to rocky bottoms	Adults are not common but can be found near the shoreline to mid-shelf with rocky bottoms and coral reefs, feed on nekton, and spawn in spring and summer

Table D-3

Described Essential Fish Habitat Locations for Coastal Migratory Species

Species	Eggs	Larvae	Juveniles	Adults
King mackerel	Pelagic and occur offshore in spring and summer	Mid to outer continental shelf (25-180 m; 82-590 ft) in October and feed on other larval fishes	Inshore waters on the inner shelf and feed on estuarine dependent fish	Pelagic and occur in coastal to offshore waters, feed on nekton, and spawn from May to October on the outer continental shelf
Spanish mackerel	Pelagic and found on the continental inner shelf (<50 m; 164 ft) in spring and summer	Continental inner shelf from spring to fall and feed on larval fishes	Estuarine and coastal waters with a wide salinity range and feed on fishes	Inshore and coastal waters, feed on estuarine dependent fishes, and spawn on the inner shelf from May to September
Cobia	Top meter of the water column	Offshore waters	Coastal waters and offshore on the shelf in the upper water column, found in the summer, and feed on nekton	Shallow coastal waters and offshore shelf waters (1-70 m; 3-229 ft) from March to October and spawn in the shelf waters in the spring and summer

Table D-4

Described Essential Fish Habitat and Spawning Locations for Shrimp in the Gulf of Mexico

Species	Eggs	Larvae	Post larvae	Juveniles	Adult
Brown shrimp			Migrate to estuaries in early spring	Associated with vegetation and mud bottoms, and sub-adults utilize bays and shelf as they move from estuaries to offshore waters	Spawn in deep waters (>18 m; 59 ft) over the continental shelf generally in the spring
White shrimp	Spring and fall			Associated with soft bottoms with detritus and vegetation	Nearshore soft bottoms and spawn at <27 m (88 ft) from spring to fall, and migrate through the water column between night and day
Pink shrimp	Spring and summer			Utilize the seagrass beds (*Halodule* and *Thalassia*, depending on size)	Offshore over the continental shelf on sand/shell bottoms
Royal red shrimp	Winter and spring on the upper slope (250-550 m; 820-1,804 ft)				Upper slope associated with muddy bottoms and spawn there from winter to spring, feed on benthic organisms, and are not estuarine dependent

Table D-5

Described Essential Fish Habitat Locations for Highly Migratory Species in the Gulf of Mexico

Species	Eggs	Larvae	Juvenile	Adult
Atlantic bluefin tuna	100 m (328 ft) to the EEZ	100 m (328 ft) to the EEZ		Spawn in the spring over the continental shelf in the Gulf
Atlantic bigeye tuna			Found in waters adjacent to Louisiana/Mississippi and Florida*	Central Gulf**
Atlantic yellowfin tuna	Offshore	Offshore	Central Gulf from Texas to the Florida panhandle	Offshore
Albacore tuna				Central Gulf
Skipjack tuna	Offshore out to the EEZ	Offshore out to the EEZ	Central Gulf waters from Louisiana to Florida	Central Gulf waters from Texas to Florida and spawn offshore
Swordfish	100 fathoms (200 m; 656 ft) to the EEZ	100 fathoms (200 m; 656 ft) to the EEZ	Gulf waters from Texas to Florida	Spawn offshore associated with the Loop Current
Blue marlin	Mid-Florida Keys	Mid-Florida Keys	Central Gulf waters from Texas to Florida	Central Gulf waters from Texas to Florida
White marlin			Central Gulf from Texas to the Florida panhandle and Keys	Central Gulf from Texas to the Florida panhandle and Keys
Sailfish			Central Gulf waters from Texas, Louisiana, and the Florida panhandle	Central Gulf waters from Texas, Louisiana, and the Florida panhandle
Longbill spearfish			Central Gulf from Louisiana to the Florida panhandle and the Keys	Central Gulf from Louisiana to the Florida panhandle and the Keys

EEZ = Exclusive Economic Zone.

*The states are used to help visualize approximately where in the Gulf the species could occur.

**Central Gulf—This is the central portion of the entire Gulf of Mexico, not the Gulf of Mexico's Central Planning Area (CPA).

Table D-6

Described Essential Fish Habitat Locations for Shark Species

Shark Species	Neonates	Young of Year (YOY)	Juveniles	Adult
Basking shark (no EFH described for the Gulf)				
Great hammerheads				Coastal areas from Texas to Florida*
Scalloped hammerhead	Coastal waters from Texas to Florida	Coastal waters from Texas to Florida	Coastal and offshore waters from mid-Texas to Louisiana	Coastal Gulf waters from Texas to Florida and offshore waters from Texas to eastern Louisiana
Smooth hammerhead (no EFH identified due to insufficient data)				
White sharks				Southwest coastal waters of Florida and Florida Keys
Nurse sharks				Coastal waters of Florida
Bignose shark			Localized areas from Louisiana to the Florida Keys	Localized areas from Louisiana to the Florida Keys
Blacktip sharks				Coastal waters from Texas to the Florida Keys
Bull shark	Coastal waters of Texas but are also found in localized areas in Florida	Coastal waters of Texas, but are also found in localized areas in Florida	Coastal waters from Texas through eastern Louisiana to the panhandle and western Florida	Southern and mid-coast of Texas to Louisiana and the Florida Keys
Caribbean reef sharks				Coastal waters of the Florida Keys
Dusky shark			Central Gulf** adjacent to south Texas and Florida	Central Gulf adjacent to south Texas and Florida
Galapagos shark (no EFH identified due to insufficient data)				

Table D-6. Described Essential Fish Habitat Locations for Shark Species (continued).

Shark Species	Neonates	Young of Year (YOY)	Juveniles	Adult
Lemon shark	Found in waters adjacent to mid-Texas and the Florida Keys with a localized area adjacent to the middle of Florida	Found in waters adjacent to mid-Texas and the Florida Keys with a localized area adjacent to the middle of Florida	Found in coastal waters of Texas, eastern Louisiana, and Florida	Coastal waters adjacent to Florida
Narrowtooth shark (no EFH identified due to insufficient data)				
Night sharks				Found in localized areas of offshore waters adjacent to Texas, Louisiana, and Florida
Sandbar shark				Coastal waters near Florida and some localized areas near Alabama
Silky sharks				Offshore waters in the Central Gulf adjacent to Texas, Louisiana, and the Florida Keys
Spinner shark	Coastal waters near Texas, Louisiana, and Florida	Coastal waters near Texas, Louisiana, and Florida	Localized in waters reaching from south Texas to Florida	Localized in waters reaching from south Texas to Florida
Tiger sharks	Localized areas near the Texas/Louisiana border and Florida panhandle	Localized areas near the Texas/Louisiana border and Florida panhandle	Found in Florida waters	Found in both shallow and deep waters
Bigeye sand shark (no EFH identified due to insufficient data)				
Sand shark (no EFH described in the Gulf)				
Whale sharks				Found in the waters of the central Gulf ranging from Texas to the Florida panhandle
Atlantic angel shark			Localized in coastal waters from eastern Louisiana to the Florida panhandle	Localized in coastal waters from eastern Louisiana to the Florida panhandle

Table D-6. Described Essential Fish Habitat Locations for Shark Species (continued).

Shark Species	Neonates	Young of Year (YOY)	Juveniles	Adult
Caribbean sharpnose shark (no EFH identified due to insufficient data)				
Bonnethead shark				Found in coastal shallow waters with sandy and muddy bottoms around Texas, eastern Mississippi, and to the Florida Keys
Atlantic sharpnose shark				Found in coastal waters from Texas to the Florida Keys
Blacknose shark	Found in the coastal waters of Florida	Found in the coastal waters of Florida	Localized in the coastal waters of Texas, western Louisiana, and Mississippi to Florida	Localized areas in waters from Texas to the Florida Keys
Finetooth shark	Inshore waters from Texas, eastern Louisiana, Mississippi, Alabama, and the Florida panhandle	Inshore waters from Texas, eastern Louisiana, Mississippi, Alabama, and the Florida panhandle	Found in inshore waters from south Texas and the Florida Keys, and from eastern Louisiana to the Florida panhandle	Found in inshore waters from south Texas and the Florida Keys, and from eastern Louisiana to the Florida panhandle
Oceanic whitetip shark				Found in the central Gulf and the Florida Keys
Common thresher shark				Found in the central Gulf and the Florida Keys
Bigeye thresher shark				Found in the central Gulf and Key West, Florida
Longfin makos and shortfin makos				Deepwater offshore in the central Gulf and the Florida Keys
Porbeagle shark (no EFH described for the Gulf)				
Blue shark (no EFH described for the Gulf)				

*The states are used to help visualize approximately where in the Gulf the species could occur.

**Central Gulf—This is the central portion of the entire Gulf of Mexico, not the Gulf of Mexico's Central Planning Area (CPA).

APPENDIX E

STATE COASTAL MANAGEMENT PROGRAMS

E. STATE COASTAL MANAGEMENT PROGRAMS

Each State's Coastal Management Program (CMP), federally approved by the National Oceanic and Atmospheric Administration (NOAA), is a comprehensive statement setting forth objectives, enforceable policies, and standards for public and private use of land and water resources and uses in that State's coastal zone. The program provides for direct State land and water use planning and regulations. The plan also includes a definition of what constitutes permissible land uses and water uses. Federal consistency is the Coastal Zone Management Act (CZMA) requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. The latest Federal consistency regulations concerning State coastal zone management programs are found in the *Federal Register* at 65 FR 77123-77154 (December 8, 2000) and 71 FR 788-831 (January 5, 2006).

Each Gulf State's official coastal boundary can be identified from NOAA's website at http://coastalmanagement.noaa.gov/mystate/docs/StateCZBoundaries.pdf. Once a State's CMP is federally approved, Federal agencies must ensure that their actions are consistent to the maximum extent practicable with the enforceable polices of the approved program. Federal agencies provide feedback to the States through each Section 312 evaluation conducted by NOAA.

To ensure conformance with State CMP policies and local land-use plans, the Bureau of Ocean Management (BOEM) prepares a Federal consistency determination for each proposed Outer Continental Shelf (OCS) lease sale. Through the designated State CZM agency, local land-use entities are provided numerous opportunities to comment on the OCS Program. Local land-use agencies also have the opportunity to comment directly to BOEM at any time, as well as during formal public comment periods related to the announcement of the Five-Year Program, Call for Information/Notice of Intent, environmental impact statement (EIS) scoping, public meetings on the Draft EIS, and the Proposed Notice of Sale.

A State's approved CMP may also provide for the State's review of OCS plans, permits, and license activities to determine whether they will be conducted in a manner consistent with the State's CMP. This review authority is applicable to activities conducted in any area that has been leased under the OCS Lands Act (OCSLA) and that affect any land or water use or natural resource within the State's coastal zone (16 U.S.C. § 1456(c)(3)(B)).

State of Texas Coastal Management Program

The Texas Coastal Management Program (TCMP)/Final EIS was published in August 1996. On December 23, 1996, NOAA approved the TCMP, and the requirements therein were made operational as of January 10, 1997. The TCMP is based primarily on the Coastal Coordination Act of 1991 (33 Tex. Nat. Res. Code Ann. Ch. 201, et seq.), as amended by House Bill 3226 (1995), which calls for the development of a comprehensive coastal program based on existing statutes and regulations. The Coastal Coordination Act of 1991 established the geographic scope of the program by identifying the program's inland, interstate, and seaward boundaries. The program's seaward boundary is the State's territorial seaward limit (3 marine leagues or 9 nautical miles or 10.36 [mi] or 16.67 kilometers [km]). The State's inland boundary is based on the State's Coastal Facilities Designation Line (CFDL). The CFDL was developed in response to the Oil Spill Prevention and Response Act of 1991 and basically delineates those areas within which oil spills could affect coastal waters or resources. For the purposes of the TCMP, the CFDL has been modified to capture wetlands in the upper reaches of tidal waters. The geographic scope also extends upstream 200 mi (322 km) from the mouths of rivers draining into coastal bays and estuaries in order to manage water appropriations on those rivers. The program's boundaries encompass all or portions of 18 coastal counties (including Cameron, Willacy, Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, Calhoun, Victoria, Jackson, Matagorda, Brazoria, Galveston, Harris, Chambers, Jefferson, and Orange Counties), roughly 8.9 million acres (3.6 million hectares) of land and water.

Within this coastal zone boundary, the scope of the TCMP's regulatory program is focused on the direct management of 16 generic "Areas of Particular Concern," called coastal natural resource areas (CNRA's). These CNRA's are associated with valuable coastal resources or vulnerable or unique coastal areas and include the following: waters of the open Gulf of Mexico (GOM); waters under tidal influence; submerged lands; coastal wetlands; seagrasses; tidal sand and mud flats; oyster reefs; hard substrate reefs; coastal barriers; coastal shore areas; GOM beaches; critical dune areas; special hazard areas; critical erosion areas; coastal historic areas; and coastal preserves.

The State has designated the Western Planning Area (WPA) as the geographical area in which Federal consistency shall apply outside of the coastal boundary. The TCMP also identifies Federal lands excluded from the State's coastal zone, such as U.S. Department of Defense facilities and wildlife refuges.

Land and water uses subject to the program generally include the siting, construction, and maintenance of electric generating and transmission facilities; oil and gas exploration and production; and the siting, construction, and maintenance of residential, commercial, and industrial development on beaches, critical dune areas, shorelines, and within or adjacent to critical areas and other CNRA's. Associated activities also subject to the program include canal dredging; filling; placement of structures for shoreline access and shoreline protection; on-site sewage disposal, storm-water control, and waste management for local governments and municipalities; the siting, construction, and maintenance of public buildings and public works such as dams, reservoirs, flood control projects, and associated activities; the siting, construction, and maintenance of roads, highways, bridges, causeways, airports, railroads, and nonenergy transmission lines and associated activities; certain agricultural and silvicultural activities; water impoundments and diversions; and the siting, construction, and maintenance of marinas, State-owned fishing cabins, artificial reefs, public recreational facilities, structures for shoreline access and shoreline protection, boat ramps, and fishery management measures in the Gulf of Mexico.

The TCMP is a networked program that is implemented primarily through 8 State agencies, 18 local governments, and the Coastal Coordination Council (Council). The program relies primarily on direct State control of land and water uses, although local governments will implement State guidelines related to beach and dune management. Implementation and enforcement of the coastal policies is primarily the responsibility of the networked agencies and local governments through their existing statutes, regulatory programs, or other authorizations. Networked agencies include the General Land Office/School Land Board, Texas Commission on Environmental Quality, Railroad Commission of Texas, Parks and Wildlife Commission, Texas Transportation Commission, Texas Historical Commission, the Public Utility Commission, the Texas State Soil and Water Conservation Board, and the Texas Water Development Board. In addition, the Texas Sea Grant College Program is a nonvoting member of the Council. Other members on the Council include four gubernatorial appointees: a coastal business representative; an agriculture representative; a local elected official; and a coastal citizen. Similarly, 18 county and municipal governments, in those counties with barrier islands, are also networked entities with responsibilities for program implementation vis-a-vis beaches and dunes.

Local land uses and government entities are linked to the management of Texas CNRA's in the TCMP. Local governments are notified of relevant TCMP decisions, including those that may conflict with local land-use plans or zoning ordinances. The Coastal Coordination Council includes a local government representative as a full-voting member. An additional local government representative can be added to the Council as a nonvoting member for special local matters under review. The Council will establish a permanent advisory committee to ensure effective communication for local governments with land-use authority.

In 1994, this Agency entered into a Memorandum of Understanding (MOU) with the Texas General Land Office to address similar mineral resource management responsibilities between the two entities and to encourage cooperative efforts and promote consistent regulatory practices. This Memorandum of Understanding, which encompasses a broad range of issues and processes, outlines the responsibilities and cooperative efforts, including leasing and CZMA review processes, agreed to by the respective agencies. Effective January 10, 1997, all operators were required to submit to BOEM certificates of consistency with the TCMP for proposed operations in the WPA.

This Agency developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. The WPA Lease Sale 168 was this Agency's first Federal action subject to State consistency review. This Agency and the State of Texas revised CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest Notices to Lessees and Operators (NTL's) (NTL's 2010-N06 and 2009-G27). The State of Texas requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State's requirements for Federal consistency review are based specifically on U.S. Department of the Interior's (DOI's) regulations at 30 CFR part 550, 30 CFR part 254, 30 CFR part 250, 30 CFR part 256, and NOAA's Federal consistency regulations at 15 CFR part 930. This Agency will be continuing a dialogue with the State of Texas on reasonably foreseeable coastal effects for pipelines and other permits, and the result of these discussions will be incorporated into future updates of this Agency's NTL's and/permitting procedures.

State of Louisiana Coastal Resources Program

The statutory authority for Louisiana's coastal zone management program, the Louisiana Coastal Resources Program (LCRP), is the State and Local Coastal Resources Management Act of 1978, *et seq.* (Louisiana Administrative Code, Vol. 17, Title 43, Chapter 7, Coastal Management, June 1990 revised). The State statute puts into effect a set of State coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing State regulations are also incorporated into the program, including those concerning oil and gas and other mineral operations; leasing of State lands for mineral operations and other purposes; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; air and water quality; and the Louisiana Superport.

The State statute also authorized establishment of Special Management Areas. Included or planned to be included as Special Management Areas are LOOP and Marsh Island. For purposes of the CZMA, only that portion of LOOP within Louisiana's coastal zone is part of the Special Management Area. In April 1989, the Louisiana Legislature created the Wetlands Conservation and Restoration Authority and established a Wetlands Conservation and Restoration Trust Fund to underwrite restoration projects. The Legislature also reorganized part of the Louisiana Department of Natural Resources (LADNR) by creating the Office of Coastal Restoration and Management.

Local governments (parishes) may assume management of uses of local concern by developing a local coastal program consistent with the State CMP. The State of Louisiana has 11 approved local coastal management programs (Calcasieu, Cameron, Jefferson, Lafourche, Orleans, St. Bernard, St. James, St. John the Baptist, Plaquemines, Terrebonne, and St. Tammany Parishes). Eight other programs (Assumption, Iberia, Livingston, St. Charles, St. Martin, St. Mary, Tangipahoa, and Vermilion Parishes) have not been formally approved by NOAA. The parish planning and/or permits offices often serve as the permitting agency for projects limited to local concern. Parish-level programs, in addition to issuing permits for uses of local concern, also function as a commenting agency to Louisiana's CZM agency, the Coastal Management Division, regarding permitting of uses of State concern.

Appendix C2 of the LCRP outlines the rules and procedures for the State's local CMP. Under the LCRP, parishes are authorized, though not required, to develop a local CMP. Approval of these programs gives parishes greater authority in regulating coastal development projects that entail uses of local concern. Priorities, objectives, and policies of local land-use plans must be consistent with the policies and objectives of Act 361, the LCRP, and the State guidelines, except for a variance adopted in Section IV.D of Appendix C2 of the LCRP. The Secretaries of LADNR and Wildlife and Fisheries may jointly rule on an inconsistent local program based on local environmental conditions or user practices. State and Federal agencies review parish programs before they are adopted.

The coastal use guidelines are based on seven general policies. State concerns that could be relevant to an OCS lease sale and its possible direct effects or associated facilities and nonassociated facilities are (1) any dredge and fill activity that intersects more than one water body, (2) projects involving the use of State-owned lands or water bottoms, (3) national interest projects, (4) pipelines, and (5) energy facility siting and development. Some coastal activities of concern that could be relevant to a lease sale include wetland loss due to channel erosion from OCS traffic; activities near reefs and topographic highs; activities that might affect endangered, threatened, or commercially valuable wildlife; and potential socioeconomic impacts due to offshore development. Secondary and cumulative impacts to coastal resources such as onshore facility development, cumulative impacts from infrastructure development, saltwater intrusion along navigation channels, etc. are also of particular concern.

Effective August 1993, the LADNR's Coastal Management Division required that any entity applying for permits to conduct activities along the coast must notify the landowner of the proposed activity. An affidavit must also accompany any permit application. Through this regulation, the State strives to minimize coastal zone conflicts.

This Agency and the State of Louisiana revised CZM consistency information for OCS plans, permits, and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2010-N06 and 2009-G27). Federal consistency for right-of-way (ROW) pipelines is addressed in NTL 2007-G20. The State of Louisiana requires an adequate description, objective, and schedule for the project. Also, the State requires site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges (including any disposal of wastes within the State coastal zone and waters and municipal, parish, or State facilities to be used), transportation activities, air emissions, and secondary and cumulative impacts; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/CZMA/CZM-Program-Policies-for-GOM-States-pdf.aspx. The State requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR part 550, 30 CFR part 254, 30 CFR part 256, and NOAA's Federal consistency regulations at 15 CFR part 930. BOEM is continuing a dialogue with the State of Louisiana on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of the Bureau of Ocean Energy Management's NTL's and/or permitting procedures.

State of Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Department of Marine Resources. The MCP is built around several enforceable goals that promote comprehensive management of coastal resources and encourage a balance between environmental protection/preservation and development in the coastal zone. The primary coastal management statute is the Coastal Wetlands Protection Law. Other major features of the MCP include statutes related to fisheries, air and water pollution control, surface and groundwater, cultural resources, and the disposal of solid waste in marine waters. The Department of Marine Resources, the Department of Environmental Quality, and the Department of Archives and History are identified collectively as the "coastal program agencies." Mississippi manages coastal resources by regulation and by promoting activities that use resources in compliance with the MCP. The State developed a coastal wetlands use plan, which includes designated use districts in coastal wetlands and Special Management Area Plans that steer development away from fragile coastal resources and help to resolve user conflicts.

For the purposes of the coastal program, the coastal zone encompasses the three coastal counties of Hancock, Harrison, and Jackson and all coastal waters. The Mississippi coast has 369 mi (594 km) of shoreline, including the coastlines of offshore barrier islands (Cat, Ship, Horn, and Petit Bois Islands). According to NOAA, there are no approved local CMP's for the State of Mississippi. The Southern Mississippi Planning and Development District serves in an advisory capacity to the State coastal agencies.

This Agency developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. This Agency and the State of Mississippi revised CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL (NTL's 2010-N06 and 2009-G27). Federal consistency for ROW pipelines is addressed in NTL 2007-G20. The State of Mississippi requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/CZMA/CZM-Program-Policies-for-GOM-States-pdf.aspx. The State requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR part 550, 30 CFR part 254, 30 CFR part 256, and NOAA's Federal consistency requirements at 15 CFR part 930. BOEM is continuing a dialogue with the State of Mississippi on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of the Bureau of Ocean Energy Management's NTL's and/or permitting procedures.

State of Alabama Coastal Area Management Program

The Alabama Coastal Area Act provides statutory authority to review all coastal resource uses and activities that have a direct and significant effect on the coastal area. The Alabama Department of Conservation and Natural Resources (ADCNR) Lands Division, Coastal Section Office, the lead coastal management agency, is responsible for the management of the State's coastal resources through the Alabama Coastal Area Management Program (ACAMP). The ADCNR is responsible for the overall management of the program including fiscal and grants management and public education and information. The department also provides planning and technical assistance to local governments and financial assistance to research facilities and units of local government when appropriate. The State Lands Division, Coastal Section, also has authority over submerged lands in regard to piers, marinas, bulkheads, and submerged land leases.

The Alabama Department of Environmental Management (ADEM) is responsible for coastal area permitting, regulatory and enforcement functions. Most programs of ADCNR Coastal Section that require environmental permits or enforcement functions are carried out by the ADEM with the exception of submerged land issues. The ADEM has the responsibility of all permit, enforcement, regulatory, and monitoring activities, and the adoption of rules and regulations to carry out the ACAMP. The ADEM must identify specific uses or activities that require a State permit to be consistent with the coastal policies noted above and the more detailed rules and regulations promulgated as part of the ACAMP. Under the Alabama Coastal Area Act, State agency activities must be consistent with ACAMP policies and ADEM findings. Further, ADEM must make a direct permit-type review for uses that are not otherwise regulated at the State level. The ADEM also has authority to review local government actions and to assure that local governments do not unreasonably restrict or exclude uses of regional benefit. Ports and major energy facilities are designated as uses of regional benefit. The ADCNR Lands Division manages all lease sales of State, submerged bottomlands and regulates structures placed on State, submerged bottomlands.

Local governments have the option to participate in the ACAMP by developing local codes, regulations, rules, ordinances, plans, maps, or any other device used to issue permits or licenses. If these instruments are certified to be consistent with ACAMP, ADEM may allow the local government to administer them by delegating its permit authority, thereby eliminating the need for ADEM's case-by-case review.

The South Alabama Regional Planning Commission provides ongoing technical assistance to ADCNR for Federal consistency, clearinghouse review, and public participation procedures. Uses subject to the Alabama's CZMP are divided into regulated and nonregulated categories. Regulated uses are those that have a direct and significant impact on the coastal areas. These uses either require a State permit or are required by Federal law to be consistent with the management program. Uses that require a State permit must receive a certificate of compliance. Nonregulated uses are those activities that have a direct and significant impact on the coastal areas that do not require a State permit or Federal consistency certification. Nonregulated uses must be consistent with ACAMP and require local permits to be administered by ADEM.

This Agency developed coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. This Agency and the State of Alabama have revised CZM consistency information for OCS plans, permits and licenses to conform to the revised CZM regulations that were effective January 8, 2001, and updated on January 5, 2006, and have also incorporated streamlining improvements into the latest NTL's (NTL's 2010-N06 and 2009-G27). Federal consistency for ROW pipelines is addressed in NTL 2007-G20. The State of Alabama requires an adequate description, objective, and schedule for the project; site-specific information on the onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. The State enforceable policies that must be addressed for OCS activities are found at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/CZMA/CZM-Program-Policies-for-GOM-States-pdf.aspx. The State's requirements for Federal consistency review are based specifically on DOI's regulations at 30 CFR part 550, 30 CFR part 254, 30 CFR part 256, and NOAA's Federal consistency requirements at 15 CFR part 930. BOEM is continuing a dialogue with the State of Alabama on reasonably foreseeable coastal effects associated with pipelines and other permits, and the result of these discussions will be incorporated into future updates of the Bureau of Ocean Energy Management's NTL's and/or permitting procedures.

State of Florida Coastal Management Program

For purposes of the CZMA, the State of Florida's coastal zone includes the area encompassed by the State's 67 counties and its territorial seas. Lands owned by the Federal Government and the Seminole and Miccosukee Indian tribes are not included in the State's coastal zone; however, Federal activities in or outside the coastal zone, including those on Federal or tribal lands, that affect any land or water or natural resource of the State's coastal zone are subject to review by Florida under the CZMA. The Florida Coastal Management Act, codified as Chapter 380, Part II, Florida Statutes, authorized the development of a coastal management program. In 1981 the Florida Coastal Management Program (FCMP) was approved by NOAA.

The policies identified by the State of Florida as being enforceable in the FCMP are the 24 chapters that NOAA approved for incorporation in the State's program. The 2011 Florida Statutes are the most recent version approved by NOAA, and the Statutes include the listing of OCSLA permits under Subpart E and the addition of draft environmental assessments and EIS's as necessary data and information for Federal consistency review.

A network of 10 State agencies and five regional water management districts implement the FCMP's 24 statutes. The water management districts are responsible for water quantity and quality throughout the State's watersheds. The State agencies include the following: the Department of Environmental Protection (DEP), the lead agency for the FCMP and the State's chief environmental regulatory agency and steward of its natural resources; the Department of Economic Opportunity, which serves as the State's land planning agency; the Department of Health, Division of Environmental Health, which, among other responsibilities, regulates on-site sewage disposal; the Department of State, Division of Historical Resources, which protects historic and archaeological resources; the Division of Emergency Management, which ensures that Florida is prepared to respond to emergencies; the Fish and Wildlife Conservation Commission, which protects and regulates fresh and saltwater fisheries, marine mammals, and birds and upland species, including protected species and the habitat used by these species; the Department of Transportation, which is charged with the development, maintenance, and protection of the transportation system; the Department of Agriculture and Consumer Services, which manages State forests and administers aquaculture and mosquito control programs; the Florida Building Commission, which is responsible for the adoption of the Florida Building Code; and the Governor's Office of Planning and Budget, which plays a role in the comprehensive planning process.

Effective July 1, 2000, the Governor of Florida assigned the State's responsibilities under the OCSLA to the Secretary of the Florida DEP. The DEP's Office of Intergovernmental Programs coordinates the review of OCS plans with FCMP member agencies to ensure that the plan is consistent with applicable State enforceable policies and the Governor's responsibilities under the Act.

This Agency developed coordination procedures with the State for the submittal of offshore lease sale consistency determinations and plans of operation. In 2003, this Agency and the State revised CZM consistency information for OCS plans, permits, and licenses to conform with the revised CZM regulations that were effective on January 8, 2001, and updated on January 5, 2006, and they have also incorporated streamlining improvements into the latest NTL's (NTL's 2010-N06 and 2009-G27). Federal consistency for ROW pipelines is addressed in NTL 2007-G20.

The State of Florida requires an adequate description, objective, and schedule for all activities associated with a project; specific information on the natural resources potentially affected by the proposed activities; and specific information on onshore support base, support vessels, shallow hazards, oil-spill response, wastes and discharges, transportation activities, and air emissions; and a Federal consistency certification, assessment, and findings. As identified by the State of Florida, the State enforceable policies that must be addressed for OCS activities are found at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/CZMA/CZM-Program-Policies-for-GOM-States-pdf.aspx. These requirements have been incorporated into the Plans and Regional Oil-Spill Response NTL's. The State requirements for Federal consistency review are based on the requirements of State statutes, CZMA regulations at 15 CFR part 930, and DOI's regulations at 30 CFR part 550, 30 CFR part 254, and 30 CFR part 256. BOEM is continuing a dialog with the State of Florida on reasonably foreseeable coastal effects associated with OCS plans, pipelines, and other permits; the result of these discussions will be incorporated into future updates of the Bureau of Ocean Energy Management's NTL's and/or permitting procedures.

APPENDIX F

RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO OCS REGION, 2006–PRESENT

F. RECENT PUBLICATIONS OF THE ENVIRONMENTAL STUDIES PROGRAM, GULF OF MEXICO OCS REGION, 2006–PRESENT

Published in 2013	
Study Number	Title
BOEM 2013-0111	*Socioeconomic Responses to Coastal Land Loss and Hurricanes: Measuring Resilience among Outer Continental Shelf Related Coastal Communities in Louisiana*
BOEM 2013-01110	*Meteorological and Wave Measurements for Improving Meteorological Modeling*
BOEM 2013-0112	*Offshore Drilling Industry and Rig Construction Market in the Gulf of Mexico*
BOEM 2013-0113 BOEM 2013-0114	*Energy Market and Infrastructure Information for Evaluating Renewable Energy Projects for the Atlantic and Pacific OCS Regions* *Volume I: Technical Report* *Volume II: Appendices*
BOEM 2013-01157	*South Atlantic Information Resources: Data Search and Literature Synthesis*
Published in 2012	
Study Number	Title
BOEM 2012-004	*Ultra-Deepwater Circulation Processes in the Gulf of Mexico*
BOEM 2012-006 BOEM 2012-007	*Evaluation of Visual Impact on Cultural Resources/Historic Properties: North Atlantic, Mid-Atlantic, and Florida Straits* *Volume I: Technical Report of Findings* *Volume II: Appendices*
BOEM 2012-008	*Inventory and Analysis of Archaeological Site Occurrence on the Atlantic OCS*
BOEM 2012-015	*Seismic Survey Mitigation Measures and Marine Mammal Observer Reports*
BOEM 2012-102	*Gulf of Mexico MAG-PLAN 2012: Updated and Revised Economic Impact Model*
BOEM 2012-106	*Exploration and Research of Northern Gulf of Mexico Deepwater Natural and Artificial Hard-Bottom Habitats, with Emphasis on Coral Communities: Reefs, Rigs, and Wrecks-*“Lophelia *II” Interim Report*
BOEM 2012-107	*Proceedings: Twenty-Sixth Gulf of Mexico Information Transfer Meeting*
BOEM 2012-108	*Integrated Bio-Physical Modeling of Louisiana-Texas (Latex) Shelf*
BOEM 2012-109	*Literature Search and Data Synthesis for Marine Mammals and Sea Turtles in the US Atlantic from Maine to the Florida Keys*

Published in 2011	
Study Number	Title
BOEMRE 2011-001	*Analysis of the Oil Services Contract Industry in the Gulf of Mexico Region*
BOEMRE 2011-002	*Status and Applications of Acoustic Mitigation and Monitoring Systems for Marine Mammals: Workshop Proceedings, November 17-19, 2009, Boston, Massachusetts*
BOEMRE 2011-003	*Impact of Recent Hurricane Activity on Historic Shipwrecks in the Gulf of Mexico Outer Continental Shelf*
BOEMRE 2011-004	*Archival Investigations for Potential Colonial-Era Shipwrecks in Ultra-Deepwater within the Gulf of Mexico*
BOEMRE 2011-011	*User's Guide for the 2011 Gulfwide Offshore Activities Data System (GOADS-2011)*
BOEMRE 2011-012	*Literature Synthesis for the North and Central Atlantic Ocean*
BOEMRE 2011-028	*Assessment of Opportunities for Alternative Uses of Hydrocarbon Infrastructure in the Gulf of Mexico*
BOEMRE 2011-040	*Shipwreck Research in the New Orleans Notarial Archives*
 BOEM 2011-043 BOEM 2011-044	*OCS-Related Infrastructure Fact Book* *Volume I: Post-Hurricane Impact Assessment* *Volume II: Communities in the Gulf of Mexico*
BOEM 2011-054	*Diversifying Energy Industry Risk in the Gulf of Mexico: Post-2004 Changes in Offshore Oil and Gas Insurance Markets*

Published in 2010	
Study Number	Title
MMS 2010-001	*Proceedings: USA-Mexico Workshop on the Deepwater Physical Oceanography of the Gulf of Mexico, June 2007*
MMS 2010-002	*Proof of Concept for Platform Recruited Reef Fish, Phase 1: Do Platforms Provide Habitat for Subadult Red Snapper?*
MMS 2010-007	*Assessment of Marginal Production in the Gulf of Mexico and Lost Production from Early Decommissioning*
MMS 2010-015	*Low-Frequency Variability of Currents in the Deepwater Eastern Gulf of Mexico*
MMS 2010-016	*Trophic Aspects of Sperm Whales (*Physeter macrocephalus*) in the Northern Gulf of Mexico Using Stable Isotopes of Carbon and Nitrogen*
BOEMRE 2010-039	*Bank Erosion of Navigation Canals in the Western and Central Gulf of Mexico*
BOEMRE 2010-041	*Study of Deepwater Currents in the Eastern Gulf of Mexico*
BOEMRE 2010-042	*Fact Book: Offshore Oil and Gas Industry Support Sectors*
BOEMRE 2010-043	*Determination of Net Flux of Reactive Volatile Organic Compounds at the Air-Water Interface in the Gulf of Mexico*

BOEMRE 2010-044	*Full-Water Column Current Observations in the Western Gulf of Mexico*
BOEMRE 2010-045	*Year 2008 Gulfwide Emission Inventory Study*
BOEMRE 2010-046	*Multicomponent and Multifrequency Seismic for Assessment of Fluid-Gas Expulsion Geology and Gas-Hydrate Deposits: Gulf of Mexico Hydrates*
BOEMRE 2010-050	*Satellite Data Assimilation into Meteorological/Air Quality Models*
BOEMRE 2010-051	*Evaluation of NASA Aura's Data Products for Use in Air Quality Studies over the Gulf of Mexico*
BOEMRE 2010-052 BOEMRE 2010-053	*Long-Term Monitoring at the East and West Flower Garden Banks: 2004-2008* *Volume 1: Technical Report* *Volume 2: Appendices*
Published in 2009	
Study Number	Title
MMS 2009-010	*Quality Control and Analysis of Acoustic Doppler Current Profiler Data Collected on Offshore Platforms of the Gulf of Mexico*
MMS 2009-013	*Foraminiferal Communities of Bathyal Hydrocarbon Seeps, Northern Gulf of Mexico: A Taxonomic, Ecologic, and Geologic Study*
MMS 2009-023	*Loop Current Frontal Eddies Based on Satellite Remote Sensing and Drifter Data*
MMS 2009-032	*Post-Hurricane Assessment of Sensitive Habitats of the Flower Garden Banks Vicinity*
MMS 2009-039	*Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study: Final Report*
MMS 2009-043	*Blue Crab* (Callinectes sapidus) *Use of the Ship/Trinity/Tiger Shoal Complex as a Nationally Important Spawning/Hatching/Foraging Ground: Discovery, Evaluation, and Sand Mining Recommendations Based on Blue Crab, Shrimp, and Spotted Seatrout Findings*
MMS 2009-046	*Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico, Interim Report 2*
MMS 2009-048	*Outer Continental Shelf (OCS)-Related Pipelines and Navigation Canals in the Western and Central Gulf of Mexico: Relative Impacts on Wetlands Habitats and Effectiveness of Mitigation*
MMS 2009-050	*Observation of the Deepwater Manifestation of the Loop Current and Loop Current Rings in the Eastern Gulf of Mexico*
MMS 2009-051	*Proceedings: Twenty-fifth Gulf of Mexico Information Transfer Meeting, January 2009*

	Synthesis, Analysis, and Integration of Meteorological and Air Quality Data for the Gulf of Mexico Region
MMS 2009-055	*Volume I: User's Manual for the Gulf of Mexico Air Quality Database (Version 1.0)*
MMS 2009-056	*Volume II: Technical Reference Manual for the Gulf of Mexico Air Quality Database*
MMS 2009-057	*Volume III: Data Analysis*
MMS 2009-058	*Volume IV: Cart Analysis of Modeling Episode Days*
MMS 2009-059	*Evaluation of Oil and Gas Platforms on the Louisiana Continental Shelf for Organisms with Biotechnology Potential*
MMS 2009-060	*Modeling Waves and Currents Produced by Hurricanes Katrina, Rita, and Wilma*
Published in 2008	
Study Number	Title
MMS 2008-001	*Deepwater Currents in the Eastern Gulf of Mexico: Observations at 25.5°N and 87°W*
MMS 2008-006	*Sperm Whale Seismic Study in the Gulf of Mexico: Synthesis Report*
MMS 2008-009	*Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico: Interim Report 1*
MMS 2008-012	*Proceedings: Twenty-Fourth Gulf of Mexico Information Transfer Meeting, January 2007*
MMS 2008-015	*Characterization of Northern Gulf of Mexico Deepwater Hard Bottom Communities with Emphasis on* Lophelia *Coral*—Lophelia *Reef Megafaunal Community Structure, Biotopes, Genetics, Microbial Ecology, and Geology (2004-2006)* NOTE: This study was conducted by the U.S. Geological Survey (USGS) for the Agency's Headquarters' Office, and it was funded by USGS.
MMS 2008-017	*Examination of the Development of Liquefied Natural Gas on the Gulf of Mexico*
MMS 2008-018	*Viosca Knoll Wreck: Discovery and Investigation of an Early Nineteenth-Century Wooden Sailing Vessel in 2,000 Feet of Water*
MMS 2008-019	*Post-Hurricane Assessment at the East Flower Garden Bank Long-Term Monitoring Site: November 2005*
MMS 2008-022	*Effects of Subsea Processing on Deepwater Environments in the Gulf of Mexico*
MMS 2008-024	*Executive Summary: 3rd International Deep-Sea Coral Symposium in Miami*
	Long-Term Monitoring at the East and West Flower Garden Banks, 2004-2005—Interim Report
MMS 2008-027	*Volume I: Technical Report*
MMS 2008-028	*Volume II: Appendices*

MMS 2008-029	*Five-Year Meteorological Datasets for CALMET/CALPUFF and OCD5 Modeling of the Gulf of Mexico Region*
	Study of Deepwater Currents in the Northwestern Gulf of Mexico
MMS 2008-030	*Volume I: Executive Summary*
MMS 2008-031	*Volume II: Technical Report*
	History of the Offshore Oil and Gas Industry in Southern Louisiana
MMS 2008-042	*Volume I: Papers on the Evolving Offshore Industry*
MMS 2008-043	*Volume II: Bayou Lafourche—Oral Histories of the Oil and Gas Industry*
MMS 2008-044	*Volume III: Morgan City's History in the Era of Oil and Gas—Perspectives of Those Who Were There*
MMS 2008-045	*Volume IV: Terrebonne Parish*
MMS 2008-046	*Volume V: Guide to the Interviews*
MMS 2008-047	*Volume VI: A Collection of Photographs*
MMS 2008-048	*Platform Debris Fields Associated with the Blue Dolphin (Buccaneer) Gas and Oil Field Artificial Reef Sites Offshore Freeport, Texas: Extent, Composition, and Biological Utilization*
	Labor Needs Survey
MMS 2008-050	*Volume I: Technical Report*
MMS 2008-051	*Volume II: Survey Instruments*
MMS 2008-052	*Benefits and Burdens of OCS Activities on States, Labor Market Areas, Coastal Counties, and Selected Communities*
MMS 2008-058	*Cumulative Increment Analysis for the Breton National Wilderness Area*
Published in 2007	
Study Number	Title
MMS 2007-015	*Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico; Artificial Reef Effect in Deepwater*
MMS 2007-019	*Mixtures of Metals and Polynuclear Aromatic Hydrocarbons May Elicit Complex, Nonadditive Toxicological Interactions*
MMS 2007-022	*Full-Water Column Current Observations in the Central Gulf of Mexico: Final Report*
MMS 2007-030	*Incorporation of Gulf of Mexico Benthic Survey Data into the Ocean Biogeographic Information System*
MMS 2007-031	*Idle Iron in the Gulf of Mexico*
MMS 2007-033	*Cooperative Research to Study Dive Patterns of Sperm Whales in the Atlantic Ocean*
MMS 2007-034	*Competition and Performance in Oil and Gas Lease Sales and Development in the U.S. Gulf of Mexico OCS Region, 1983-1999*

MMS 2007-035	*Seafloor Characteristics and Distribution Patterns of Lophelia pertusa and Other Sessile Megafauna at Two Upper-Slope Sites in the Northeastern Gulf of Mexico*
MMS 2007-044	*Characterization of Northern Gulf of Mexico Deepwater Hard-Bottom Communities with Emphasis on* Lophelia *Coral*
MMS 2007-056	*Full-Water Column Currents Near the Sigsbee Escarpment (91-92º W. Longitude) and Relationships with the Loop Current and Associated Warm- and Cold-Core Eddies*
MMS 2007-061	*Study of Barite Solubility and the Release of Trace Components to the Marine Environment*
MMS 2007-067	*Year 2005 Gulfwide Emission Inventory Study*
MMS 2007-068	*User's Guide for the 2008 Gulfwide Offshore Activities Data System (GOADS-2008)*

Published in 2006

Study Number	Title
MMS 2006-005	*Fidelity of Red Snapper to Petroleum Platforms and Artificial Reefs in the Northern Gulf of Mexico*
MMS 2006-011	*Sustainable Community in Oil and Gas Country: Final Report*
MMS 2006-028	*Degradation of Synthetic-Based Drilling Mud Base Fluids by Gulf of Mexico Sediments, Final Report*
MMS 2006-030	*Accounting for Socioeconomic Change from Offshore Oil and Gas: Cumulative Effects on Louisiana's Coastal Parishes, 1969-2000*
MMS 2006-034	*Sperm Whale Seismic Study in the Gulf of Mexico, Summary Report: 2002-2004*
MMS 2006-035	*Long-Term Monitoring at the East and West Flower Garden Banks National Marine Sanctuary, 2002-2003*
MMS 2006-036	*Study to Conduct National Register of Historic Places Evaluations of Submerged Sites on the Gulf of Mexico Outer Continental Shelf*
MMS 2006-037	*Effect of Depth, Location, and Habitat Type, on Relative Abundance and Species Composition of Fishes Associated with Petroleum Platforms and Sonnier Bank in the Northern Gulf of Mexico*
MMS 2006-044 MMS 2006-045 MMS 2006-046	*Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico;* *Volume I: Executive Summary* *Volume II: Technical Report* *Volume III: Appendices*

MMS 2006-063	*Economic Effects of Petroleum Prices and Production in the Gulf of Mexico OCS on the U.S. Gulf Coast Economy*
MMS 2006-064	*Capital Investment Decisionmaking and Trends in Petroleum Resource Development in the U.S. Gulf of Mexico*
MMS 2006-067	*Sperm Whale Seismic Study in the Gulf of Mexico, Annual Report: Years 3 and 4*
MMS 2006-071	*Annotated Bibliography of the Potential Environmental Impacts of Chlorination and Disinfection Byproducts Relevant to Offshore Liquefied Natural Gas Port Facilities*
MMS 2006-072	*Mica Shipwreck Project Report: Deepwater Archaeological Investigation of a 19th Century Shipwreck in the Gulf of Mexico*
 MMS 2006-073 MMS 2006-074	*Exploratory Study of Deepwater Currents in the Gulf of Mexico* *Volume I: Executive Summary* *Volume II: Technical Report*

APPENDIX G

AIR QUALITY OFFSHORE MODELING ANALYSIS

G. AIR QUALITY OFFSHORE MODELING ANALYSIS

Introduction

This Appendix discusses the coastal dispersion modeling analysis and the potential impacts of offshore emissions from an EPA proposed action to onshore air quality. The latest version of the Offshore and Coastal Dispersion Model (Version 5.0, dated May 16, 2005) was used to calculate impacts. The objective of the analysis was to determine if the impacts from an EPA proposed action would significantly affect the environment, particularly public health and public welfare.

Background

The proposed EPA lease sale area is located east of 87.5° W. longitude in the portion of the Gulf of Mexico for which jurisdiction on air quality matters has been assigned to the U.S. Environmental Protection Agency (USEPA). In order to conduct activities at the lease, lessees must obtain an air permit from USEPA pursuant to Section 328 of the Clean Air Act, 42 U.S.C. § 7627, and the implementing OCS Air Regulations at 40 CFR part 55, which incorporate by reference the Prevention of Significant Deterioration (PSD) of air quality regulations at 40 CFR § 52.21. These regulations require that sources within 25 miles (mi) (40 kilometers ([km]) of a State's seaward boundary comply with the applicable regulations of the corresponding onshore area, generally a state. Areas beyond 25 mi (40 km) of the State's seaward boundary are subject to Federal requirements, including the requirements for construction and operating permits and equipment-specific performance standards. The proposed EPA lease sale area is beyond 25 mi (40 km) of the State's seaward boundary.

Although the proposed EPA lease sale areas falls east of 87.5° W. longitude and operators with actions that affect air quality in this area must comply with USEPA's air quality regulations, under the National Environmental Policy Act (NEPA) BOEM must evaluate the environmental impacts of an EPA proposed action. The discussion that follows refers to USEPA's and BOEM's regulations as a means to evaluate environmental impacts to the air resulting from an EPA proposed action. As noted in the tables, BOEM's regulations are different from USEPA's regulations. Although NEPA does not require a regulatory proxy for the significance of an EPA proposed action, for the sake of comparison, BOEM has included these regulatory levels for evaluation.

The Clean Air Act, which was last amended in 1990, requires USEPA to set National Ambient Air Quality Standards (NAAQS, [40 CFR part 50]) for pollutants considered harmful to public health and the environment. The USEPA has set NAAQS for six principal pollutants, which are called "criteria" pollutants. These pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution (listed as $PM_{2.5}$ and PM_{10}), and sulfur dioxide.

The NAAQS were developed to protect the public health and welfare while allowing for an adequate margin of safety. Primary NAAQS protect the public health including sensitive subpopulations such as infants and the elderly. Secondary NAAQS standards protect public welfare such as the prevention of aquatic acidification, plant leaf damage, or visibility impairment. Significant Impact Levels (SIL's) are a de minimis threshold that USEPA derived from the NAAQS and are applied to individual facilities that apply for a USEPA permit to emit a regulated pollutant in an area that meets the NAAQS. On the Outer Continental Shelf (OCS), USEPA must determine if emissions from that facility will cause the air quality to worsen. The SIL is a screening tool for whether a source may cause or contribute to a violation of a PSD increment or the NAAQS, i.e., a significant deterioration of air quality. If an individual facility projects an increase in emissions that result in ambient impacts greater than the established SIL, the permit applicant would be required to perform additional analyses to determine if those impacts will be more than the amount of the PSD increment. This analysis would combine the impact of the proposed facility when added on to all other sources in the area.

The PSD increments prevent the air quality in clean areas from deteriorating to the level set by the NAAQS. The NAAQS is a maximum allowable concentration "ceiling." A PSD increment, on the other hand, is the maximum allowable increase in concentration that is allowed to occur above a baseline concentration for a pollutant. The baseline concentration is defined for each pollutant and, in general, it is the ambient concentration existing at the time that the first complete PSD permit application affecting the area is submitted. Significant deterioration is said to occur when the amount of new pollution would exceed the applicable PSD increment. More specifically, increments are the maximum allowable increase in ambient air concentrations of a criteria pollutant from a baseline concentration. Because increments only apply in areas covered by the PSD program, they are generally known as PSD increments. The SIL's and increments exist for Class I and Class II areas. Thus, for NEPA evaluation purposes, it is reasonable to presume that concentrations of emissions from offshore activities that, following transport to shore, do not cause exceedances of the U.S. Environmental Protection Agency's SIL's and PSD increments will have minimal impacts to onshore air quality.

BOEM-regulated pollutants include carbon monoxide, suspended particulates, sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC's). The original NAAQS' particulate standard was for total suspended particulates, which BOEM adopted. This standard has been replaced with PM_{10} and $PM_{2.5}$ (particulate matter equal to or below 10 µm and equal to or below 2.5µm in size) because these specific size classifications better define the size range that has greatest environmental impact. BOEM's regulations continue to include total suspended particulates; however, for purposes of this NEPA analysis, BOEM determined levels of PM_{10} and $PM_{2.5}$ so that the data are compatible with USEPA's data for the sake of comparison. This is one example of where USEPA's regulations and BOEM's regulations are different. Similarly, BOEM's regulations still employ 3-hour, 24-hour, and annual standards while the NAAQS have 1-hour standards to limit pollutant spikes that are not detectable when concentrations are averaged over a longer time period. BOEM has included both types of particulate designations in this Appendix.

For OCS oil and gas activities in the GOM west of 87.5° W. longitude, BOEM has developed evaluation criteria and screening tools. Refer to Chapter 4.2.1.1 of *Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014; Western Planning Area Lease Sale 233; Central Planning Area Lease Sale 231, Draft Environmental Impact Statement* (WPA 233/CPA 231 Supplemental EIS). As USEPA has air permitting authority in the EPA, lessees are generally required to obtain Clean Air Act permits prior to conducting postlease activities approved by BOEM or BSEE.

According to the Clean Air Act Amendments, the air quality in national parks, national wilderness areas, national monuments, and national seashores (42 U.S.C. § 7470) must be preserved. The Clean Air Act Amendments establish Class I and II areas, where emissions of particulate matter and sulfur dioxide are to be restricted. The restrictions are most severe in Class I areas and are progressively less restrictive in Class II areas. In the Gulf of Mexico, the Breton National Wilderness Area, 134 mi (216 km) from the proposed EPA lease sale area, is the Class I area most likely to be impacted by OCS activity. When these same emissions from offshore activities are modeled to determine that concentrations at the Breton Class I area are also below the U.S. Environmental Protection Agency's SIL's, it is reasonable to presume for NEPA evaluation purposes that the concentrations of emissions from offshore activities have negligible impacts to the air quality of this pristine Federal area.

In addition to the Breton National Wilderness Area, three additional U.S. Fish and Wildlife Service or U.S. Forest Service wilderness areas are present on the Florida Gulf Coast. They are St. Marks, Bradwell Bay, and Chassakowitza National Wilderness Areas, which are located on the Florida Gulf Coast at a minimum of 180 mi (290 km) from the EPA proposed action area. Impacts to these additional areas were not modeled as they are almost 50 mi (80 km) farther away from the EPA proposed action area. As such, impacts from an EPA proposed action would be expected to be even smaller than those expected at the Breton National Wilderness Area.

Offshore and Coastal Dispersion Model Version 5

The Offshore and Coastal Dispersion model version 5 (OCD 5 model) was developed by USEPA in conjunction with BOEM's predecessor agency, the Minerals Management Service, in the late 1980's, and the model was formally approved for use in January 1988. The OCD 5 model is a coastal dispersion model that was formulated to estimate shoreline concentrations resulting from releases taking place from offshore petroleum drilling platforms. The developers suggest that direct turbulence measurements be used to estimate the dispersion parameters over water. As the plume comes ashore, dispersion is estimated for the effect of transport over land using traditional techniques (Turner and Schulze, 2007).

The OCD 5 model input data comprises source-specific data as well as meteorological data. The source-specific data includes location of activities, emission rate information for all sources associated with activities at the given location, and stack parameters for each source. The model requires both over-land and over-water meteorological data to determine the potential onshore impacts of the offshore operations. These data include overland surface characteristics such as surface roughness and over-water data such as water temperature, over-water air temperature, over-water dew point, over-water wind speed, and over-water wind direction. These data are usually obtained from the offshore buoy closest to the source at three different mixing heights—300 meters, 600 meters, and 900 meters (984 feet, 1,969 feet, and 2,953 feet).

The model parameters are populated by choosing onshore locations (receptors) at which the OCD 5 model will predict the pollutant concentrations of the modeled emission sources. Receptors are identified on the shoreline and at nearby Class I areas. Although the OCD 5 model does not include algorithms for parameters such as regional haze and acid deposition, its relatively simpler data processing makes it an efficient model for use in predicting pollutant impacts from offshore sources.

The OCD 5 model was chosen to analyze the proposed impacts because it performs best when meteorological data is collected over the water. The OCD 5 model was approved for use by the Director of the Minerals Management Service (currently BOEM), and it is listed as an approved air quality model in Appendix W of 40 CFR part 51. More recently, the BOEM Director approved the use of the California-PUFF model (CALPUFF), another approved dispersion model listed in Appendix W of 40 CFR part 51. However, the OCD 5 model was chosen because BOEM continues to believe it is the more conservative of the two models.

The OCD model does not include a simulation of onshore ozone levels. Several prior studies have demonstrated that OCS activities have only a small contribution to onshore ozone formation. Because the offshore activities' contribution to onshore ozone has been shown to be very small, BOEM chose to run the OCD 5 model. The studies that support this decision include the *Gulf of Mexico Air Quality Study* (Science Applications International, 1995), in which this Agency used the Urban Airshed Model (UAM-V) to assess the potential impacts of OCS activity in the CPA and WPA on USEPA-designated ozone nonattainment areas in urban onshore Texas and Louisiana. Relative to onshore contributors, OCS contributors to onshore ozone formation were low. The *Gulf of Mexico Air Quality Study* was followed by a study in 2000 that used the 2000 Gulfwide emissions to assess the OCS contribution to onshore ozone in the Houston/Brazoria/Galveston region of Texas. The Comprehensive Air Quality Model with extensions (CAMx) was used to model contribution during an August 2000 ozone episode (Yarwood, 2004). The OCS contributions to ozone exceedances were minor. A second follow-up study was conducted in 2008 using the updated 2005 Gulfwide Emission Inventory Study to model ozone formation in Louisiana, Mississippi, Alabama, and Florida based on an August 1999 ozone episode (Haney et al., 2008). The study domain included Santa Rosa, Escambia, and Bay Counties in Florida. In this study, OCS oil and gas activity contributed only slightly to the simulated onshore ozone exceedances. No study has been conducted to estimate emissions from activities east of 87.5° W. longitude or the EPA proposed action area to onshore ozone. Because of the relatively small area of an EPA proposed action, the limited activity defined by the scenario, and the great distance to shore, BOEM believes that it is a reasonable estimation that activities associated with an EPA proposed action will have a very slight, if any, effect on onshore ozone.

OCD Model Version 5 Protocol

The OCD 5 model was used to analyze an EPA proposed action's impacts on the onshore community. BOEM's regulations at 30 CFR § 550.303 cite that an approved model should be used to assess impacts. The USEPA lists approved models in 40 CFR Chapter 1, Part 51, Appendix W 7.2.4., "Modeling Guidance for Other Governmental Programs." The model was used to compute concentrations of SO_2, NO_x, VOC's, carbon monoxide (CO), PM_{10}, and $PM_{2.5}$.

BOEM's regulations do not include ozone as it is not directly emitted into the air from OCS oil and gas activities. BOEM does regulate the pollutants VOC and nitrogen dioxide (NO_2), which are precursors to ozone. Ozone formation from VOC's and NO_2 is dependent upon a photochemical reaction in the ambient air that includes heat and sunlight. Ozone formation is a problem in onshore urban areas with many sources of pollutants. The OCD 5 model cannot simulate ozone generation. Several studies that BOEM has conducted and that are discussed above have shown that OCS activities are only a small contributor to onshore ozone exceedance so there was no need to perform ozone modeling. Estimates of the amount of activity that will result from a proposed EPA lease sale were made using the scenarios for both an individual typical lease sales and all cumulative OCS activities in the EPA (**Tables 3-2, 3-3, and 3-4** of this EIS). BOEM can attribute an amount of emissions generated by each activity through information collected in the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and Rigzone (2009). Billings et al. (official communication, 2012), developed a spreadsheet based on the findings of the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010). Using the level of activity and the activity's known emissions, total emissions were determined for each type of activity for the 40-year analysis period for an EPA proposed action.

Yearly emissions from all of these activities and sources were summed together and modeled: exploration and delineation drilling; development and production drilling; platform installation and removal; pipeline installation; production platform operations; tanker loading; tanker in transit; tanker unloading; and helicopters and support vessels. Drilling comprises approximately 60-75 percent of the total emissions. Emissions for the year with the highest annual emissions during the 40-year analysis period (tons/year) and the cumulative sum of all emissions from all OCS-related activities in the EPA during the 40-year analysis period (tons) are shown in **Tables G-1 and G-2**. The data in the spreadsheets developed by Billings et al. (official communication, 2012) based on an average drillship as reported in Wilson et al. (2010) and Rigzone (2009) for the Gulf of Mexico. Drilling days and average kilowatts were used to calculate reasonably foreseeable emissions. Specific drillships can be significantly larger or smaller than the average value used in the spreadsheet, and greater total emissions could be generated if the drillship stays on location longer. These averages may not, in every situation, directly translate to the short-term (as opposed to annual) NAAQS; nevertheless, BOEM's subject-matter experts believe that the analysis remains conservative with regards to reasonably foreseeable emissions expected to result from an EPA proposed action.

The single sale projected emissions were then assigned to De Soto Canyon Block 548 within the EPA for OCD 5 modeling. Modeling emissions from cumulative sales was not performed because although the cumulative emissions are greater than the lease sale emissions, the emissions would be widely distributed across the planning areas and would be the result of activities based on all stages of the life of the lease. Since drilling is the activity with the greatest emissions and is most concentrated in a new lease, modeling for a single lease sale was considered sufficient. At the time of the proposed EPA lease sale, BOEM can only generally predict where or when the activities that generate air pollutants will occur during the 40-year analysis period within EPA. Since the EPA proposed action area is relatively small, De Soto Canyon Block 548 was selected because it was in sufficiently deep waters, close to shore, and not already leased. Of the various types of drilling rigs, the drillship was chosen because it generates the greatest amount of emissions since it is not anchored to the seafloor. Instead, the drillship depends on engines to stay on location. Thus, the drillship's emissions result from both drilling and the thrusters used to maintain location. A drillship generates an average of 773 tons of NO_x per well whereas a jack-up rig generates 47 tons of NO_x per well. The selected EPA source (De Soto Canyon Block 548 is about 125 mi (201 km) from the closest shoreline and 134 mi (216 km) from the Breton Class I Area. All of the emissions from the year with the highest activity were placed in one location rather than distributed across the proposed EPA lease sale area. The modeling scenario is presented in **Table G-3**.

The meteorological data used are described in BOEM's *Five-Year Meteorological Datasets for CALMET/CALPUFF and OCD5 Modeling of the Gulf of Mexico Region* (Douglas and Hudischewskyj, 2008). The meteorological files to use in the OCD 5 model were prepared using onshore surface and upper-air data from the National Weather Service, mixing height estimates obtained from the National Climatic Data Center, and offshore buoy data from the National Data Buoy Center (Douglas and Hudischewskyj, 2008). For the De Soto Canyon Block 548 OCD 5 modeling effort, the meteorological data were from 2000 through 2004 for both surface and upper air, and the buoy used is Buoy 13899. These meteorological data points are the closest physically to the proposed EPA lease sale area that are available to BOEM and, therefore, are the best approximation available.

The modeling domain was selected to include the closest shoreline area potentially impacted by emissions. Receptors were set at the Breton Class I area and at the States' shorelines. For the De Soto Canyon Block 548 source, 27 onshore receptors were used: 6 in Florida; 3 in Alabama; 3 in Mississippi; 8 in Louisiana; and 7 in the Breton Class I area.

Limitations

There are limitations associated with this modeling effort. The OCD 5 model was selected because it was specifically designed to include overwater conditions. The other models, which might have been selected, would possibly have included features such as the ability to determine ozone formation and the ability to model vessel emissions as a moving rather than stationary source. These models were not chosen because they are either not approved in USEPA's Appendix W or they do not reflect overwater conditions.

Furthermore, a more realistic estimation of shoreline impacts could have been obtained by distributing the sources of emissions across the OCS rather than using the assumption that all emissions occur at a single location in the EPA (De Soto Canyon Block 548). Results are not available for every point on the coast. The inclusion of more receptor locations would provide greater detail to the results. Modeling did not include every type of exploration and production activity or accidental event. Modeling did not include drilling at a location closer to shore with emissions representative of a more appropriate bottom-founded rig.

Nevertheless, by using a reasonable conservative approach, which includes the overestimation of reasonable emissions, and attribution of the source of these emissions to a single point in the proposed EPA lease sale area rather than at more dispersed source points throughout the proposed EPA lease sale area, and by using the conservative OCD 5 model, which is specifically designed to represent the offshore and coastal environment, the results of this modeling effort adequately represent a demonstration of the impacts of offshore emissions to the shoreline and to the Class I area.

OCD Model Version 5 Results

The OCS emissions for the criteria pollutants as a result of the EPA proposed action is based on the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and Billings et al. (official communication, 2012). The major pollutant emitted is NO_x, while PM_{10} is the least-emitted pollutant. Platform operations are contributors of VOC emissions. Commercial marine vessels are contributors of SO_2 and PM emissions. Support activities for OCS activities including crew and supply boats, helicopters, and pipeline vessels consist mainly of NO_x and CO emissions. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly to NO_x.

Since NO_x has the highest potential emissions for OCS activities, annual NO_2 and 1-hour NO_2 were analyzed and compared with the U.S. Environmental Protection Agency's SIL's. To be conservative, all emissions of NO_x were assumed to be equal to NO_2 for modeling purposes.

Results are provided in **Table G-4** for the EPA Class I and EPA Class II areas, respectively. The averaging times modeled for each pollutant were based on USEPA and BOEM's regulations. The USEPA has not decided on Class I SIL's for 1-hour SO_2 or 1-hour NO_2. Therefore, the SIL is noted as "To Be Determined (TBD)" in **Table G-4**.

The OCD 5 modeling results indicate that the EPA proposed actions operations do not contribute to the exceedance of the U.S. Environmental Protection Agency's SIL's or NAAQS for any pollutant in an onshore area. Since the modeled impacts are lower than the NAAQS and the U.S. Environmental Protection Agency's SIL's and since studies have shown only a slight contribution to onshore ozone at study locations adjacent to the CPA and WPA, BOEM is confident that the proposed action activities for the EPA will not significantly impact onshore air quality.

The results for the Class I Breton National Wilderness Area also demonstrate that an EPA proposed action does not exceed the NAAQS and the U.S. Environmental Protection Agency's SIL's (**Table G-4**).

The results for the Class II area also demonstrate that an EPA proposed action does not exceed the NAAQS and the U.S. Environmental Protection Agency's SIL's (**Table G-4**). The results also indicate that the maximum modeled concentrations for the 1-hour averaging period for the NO_2 combined with the nearest representative onshore NO_2 monitored concentrations do not exceed the NO_2 1-hour U.S. Environmental Protection Agency's SIL for the Breton National Wilderness Area as well as for the entire EPA (**Table G-4**). The results of the modeled impacts support the conclusion that there will be minimal impacts to onshore air quality.

Conclusion

Based on studies conducted in 1995 (Systems Applications International et al., 1995), 2000 (Yarwood et al., 2004), and 2008 (Wilson et al., 2010), BOEM has determined that OCS activities contributed only slightly to onshore ozone exceedances in the Houston/Brazoria/Galveston areas of Texas, and the States of Louisiana, Mississippi, Alabama, and Florida. Consequently, ozone modeling was not performed for this analysis. The OCD model was selected to model for the pollutants CO, NO_x, SO_x, $PM_{2.5}$, and PM_{10}. BOEM used a conservative approach in choosing and populating the OCD model for this analysis, which includes the overestimation of reasonable emissions and the attribution of the source of these emissions to a single point in the proposed EPA lease sale area rather than at more realistic source points throughout the proposed EPA lease sale area. The conservative OCD 5 model is specifically designed to represent the offshore and coastal environments. The results of this modeling effort adequately represent a demonstration of the impacts of offshore emissions to the shoreline and to the Class I area.

The OCD 5 modeling was performed for the Breton Class I and Class II areas from Louisiana to Florida. The EPA hypothetical source location was chosen approximately 125 mi (201 km) from shore. Even with all the emissions being attributed to a single point, which would not be the case in reality, EPA emissions would minimally impact onshore air quality. Significant impacts to air quality are not expected to result from an EPA proposed action.

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Table G-1

Eastern Planning Area, Estimated High-Case Emissions for a Single Lease Sale, Highest Year of Emissions during the 40-Year Period of Activity (tons/year)

	NO_x	SO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	368.63	0.29	12.87	12.49	6.51	95.77	31,239.58	0.22	1.33
Development/Production Well Drilling	1,179.93	0.92	41.19	39.96	20.85	306.41	100,044.06	0.71	4.25
Platform Installation and Removal	195.69	0.14	6.71	6.50	2.86	52.12	15,594.87	0.09	0.71
Pipeline Installation	1.68	0.00	0.05	0.05	0.05	0.35	181.05	0.00	0.01
Production Platforms	49.92	0.69	0.52	0.52	40.73	55.21	5,656.70	283.64	0.08
Tankers Loading	0.05	0.00	0.0011	0.0010	10.50	0.0045	1.99	2.05E-05	0.0001
Tankers in Transit	2.31	0.00	0.06	0.05	0.22	0.23	100.83	0.0005	0.00
Tankers Unloading	0.05	0.00	0.0011	0.0010	3.23	0.0045	1.99	2.05E-05	0.0001
Helicopters	0.0005	0.0001	0.0001	0.0001	0.0012	0.01	0.62	0.00E+00	0.00E+00
Support Vessels	281.56	0.34	9.65	9.36	4.12	74.99	22,438.08	0.14	1.02
Total	2,079.83	2.38	71.05	68.93	89.07	585.08	175,259.77	284.80	7.41

CO = carbon monoxide.
CO_2 = carbon dioxide.
CH_4 = methane.
N_2O = nitrous oxide.
NO_x = nitrogen oxides.
PM_{10} = particulate material less than 10 µm in size.
$PM_{2.5}$ = particulate material less than 2.5 µm in size.
SO_x = sulfur oxides.
VOC = volatile organic compound.

Table G-2

Eastern Planning Area, Estimated High-Case Emissions for Cumulative Sales, Total Emissions during the 40-Year Period of Activity (tons)

	NO_x	SO_x	PM_{10}	$PM_{2.5}$	VOC	CO	CO_2	CH_4	N_2O
Exploration/Delineation Well Drilling	6,058.67	4.86	207.38	201.15	114.29	1,540.28	528,021.44	4.04	24.10
Development/Production Well Drilling	8,975.81	7.20	307.22	298.01	169.32	2,281.89	782,253.99	5.99	35.71
Platform Installation and Removal	587.07	0.43	20.12	19.51	8.59	156.36	46,784.60	0.28	2.14
Pipeline Installation	243.96	0.24	6.92	6.71	7.13	50.52	26,252.58	0.31	1.20
Production Platforms	1,382.88	19.01	14.52	14.32	1,128.31	1,529.20	156,690.50	7,856.92	2.33
Tankers Loading	0.41	0.01	1.01E-02	9.23E-03	94.52	0.04	17.94	0.0002	0.0007
Tankers in Transit	21.17	0.56	5.20E-01	4.76E-01	2.01	2.10	924.12	0.0048	0.04
Tankers Unloading	0.41	0.01	1.01E-02	9.23E-03	29.03	0.04	17.94	0.0002	0.0007
Helicopters	0.03	0.0068	5.45E-03	5.45E-03	0.07	0.34	34.08	0.00E+00	0.00E+00
Support Vessels	16,542.56	14.21	567.20	550.18	242.08	4,402.80	1,317,179.31	8.01	60.12
Total	33,812.97	46.53	1,123.89	1,090.38	1,795.33	9,963.57	2,858,176.51	7,875.55	125.64

CO = carbon monoxide.
CO_2 = carbon dioxide.
CH_4 = methane.
NO_x = nitrogen oxides.
PM_{10} = particulate material less than 10 µm in size.
$PM_{2.5}$ = particulate material less than 2.5 µm in size.
SO_x = sulfur oxides.
VOC = volatile organic compound.

Table G-3

Modeling Scenario

Modeling Scenario	Source Location		Activity Represented	NO_x (g/sec)	SO_x (g/sec)	PM_{10} (g/sec)	$PM_{2.5}$ (g/sec)	VOC (g/sec)	CO (g/sec)
	Area	Area/Block							
1	EPA	De Soto Canyon Block 548	All activity during the year with the highest lease sale emissions	59.83	0.07	2.04	1.98	2.56	16.83

CO = carbon monoxide.
EPA = Eastern Planning Area.
g/sec = grams per second.
NO_x = nitrogen oxides.
PM_{10} = particulate material less than 10 µm in size.
$PM_{2.5}$ = particulate material less than 2.5 µm in size.
SO_x = sulfur oxides.
VOC = volatile organic compound.

Table G-4

Modeling Results for an EPA Proposed Action Compared with USEPA's Significance Impact Levels and the NAAQS

Pollutant	Averaging Times	BOEM Significance Levels ($\mu g/m^3$)	BOEM Maximum Allowable Increases ($\mu g/m^3$)		NAAQS ($\mu g/m^3$)	USEPA PSD Significance Impact Levels ($\mu g/m^3$)		BOEM Modeled Impacts ($\mu g/m^3$)	
			Class I	Class II		Class I	Class II	Class I	Class II
CO	8-hour	500	None	None	10,000	None	500	None	None
	1-hour	2,000	None	None	40,000	None	2,000	None	None
NO_2	Annual	1	None	None	100	0.1	1	0.03	0.03
	1-hour	None	None	None	188	TBD	7.5[a]	4.32[b]	99.29[c]
SO_2	Annual	1	2	20	80[d]	0.1	1	0.0	0.0
	24-hour	5	5	91	365[d]	0.2	5	0.0	0.2
	3-hour	25	2	512	1,300	1	25	0.0	0.5
	1-hour	None	None	None	196	TBD	7.86[a]	0.01	0.01
$PM_{2.5}$[e]	Annual	1	5	19	12	0.06	0.3	0.0	0.0
	24-hour	5	10	37	35	0.07	1.2	0.02	0.02
PM_{10}[e]	Annual	1	5	19	None	0.2	1	0.0	0.0
	24-hour	5	10	37	150	0.3	5	0.02	0.02

Note: All units have been converted to $\mu g/m^3$.

[a] Interim Significant Impact Level

[b] No background NO_2 concentration available for the Breton National Wilderness Area.

[c] Determined by adding modeled concentration (5.22 $\mu g/m^3$) to Kenner, Louisiana, 1-hour NO_x monitor background (94.07 $\mu g/m^3$) and compared with the NAAQS.

[d] To be revoked 1 year after designations for the 1-hour standard.

[e] BOEM's total suspended particulate regulatory value has been inserted as a substitute for $PM_{2.5}$ and PM_{10}.

CO = carbon monoxide.
NAAQS = National Ambient Air Quality Standards.
NO_2 = nitrogen dioxide.
PM_{10} = particulate material less than 10 µm in size.
$PM_{2.5}$ = particulate material less than 2.5 µm in size.
PSD = Prevention of Significant Deterioration.
SO_2 = sulfur dioxide.
TBD = to be determined.
$\mu g/m^3$ = micrograms per cubic meter.

MARCH 3, 1849

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) promotes energy independence, environmental protection, and economic development through responsible, science-based management of offshore conventional and renewable energy.