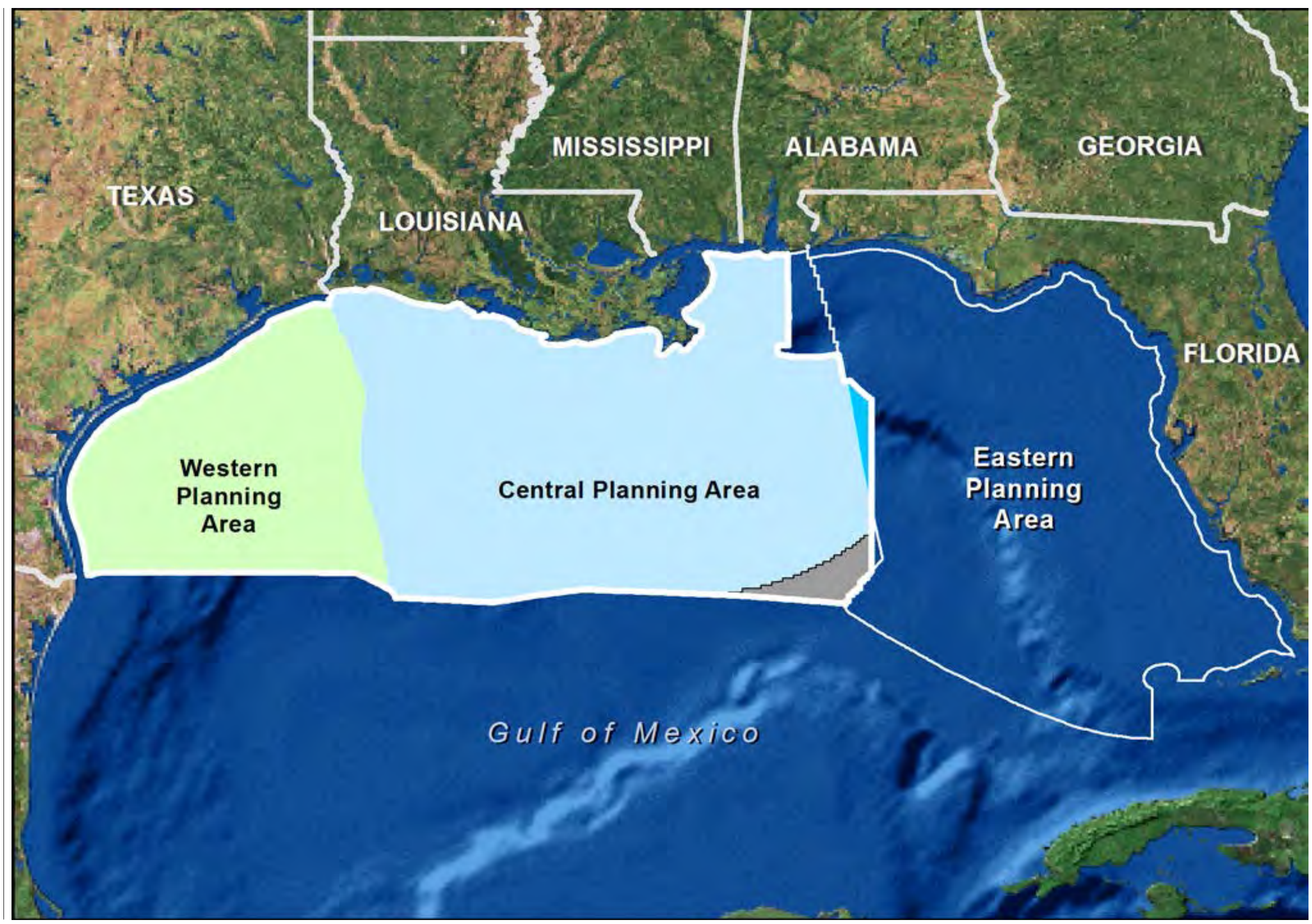
OCS EIS/EA
BOEM 2017-013

Gulf of Mexico OCS Lease Sale

Draft Supplemental Environmental Impact Statement 2018



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

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Gulf of Mexico OCS Region

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REGIONAL DIRECTOR'S NOTE

This Supplemental Environmental Impact Statement (EIS) addresses a proposed Federal action – a regionwide lease sale. This Supplemental EIS is expected to be used to inform decisions for proposed Outer Continental Shelf (OCS) oil and gas Lease Sales 250 and 251 in the Gulf of Mexico, as scheduled in the *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (Five-Year Program). This Supplemental EIS is expected to be used to inform decisions for each of the two proposed lease sales scheduled in 2018 and to be used and supplemented as necessary for decisions on future Gulf of Mexico proposed regionwide lease sales. This Supplemental EIS contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale in the Gulf of Mexico as scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed regionwide lease sales scheduled in the Five-Year Program. This Supplemental EIS tiers from and updates the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS) and incorporates by reference all of the relevant material in the 2017-2022 GOM Multisale EIS.

Pursuant to the Outer Continental Shelf Lands Act's staged leasing process, the Bureau of Ocean Energy Management (BOEM) must make an individual decision on whether and how to proceed with each proposed lease sale. Therefore, in order to make an informed decision on a proposed regionwide lease sale, the analyses contained in this Supplemental EIS will be used to inform a decision for proposed Lease Sale 250, which is the first proposed lease sale for 2018. A separate decision will be made for the second proposed lease sale for 2018, which is proposed Lease Sale 251. A decision on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional National Environmental Policy Act (NEPA) reviews that may update this NEPA analysis, as necessary. Supplemental NEPA reviews, including opportunities for public involvement, are currently planned to be conducted annually for the remaining proposed lease sales.

This Draft Supplemental EIS analyzes the potential impacts of a proposed action on the marine, coastal, and human environments. It is important to note that this Draft Supplemental EIS was prepared using the best information that was publicly available at the time the document was prepared. This Supplemental EIS's analysis focuses on identifying the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the GOM. This Supplemental EIS will also assist decisionmakers in making informed, future decisions regarding the approval of operations, as well as leasing. At the completion of this EIS process, a decision will be made on whether and how to proceed with proposed Lease Sale 250.

BOEM's Gulf of Mexico OCS Region and its predecessors have been conducting environmental analyses of the effects of Outer Continental Shelf (OCS) oil and gas development since the inception of the National Environmental Policy Act of 1969. We have prepared and published more than 70 draft and 70 final EISs. Our goal has always been to provide factual, reliable, and clear analytical statements in order to inform decisionmakers and the public about the environmental effects of proposed OCS oil- and gas-related activities and their alternatives. We view the EIS process as providing a balanced forum for early identification, avoidance, and resolution of potential conflicts. It is in this spirit that we welcome comments on this document from all concerned parties.

Michael A. Celata
Regional Director
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

COVER SHEET

Draft Supplemental Environmental Impact Statement for the Proposed 2018 Gulf of Mexico OCS Lease Sales

Draft (x) **Final ( )**

Type of Action: Administrative (x) Legislative ( )

Area of Potential Impact: Offshore Marine Environment and Coastal Counties/Parishes of Texas, Louisiana, Mississippi, Alabama, and northwestern Florida

Agency	Headquarters' Contact	Region Contacts
U.S. Department of the Interior Bureau of Ocean Energy Management Gulf of Mexico OCS Region (GM 623E) 1201 Elmwood Park Boulevard New Orleans, LA 70123-2394	Robert Martinson U.S. Department of the Interior Bureau of Ocean Energy Management 45600 Woodland Road (VAM-OEP) Sterling, VA 20166-9216 703-787-1574	Michelle K. Nannen 504-731-6682 Greg Kozlowski 504-736-2512

ABSTRACT

This Draft Supplemental Environmental Impact Statement (EIS) addresses a proposed Gulf of Mexico OCS oil and gas lease sale as scheduled in the *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (Five-Year Program). This Supplemental EIS is expected to be used to inform decisions for each of the two proposed regionwide lease sales scheduled for 2018 and to be used and supplemented as necessary for decisions on future Gulf of Mexico proposed regionwide lease sales. This Supplemental EIS contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale in the Gulf of Mexico as scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary to inform decisions for each remaining proposed lease sale scheduled in the Five-Year Program.

The proposed action (lease sale) is a Federal action requiring an environmental review. This Draft Supplemental EIS provides the following information in accordance with the National Environmental Policy Act and its implementing regulations, and it will be used in making a decision on the proposed action. This document includes the purpose and background of the proposed action, identification of the alternatives, description of the affected environment, and an analysis of

the potential environmental impacts of the proposed action, alternatives, and associated activities, including proposed mitigating measures and their potential effects. Potential contributions to cumulative impacts resulting from activities associated with the proposed action are also analyzed.

Hypothetical scenarios were developed on the levels of activities, accidental events that are foreseeable (such as oil spills), and potential impacts that might result if the proposed action is adopted. Activities and disturbances associated with the proposed action on biological, physical, and socioeconomic resources are considered in the analyses.

This Draft Supplemental EIS analyzes the potential impacts of the proposed action on air and water quality, coastal habitats, deepwater benthic communities, *Sargassum*, live bottom habitats, fishes and invertebrates, birds, protected species, commercial and recreational fisheries, recreational resources, archaeological resources, human resources, and land use. It is important to note that this Draft Supplemental EIS was prepared using the best information that was publicly available at the time the document was prepared. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives and if so, was either acquired or in the event it was impossible or exorbitant to acquire the information, accepted scientific methodologies were applied in its place.

Additional copies of this Draft Supplemental EIS and the other referenced publications may be obtained from the Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, Public Information Office (GM 335A), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, by telephone at 504-736-2519 or 1-800-200-GULF, or on the Internet at http://www.boem.gov/nepaprocess/.

EXECUTIVE SUMMARY

PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

2017-2022 Schedule of Proposed Gulf of Mexico OCS Region Lease Sales	
Lease Sale Number	Year
249	2017
250 and 251	2018
252 and 253	2019
254 and 256	2020
257 and 259	2021
261	2022

This Supplemental Environmental Impact Statement (EIS) addresses a proposed Federal action – a regionwide lease sale. This Supplemental EIS is expected to be used to inform decisions for proposed Outer Continental Shelf (OCS) oil and gas Lease Sales 250 and 251 in the Gulf of Mexico, as scheduled in the *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (Five-Year Program; USDOI, BOEM, 2016a). This Supplemental EIS is expected to be used to inform decisions for each of the two lease sales scheduled in 2018 and to be used and supplemented as necessary for decisions for each of the remaining proposed regionwide lease sales scheduled in the Five-Year Program. This Supplemental EIS contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale in the Gulf of Mexico (GOM) as scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program. This Supplemental EIS tiers from and updates the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS; USDOI, BOEM, 2017a) and provides analyses for the remaining proposed GOM lease sales in that document. This Supplemental EIS incorporates by reference all of the relevant material in the 2017-2022 GOM Multisale EIS. The decision on whether and how to proceed with proposed Lease Sale 250 will be made following the completion of this National Environmental Policy Act (NEPA) analysis. A separate decision will be made for the second proposed lease sale of 2018, i.e., Lease Sale 251. Decisions on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional NEPA review that may update this Supplemental EIS as necessary.

The Bureau of Ocean Energy Management (BOEM) has issued the Five-Year Program (USDOI, BOEM, 2016a), which proposes 10 regionwide GOM oil and gas lease sales on the OCS. Five regionwide lease sales are tentatively scheduled in August of each year from 2017 through 2021 and five regionwide lease sales are tentatively scheduled in March of each year from 2018 through 2022. The lease sales proposed in the GOM in the Five-Year Program are regionwide lease sales comprised of the Western, Central, and a small portion of the Eastern Planning Areas (WPA, CPA, and EPA, respectively) not subject to Congressional moratorium (**Figure 1**).

The development of the Five-Year Program initiates region-specific NEPA reviews for each of the proposed lease sales. Region-specific reviews are conducted by Program Area, and this Supplemental EIS contains analyses for the Gulf of Mexico OCS Region. Even though the Five-Year Program includes regionwide lease sales in the GOM, any individual lease sale could still be scaled back during the prelease sale process, including for example to employ the separate planning area model used in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program*: *2012-2017* (2012-2017 Five-Year Program; USDOI, BOEM, 2012), should circumstances warrant.

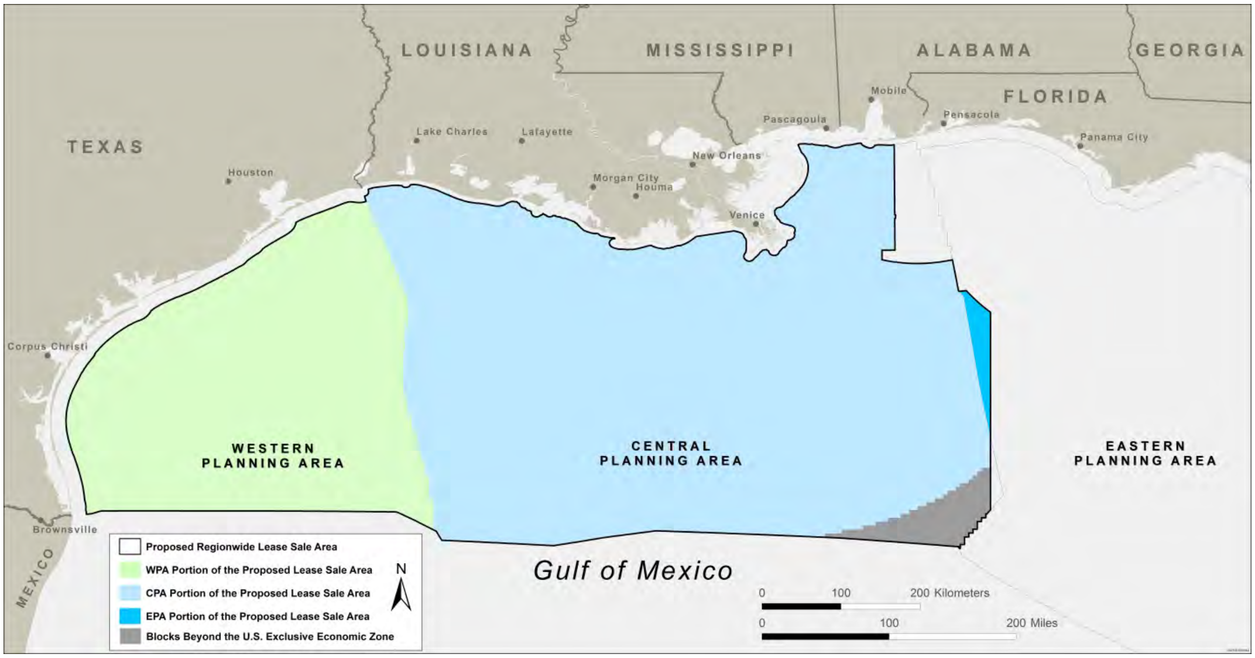

Figure 1. Proposed Regionwide Lease Sale Area Combining the Western, Central, and Eastern Planning Areas.

The Proposed Action

The proposed action evaluated in this Supplemental EIS is to hold a regionwide lease sale in the GOM according to the schedule of proposed lease sales set forth by the Five-Year Program. This Supplemental EIS has been prepared to inform decisions for the proposed 2018 GOM lease sales and analyzes a single proposed action (i.e., a single proposed lease sale in the Gulf of Mexico) as scheduled in the Five-Year Program. Since each of the 10 proposed lease sales in the GOM region are very similar and occur in close timeframes, BOEM prepared an EIS for a proposed action, looking at the 10 proposed lease sales in the Five-Year Program cumulatively (i.e., the 2017-2022 GOM Multisale EIS). The analysis in the 2017-2022 GOM Multisale EIS will be used to inform each of the 10 proposed lease sale decisions. This Supplemental EIS tiers from and updates the 2017-2022 GOM Multisale EIS and contains analyses of the potential environmental impacts that could result from a single proposed lease sale (e.g., Lease Sale 250, but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program. However, pursuant to the OCSLA's staged leasing process, BOEM must make an individual decision on whether and how to proceed with each proposed lease sale. Therefore, in order to make an informed decision on a single proposed lease sale, the analyses contained in this Supplemental EIS examine impacts from a single proposed lease sale (e.g., Lease Sale 250). The decision on whether and how to proceed with proposed Lease Sale 250, which is the first GOM lease sale proposed for 2018, will be made following the completion of this NEPA analysis. A separate decision will be made for proposed Lease Sale 251, which is the second GOM lease sale proposed for 2018. Decisions on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional NEPA reviews that may update this Supplemental EIS as necessary.

Purpose of the Proposed Action

The Outer Continental Shelf Lands Act of 1953, as amended (43 U.S.C. §§ 1331 *et seq*. [1988]), hereafter referred to as the OCSLA, establishes the Nation's policy for managing the vital energy and mineral resources of the OCS. Section 18 of the OCSLA requires the Secretary of the Interior to prepare and maintain a schedule of proposed OCS oil and gas lease sales determined to "best meet national energy needs for the 5-year period following its approval or reapproval" (43 U.S.C. § 1344). The Five-Year Program establishes a schedule that the U.S. Department of the Interior (USDOI or DOI) will use as a basis for considering where and when leasing might be appropriate over a 5-year period.

> *"It is hereby declared to be the policy of the United States that . . . the Outer Continental Shelf is a vital national resource held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs."*
>
> OCSLA, 43 U.S.C. §§ 1331 *et seq.*

The purpose of the proposed Federal action addressed in this Supplemental EIS (i.e., a proposed regionwide lease sale) is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with the OCSLA, which specifically states that these areas "should be made available for expeditious and orderly development, subject to environmental safeguards" (OCSLA, 43 U.S.C. §§ 1331 *et seq*.). Each individual proposed lease sale would provide qualified bidders the opportunity to bid upon and lease available acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. This Supplemental EIS will determine the potential environmental impacts that could result from a single proposed lease sale (e.g., Lease Sale 250) scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary for each remaining Federal action (lease sale) scheduled in the Five-Year Program.

Need for the Proposed Action

The need for the proposed action (i.e., a proposed regionwide lease sale) is to manage the development of OCS resources in an environmentally and economically responsible manner as required under Section 18 of the OCSLA. Oil serves as the feedstock for liquid hydrocarbon products, including gasoline, aviation and diesel fuel, and various petrochemicals. Oil from the Gulf of Mexico OCS contributes to meeting domestic demand and enhances national economic security. Since the U.S. is expected to continue to rely on oil and natural gas to meet its energy needs, each proposed action would contribute to meeting domestic demand and reducing the need for importing these resources.

THE DECISION TO BE MADE

This Supplemental EIS has been prepared to inform decisions for each of the proposed 2018 GOM lease sales. After completion of the NEPA process for this Supplemental EIS, a decision will be made for proposed Lease Sale 250, which is scheduled for March 2018 (i.e., prepare a Record of Decision for proposed Lease Sale 250). A second NEPA review will be conducted for proposed Lease Sale 251, which is scheduled for August 2018, to consider any relevant new information; a second Record of Decision will be prepared for proposed Lease Sale 251. As discussed in **Chapter 1.4.1**, individual decisions will be made on each subsequent proposed lease sale in the Five-Year Program after completion of the appropriate NEPA review and supplementation of this EIS if necessary.

PUBLIC INVOLVEMENT

Pursuant to the OCSLA, the Bureau of Ocean Energy Management published a Call for Information (Call) to request and gather information to determine the Area Identification (Area ID) for each proposed lease sale in the *Draft Proposed Outer Continental Shelf Oil & Gas Leasing Program: 2017-2022* (2017-2022 Draft Proposed Program), which is the draft nationwide schedule of proposed lease sales published for public input. The Call was published in the *Federal Register* (2015a) on September 4, 2015, and invited potential bidders to nominate areas of interest within the program area(s) included in the 2017-2022 Draft Proposed Program. Using information provided in response to the Call and from scoping comments, BOEM then developed an Area ID recommendation memorandum. The Area ID is an administrative prelease step that describes the geographic area for environmental analysis and consideration for leasing. On November 20, 2015, the Area ID decision was made. One Area ID was prepared for all proposed lease sales. The Area ID memorandum recommended keeping the entire GOM regionwide area included in the Draft Proposed Program for consideration in the 2017-2022 GOM Multisale EIS and supplemental NEPA analyses such as this Supplemental EIS. The area identified for lease includes all of the available unleased blocks in the GOM not subject to Congressional moratorium pursuant to the Gulf of Mexico Energy Security Act of 2006.

BOEM conducted a public scoping process for this Supplemental EIS that extended from August 19 to September 19, 2016. Public scoping meetings were held in four cities (Gulfport, Mississippi; Mobile, Alabama; Houston, Texas; and New Orleans, Louisiana). In addition to accepting oral and written comments at each public meeting, BOEM accepted written comments by mail and through the regulations.gov web portal (http://www.regulations.gov). BOEM received a total of 433 comments in response to the Notice of Intent to Prepare an EIS and 8 additional comments at the scoping meetings, for a total of 441 comments).

Almost 380 individual comments were received in support of the proposed lease sales, 356 of which were form letters. Commenters stated that future leases are vital to the national economy and security, and are integral to the State of Louisiana and local economies and jobs. Several noted that oil and gas companies and employees must be good stewards of the environment and continue to provide more emphasis on safety. Several commenters stated that the recent downturn in oil and gas prices is hurting small towns and southern states in general.

Twenty-three individual comments were received that opposed future lease sales. Commenters stated that renewable energy should be pursued instead of oil and gas, fossil fuels should be left in the ground, and new lease sales are not compatible with the U.S. commitment to reduce greenhouse gas emissions under the Paris Agreement, which the U.S. joined on April 22, 2016. Issues of concern included the impacts of oil and gas on greenhouse gas emission and global climate change, the impacts of climate change on the GOM's environmental resources, warmer oceans, increased storms and flooding events, and land loss. Several commenters also expressed concern about continuing oil and chemical spill risks, continuing effects of past oil and chemical spills, leaking wells and pipelines, and a lack of reasonable alternatives. Environmental resources of concern included protected species (i.e., marine mammals, sea turtles, beach mice, protected birds, and corals), wetlands, fish nurseries, coral reefs, safety of seafood, and environmental justice. Comments were received expressing concerns for environmental justice related to those living nearby petrochemical processing facilities.

ALTERNATIVES

A proposed action is to hold a lease sale in the GOM according to the schedule of proposed lease sales set forth by the Five-Year Program. BOEM has identified four action alternatives, and a No Action Alternative, to be analyzed in this Supplemental EIS. These alternatives are briefly described below. The mitigating measures (pre- and postlease), including the proposed stipulations, are summarized in **Chapter 2** of this Supplemental EIS and and are fully described in Chapter 2 and Appendices B and D of the 2017-2022 GOM Multisale EIS, as are the deferred alternatives not analyzed in detail.

Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Alternative A would allow for a proposed regionwide lease sale encompassing all three planning areas within the U.S. portion of the Gulf of Mexico OCS. This is BOEM's preferred alternative. This alternative would offer for lease all available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area for oil and gas operations (**Figure 2**), with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]);

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(3) whole and partial blocks within the current boundary of the Flower Garden Banks National Marine Sanctuary.

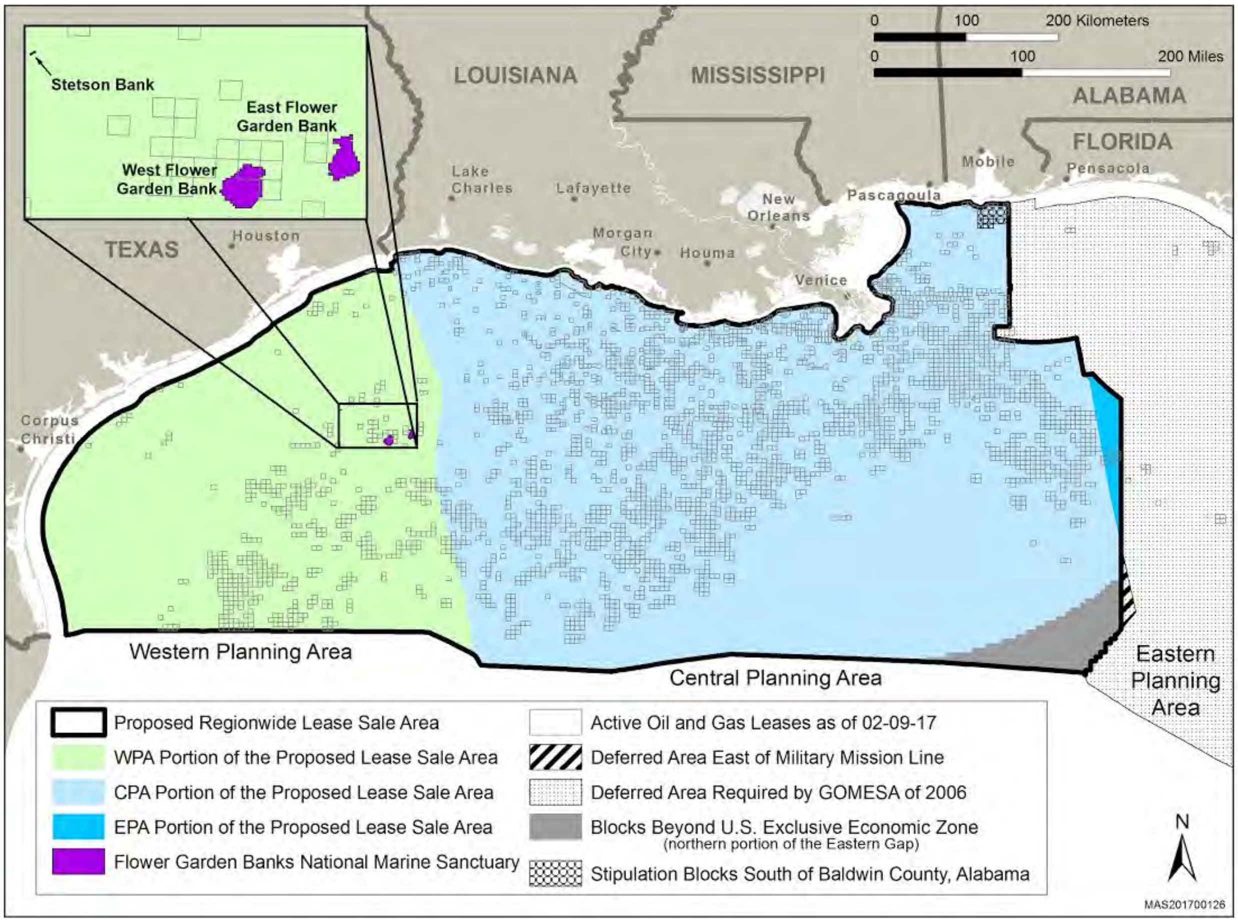

Figure 2. Proposed Regionwide Lease Sale Area, Encompassing the Available Unleased Blocks within All Three Planning Areas (approximately 91.93 million acres with approximately 75.7 million acres available for lease as of February 2017).

Alternative B—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B would allow for a proposed lease sale encompassing the CPA and EPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 3**). Available blocks within the WPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the CPA and EPA portions of the proposed lease sale area for oil and gas operations, with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]); and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

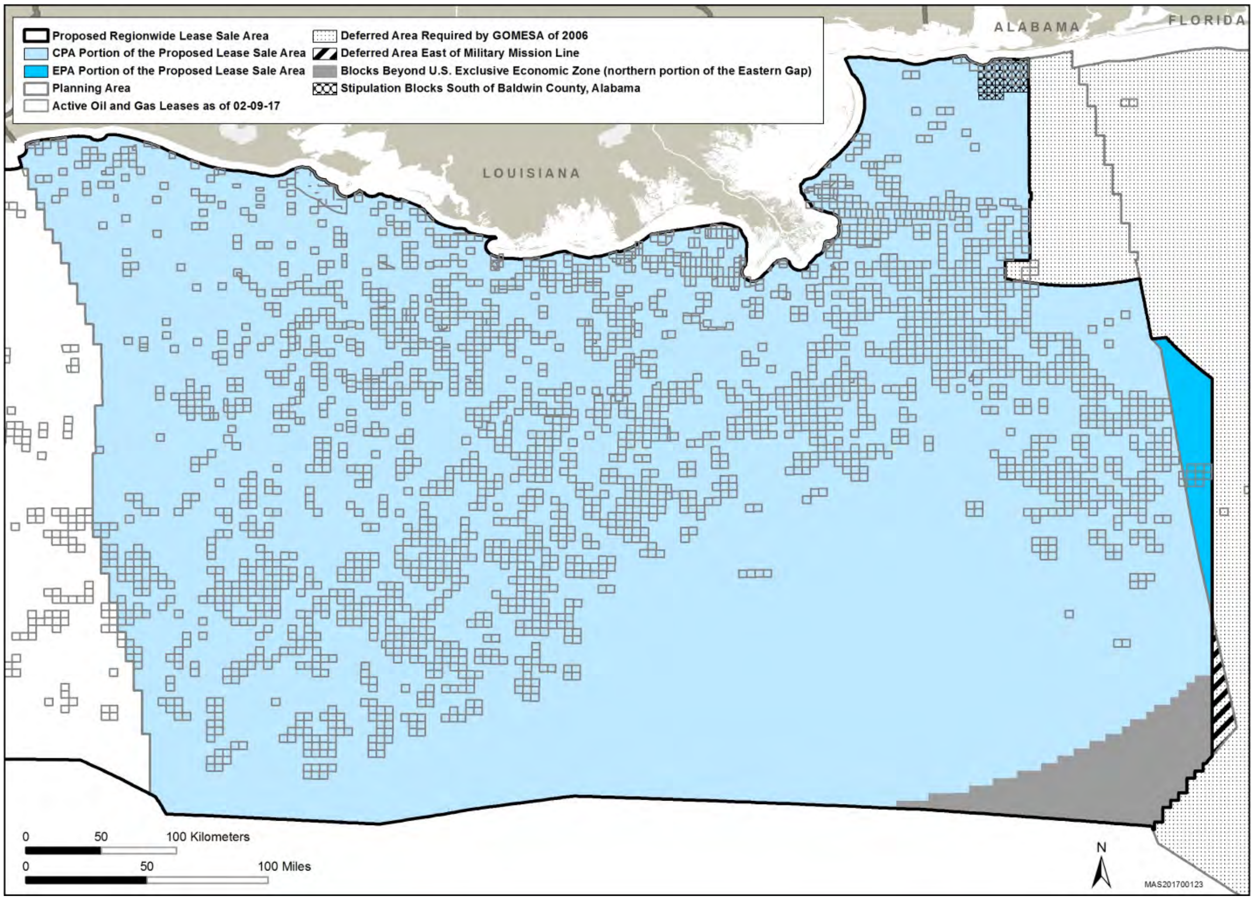

Figure 3. Proposed Lease Sale Area for Alternative B, Excluding the Available Unleased Blocks in the WPA (approximately 63.35 million acres with approximately 49.8 million acres available for lease as of February 2017).

Alternative C—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C would allow for a proposed lease sale encompassing the WPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 4**). Available blocks within the CPA and EPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the WPA portion of the proposed lease sale area for oil and gas operations, with the following exception:

(1) whole and partial blocks within the current boundary of the Flower Garden Banks National Marine Sanctuary.

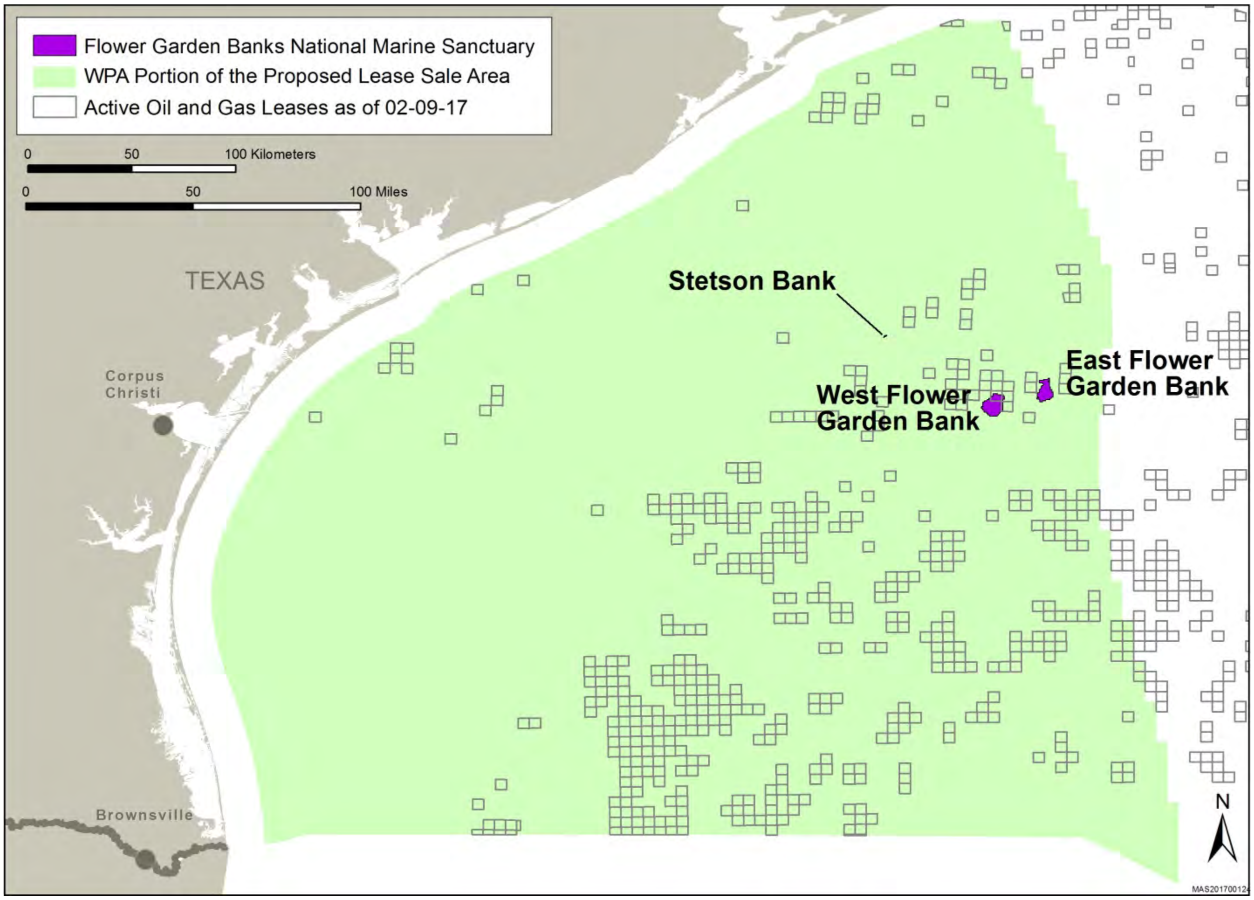

Figure 4. Proposed Lease Sale Area for Alternative C, Excluding the Available Unleased Blocks in the CPA and EPA (approximately 28.58 million acres with approximately 25.9 million acres available for lease as of February 2017).

Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D could be combined with any of the action alternatives above (i.e., Alternative A, B, or C) and would allow the flexibility to offer leases under any alternative with additional exclusions. Under Alternative D, the decisionmaker could exclude from leasing any available unleased blocks subject to any one and/or combination of the following stipulations:

- Topographic Features Stipulation;
- Live Bottom (Pinnacle Trend) Stipulation; and
- Blocks South of Baldwin County, Alabama, Stipulation (not applicable to Alternative C).

This alternative considered blocks subject to these stipulations because these areas have been emphasized in scoping, can be geographically defined, and adequate information exists regarding their ecological importance and sensitivity to OCS oil- and gas-related activities, as shown in **Figure 5**. All of the assumptions (including the other potential mitigating measures) and estimates would remain the same as described for any given alternative.

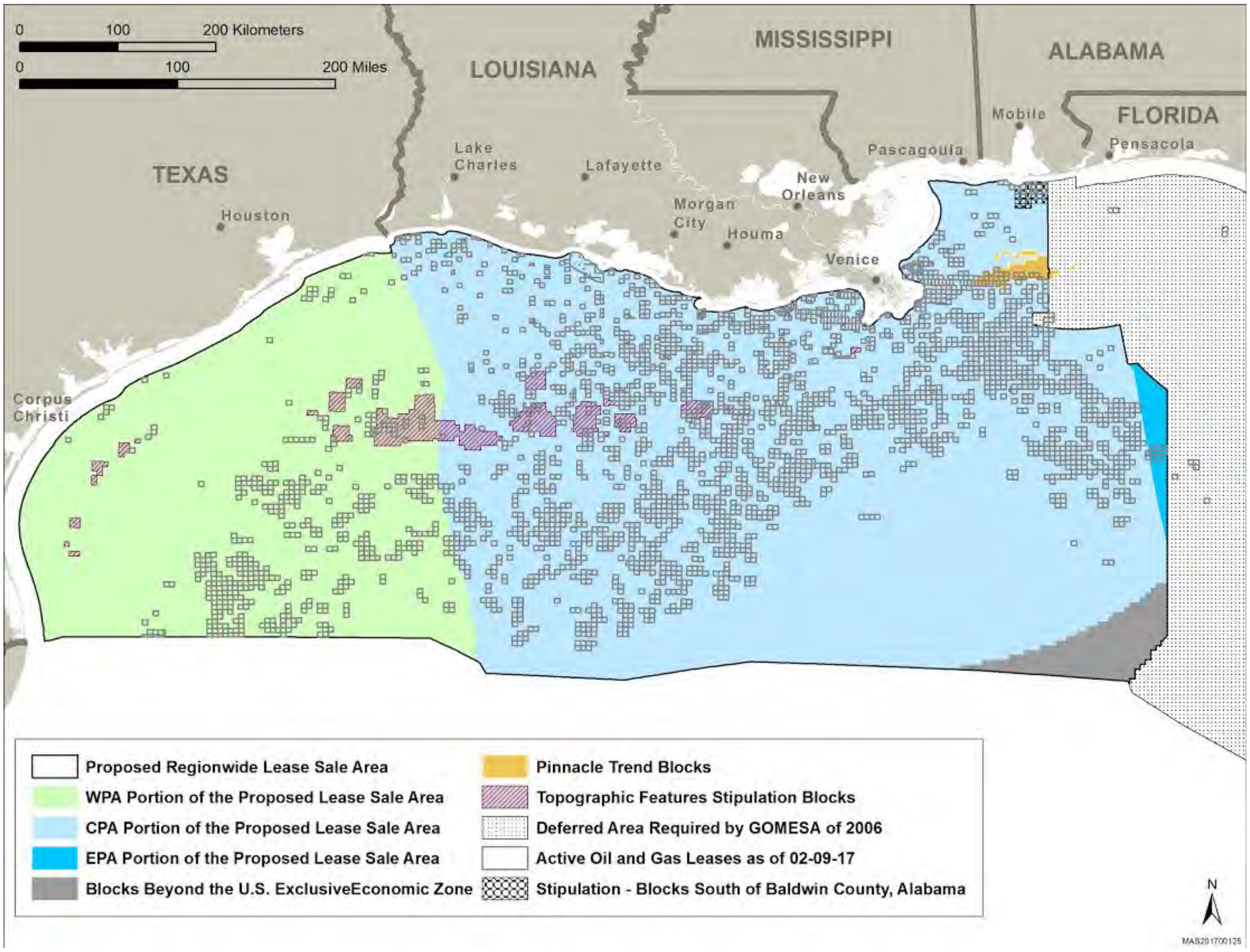

Figure 5. Identified Topographic Features, Pinnacle Trend, and Baldwin County Stipulation Blocks in the Gulf of Mexico.

Alternative E—No Action

Alternative E is the cancellation of a single proposed GOM lease sale within the Five-Year Program. The opportunity for development of the estimated oil and gas that could have resulted from a proposed action (i.e., a single proposed lease sale) or alternative to a proposed action, as described above, would be precluded or postponed to a future lease sale. Any potential environmental impacts resulting from a proposed lease sale would not occur. Activities related to previously issued leases and permits (as well as those that may be issued in the future under a separate decision) related to the OCS oil and gas program would continue. If a lease sale were to be cancelled, the resulting development of oil and gas would most likely be postponed to a future lease sale; therefore, the overall level of OCS oil- and gas-related activity would only be reduced by a small percentage, if any.

MITIGATING MEASURES

Proposed lease stipulations and other mitigating measures designed to reduce or eliminate environmental risks and/or potential multiple-use conflicts between OCS operations and U.S. Department of Defense activities may be applied to the chosen alternative. Mitigating measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease. The 10 lease stipulations being considered are the Topographic Features Stipulation; Live Bottom (Pinnacle Trend) Stipulation; Military Areas Stipulation; Evacuation Stipulation; Coordination Stipulation; Blocks South of Baldwin County, Alabama, Stipulation; Protected Species Stipulation; United Nations Convention on the Law of the Sea Royalty Payment Stipulation; Below Seabed Operations Stipulation; and the Stipulation on the Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation). The United Nations Convention on the Law of the Sea Royalty Payment Stipulation is applicable to a proposed lease sale even though it is not an environmental or military stipulation. The Topographic Features and Live Bottom (Pinnacle Trend) Stipulations have been applied as programmatic mitigation in the *Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022; Final Programmatic Environmental Impact Statement* (Five-Year Program EIS (USDOI, BOEM, 2016b) and therefore, these stipulations would apply to all leases issued under the Five-Year Program in the designated lease blocks. Refer to **Chapter 2.2.3** for BOEM's mitigating measures. Chapter 2.2.4 and Appendix D of the 2017-2022 GOM Multisale EIS provide a more detailed analysis of the 10 lease stipulations and their effectiveness.

Application of lease stipulations will be considered by the decisionmaker. The inclusion of the stipulations as part of the analysis of the proposed actions does not ensure that the decisionmaker will make a decision to apply the stipulations to leases that may result from a proposed lease sale, nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions warrant. However, the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations have been applied as programmatic mitigation in the Five-Year Program EIS and therefore, these stipulations would apply to all leases issued under the Five-Year Program in the designated lease blocks. Any lease stipulations or mitigating measures to be included in a lease sale will be described in the Final Notice of Sale. In addition, mitigations may be added to plan and/or permits for OCS oil- and gas-related activities (**Chapter 2.2.3.3**). For more information on mitigating measures that are added at the postlease stage, refer to Appendix B ("Commonly Applied Mitigating Measures") of the 2017-2022 GOM Multisale EIS.

DIRECT AND INDIRECT ACTIONS ASSOCIATED WITH A PROPOSED LEASE SALE

BOEM describes the potentially occurring actions associated with a single proposed lease sale and the cumulative activities that provide a framework for a detailed analysis of the potential environmental impacts. Exploration and development scenarios describe the infrastructure and activities that could potentially affect the biological, physical, and socioeconomic resources in the GOM. They also include a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors.

Offshore activities are described in the context of scenarios for a proposed action (**Chapter 3.1**) and for the OCS Program (**Chapter 3.3**). BOEM's Gulf of Mexico Region developed these scenarios to provide a framework for detailed analyses of potential impacts of a proposed lease sale. The scenarios are presented as ranges (low to high) of the amounts of undiscovered, unleased hydrocarbon resources estimated to be leased and produced as a result of a proposed action. The scenarios encompass a range of activities (e.g., the installation of platforms, drilling wells, and installing pipelines, and the number of helicopter operations and service-vessel trips, etc.) that would be needed to develop and produce the amount of forecasted oil and gas resources.Environmental Impacts

The affected environment and the potential impacts of a single proposed lease sale under each alternative have been described and analyzed by resource. Analysis of the alternatives for each resource considers routine activities, accidental events, cumulative impact analysis, incomplete or unavailable information, and conclusions for each resource. This Supplemental EIS also considers baseline data in the assessment of impacts from a proposed action on the resources and the environment (**Chapter 4**).

The major issues that frame the environmental analyses in this Supplemental EIS are the result of concerns raised during years of scoping for the Gulf of Mexico OCS Program. Issues related to OCS oil and gas exploration, development, production, and transportation activities include the potential for oil spills, wetlands loss, air emissions, wastewater discharges and water quality degradation, marine trash and debris, structure and pipeline emplacement activities, platform removal, vessel and helicopter traffic, multiple-use conflicts, support services, population fluctuations, land-use planning, impacts to recreation and beaches, aesthetic interference, environmental justice, and conflicts with State coastal zone management programs. Environmental resources and activities identified during the scoping process that warrant an environmental analysis include air quality, water quality, coastal habitats (including wetlands and seagrasses), barrier beaches and associated dunes, live bottom habitats (including topographic features and pinnacle trends), *Sargassum* and associated communities, deepwater benthic communities, marine mammals, sea turtles, birds, fishes and invertebrate resources, commercial fisheries, recreational fishing, recreational resources, archaeological resources, and socioeconomic factors (including environmental justice), and within the CPA only, beach mice.

Within each resource summary in **Chapter 4** and within the full analysis in the 2017-2022 GOM Multisale EIS, the cumulative analysis considers environmental and socioeconomic impacts that may result from the incremental impact of a proposed action when added to all past, present, and reasonably foreseeable future OCS oil- and gas-related activities (OCS Program), as well as non-OCS oil- and gas-related activities (e.g., import tankering and commercial fishing). This includes projected activity from lease sales that have been held but for which exploration or development has not yet begun or is continuing. In addition, impacts from natural occurrences, such as hurricanes, are analyzed.

Other relevant issues include impacts from the *Deepwater Horizon* explosion, oil spill, and response; impacts from past and future hurricanes on environmental and socioeconomic resources; and impacts on coastal and offshore infrastructure. During the past several years, the Gulf Coast States and Gulf of Mexico oil and gas activities have been impacted by major hurricanes. The description of the affected environment includes impacts from these relevant issues on the physical environment, biological environment, and socioeconomic activities, and on OCS oil- and gas-related infrastructure.

Impact Conclusions

The analyses of the potential impacts of routine activities and accidental events associated with a proposed action (lease sale) and a proposed action's incremental contribution to the cumulative impacts are described in the individual resource discussions in **Chapter 4**. A summary of the potential impacts from a proposed action on each environmental and socioeconomic resource and the conclusions of the analyses can be found in the following discussions. **Table 1** provides a comparison of expected impact levels by alternative and is derived from the analysis of each resource in **Chapter 4**. The findings for Alternatives A-E would be a proposed action's *incremental contribution* to the cumulative impacts from past, present, and future activities in the GOM. These activities would include both OCS oil- and gas-related and non-OCS oil- and gas-related activities that would be expected regardless of whether or not a lease sale was to occur. The impact-level ratings have been specifically tailored and defined for each resource within the **Chapter 4** impact analysis. Cumulative impacts of current, past, and reasonably foreseeable future activities, however, would continue to occur under Alternative E.

Table 1. Alternative Comparison Matrix.

Impact Level Key[1]					
Beneficial[2]	Negligible	Minor	Moderate	Major	
	Alternative				
Resource	A	B	C	D	E
Air Quality	Minor	Minor	Minor	Minor	None
Water Quality	Negligible	Negligible	Negligible	Negligible	None
Coastal Habitats					
Estuarine Systems	Moderate	Moderate	Minor	Moderate	Negligible
Coastal Barrier Beaches and Associated Dunes	Minor	Minor	Negligible to Minor	Negligible to Minor	Negligible
Deepwater Benthic Communities	Negligible	Negligible	Negligible	Negligible	None
Sargassum and Associated Communities	Negligible	Negligible	Negligible	Negligible	None

Impact Level Key[1]					
Beneficial[2]	Negligible	Minor	Moderate	Major	
	Alternative				
Resource	A	B	C	D	E
Live Bottoms					
Topographic Features	Negligible	Negligible	Negligible	Negligible	None
Pinnacles and Low-Relief Features	Negligible to Minor	Negligible to Minor	Negligible	Negligible	None
Fishes and Invertebrate Resources	Minor	Minor	Minor	Minor	None
Birds	Moderate	Moderate	Moderate	Moderate	None
Protected Species					
Marine Mammals	Negligible	Negligible	Negligible	Negligible	None
Sea Turtles	Negligible	Negligible	Negligible	Negligible	None
Beach Mice	Negligible	Negligible	Negligible	Negligible	None
Protected Birds	Negligible	Negligible	Negligible	Negligible	None
Protected Corals	Negligible	Negligible	Negligible	Negligible	None
Commercial Fisheries	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Recreational Fishing	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Recreational Resources	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Archaeological Resources	Negligible[3]	Negligible[3]	Negligible[3]	Negligible[3]	None
Human Resources and Land Use					
Land Use and Coastal Infrastructure	Minor	Minor	Minor	Minor	None
Economic Factors	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible to Minor
Social Factors (including Environmental Justice)	Minor	Minor	Minor	Minor	None

Impact Level Key[1]					
Beneficial[2]	Negligible	Minor		Moderate	Major
	Alternative				
Resource	A	B	C	D	E

Note: Some resources have a range for the impact levels to account for certain variables such as the uncertainty of non-OCS oil- or gas-related activities, the level and magnitude of potential accidental events, and the minimization of the OCS oil- or gas-related impacts through lease stipulations, mitigations, and/or regulations. The impact level ratings have been specifically tailored and defined for each resource within the **Chapter 4** impact analysis.

[1] The findings for Alternatives A-D are the incremental contribution of a proposed action added to what would be expected to occur under the No Action Alternative (i.e., no lease sale). Therefore, each impact determination under Alternatives A-D assumes that the conditions and impacts (i.e., past, present, and future activities as a result of past lease sales) under the No Action Alternative would still be present.

[2] The level of beneficial impacts is specified in the analysis, which could range from low, medium, or high.

[3] The level of impacts for archaeological resources ranges between negligible to major and is dependent upon whether a survey is performed, mitigation is imposed, mitigation is followed, or a site is identified prior to the activity.

Air Quality

Air quality is the degree at which the ambient air is free of pollution; it is assessed by measuring the pollutants in the air. To protect public health and welfare, the Clean Air Act established National Ambient Air Quality Standards (NAAQS) for certain common and widespread pollutants. The six common "criteria pollutants" are particle pollution (also known as particulate matter, $PM_{2.5}$ and PM_{10}), carbon monoxide (CO); nitrogen dioxide (NO_2); sulfur dioxide (SO_2); lead (Pb); and ozone (O_3). Air emissions from OCS oil and gas development in the Gulf of Mexico would arise from emission sources related to drilling and production with associated vessel support, flaring and venting, decommissioning, fugitive emissions, and oil spills. Associated activities that take place as a result of a proposed action support and maintain the OCS oil and gas platform sources. Air emissions from non-OCS oil- and gas-related emissions in the Gulf of Mexico would arise from emission sources related to State oil and gas programs, onshore industrial and transportation sources, and natural events. Since the primary NAAQS are designed to protect human health, BOEM focuses on the impact of these activities on the States, where there are permanent human populations.

In the “Air Quality Modeling in the Gulf of Mexico Region” study (**Appendices B-D**), photochemical grid modeling was conducted to assess the impacts to nearby states of existing and proposed future OCS oil and gas exploration, development, and production. This draft interim assessment is being used to disclose potential cumulative and incremental air quality impacts of the proposed lease sales; the final results are expected in fall 2017. The air quality modeling study examines the potential impacts of the proposed lease sales with respect to the NAAQS for the criteria pollutants O_3, NO_2, SO_2, CO, $PM_{2.5}$, PM_{10}; the air quality-related values (AQRVs), including visibility and acid deposition (sulfur and nitrogen) in nearby Class I and sensitive Class II areas; and the incremental impacts of Prevention of Significant Deterioration (PSD) pollutants (NO_2, PM_{10}, $PM_{2.5}$) with respect to PSD Class I and Class II increments. (*Note: This analysis does not constitute* *a regulatory PSD increment consumption analysis as would be required for major sources subject to the New Source Review program requirements of the Clean Air Act*). An assessment of the final study results will be discussed in future NEPA documents.

A regionwide lease sale has not previously been analyzed and historic trend data are limited. In the scenario in **Chapter 3.1** of this Supplemental EIS and Chapter 3.1 of the 2017-2022 GOM Multisale EIS, the projected activities of a single regionwide lease sale is based on a range of historic observations and provides a reasonable expectation of oil and gas production anticipated from a single proposed lease sale. The projected activities of 10 proposed regionwide lease sales' mid-case scenario, which was used in the model, falls within the range of a single proposed lease sale. To understand how these results would apply to a single proposed lease sale, the level of projected activity was compared between the modeled highest year of the 10 proposed lease sales to a single proposed lease sale. This is conservative because the current price of oil equals the low range of the scenario. Using these assumptions, the potential impacts of a single proposed lease sale would be **minor**. More specifically, the potential impacts of a single proposed lease sale to the Breton Wilderness Area would be **moderate**, whereas the overall potential impacts of a single proposed lease sale would be **minor** for all other areas. However, since these potential impacts are conservative given the current prices of oil and gas, BOEM anticipates future modeling. A full analysis of air quality can be found in **Chapter 4.1**.

The *incremental contribution* of a proposed lease sale to the cumulative impacts would most likely have a ***minor*** effect on coastal nonattainment areas because most impacts on the affected resource could be avoided with proper mitigation. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a proposed lease sale would be very small and would not on their own cause an exceedance.

As previously stated, BOEM contracted an air quality modeling study in the GOM region to assess the impacts of OCS oil- and gas-related development to nearby States, as required under the OCSLA. The data from forecasted emissions resulting from the 10 proposed lease sales was annualized using BOEM's Resource Evaluation's mid-case scenario. These results are presented in **Appendices B-D**. The cumulative impacts from all 10 proposed lease sales would be **minor** to **moderate**. More specifically, the cumulative impacts of 10 proposed lease sales to the Breton Wilderness Area and Gulf Islands National Seashore would be **moderate**, whereas the overall cumulative impacts of 10 proposed lease sales would be **minor** to **moderate**.

The cumulative impacts, in addition to the past, present, and future activities, of 10 proposed lease sales would most likely have a **moderate** effect on coastal nonattainment areas for certain pollutants. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the cumulative impacts from 10 proposed lease sales do not on their own cause an exceedance. A full analysis of air quality can be found in **Chapter 4.1**.

Water Quality

Water quality is a term used to describe the condition or environmental health of a waterbody or resource, reflecting its particular biological, chemical, and physical characteristics and the ability of the waterbody to maintain the ecosystems it supports and influences. It is an important measure for both ecological and human health. The largest impact-producing factors affecting water quality are operational discharges and wastes, drilling fluid spills, chemical and waste spills, and oil spills. The impacts of OCS Program-related routine operational discharges (Chapter 3.1.5.1 of the 2017-2022 GOM Multisale EIS and summarized in **Table 3-8** of this Suppplemental EIS) on water quality are considered **negligible** (beyond 1,000 meters [m]; 3,281 feet [ft]) to **moderate** (within 1,000 m; 3,281 ft) of the source. The potential impacts from OCS Program-related oil spills on water quality are considered **moderate**, even with the implementation of mitigating measures. This is because activities to address oil spills may cause secondary impacts to water quality, such as the introduction of additional hydrocarbons into the dissolved phase through the use of dispersants and the sinking of hydrocarbon residuals from burning. The impacts from a proposed action are a small addition to the cumulative impacts on water quality when compared with inputs from hypoxia, potentially leaking shipwrecks, chemical weapon dumpsites, natural oil seeps, and natural turbidity. The *incremental contribution* of the routine activities and accidental events associated with a proposed action to the cumulative impacts on water quality is expected to be ***negligible*** for any of the action alternatives. For Alternative E, the cancellation of a proposed lease sale would result in no new activities associated with a proposed lease sale; therefore, the incremental impacts would be **none**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of water quality can be found in **Chapter 4.2**.

Coastal Habitats

Estuarine Systems (Wetlands and Seagrasses/Submerged Vegetation)

The estuarine system is the transition zone between freshwater and marine environments. It can consist of many habitats, including wetlands and those containing submerged vegetation. The largest impact-producing factors affecting estuarine systems are navigation channel maintenance dredging, vessel operation, and oil spills. The impacts to these habitats from routine activities associated with a proposed action are expected to be **minor** to **moderate**. **Minor** impacts would be due to the projected low probability for any new pipeline landfalls (0-1 projected), the minimal contribution to the need for maintenance dredging, and the mitigating measures expected to be used to further reduce or avoid these impacts (e.g., the use of modern techniques such as directional drilling). However, impacts caused by vessel operations related to a proposed action over 50 years would be **moderate** considering the permanent loss of hundreds of acres of wetlands. Overall, impacts to estuarine habitats from oil spills associated with activities related to a proposed action would be expected to be **minor** because of the distance of most postlease activities from the coast, the expected weathering of spilled oil over that distance, the projected low probability of large spills near the coast, the resiliency of wetland vegetation, and the available cleanup techniques.

Cumulative impacts to estuarine habitats are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in Chapter 4.3 of the 2017-2022 GOM Multisale EIS and human and natural impacts. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Storms will continue to impact the coastal habitats and have differing impacts. The *incremental contribution* of a proposed action to the cumulative impacts on estuarine habitats is expected to be ***minor*** *to* ***moderate*** depending on the selected alternative. Under Alternative E, the cancellation of a proposed lease sale would result in no new activities associated with a proposed lease sale. There could, however, be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of estuarine habitats can be found in **Chapter 4.3.1**.

Coastal Barrier Beaches and Associated Dunes

The coastal barrier beaches and associated dunes are those beaches and dunes that line the coast of the northern GOM, including both barrier islands and beaches on the mainland. The largest impact-producing factors affecting estuarine systems are navigation channel maintenance dredging and oil spills. The impacts to coastal barrier beaches and dunes from routine activities associated with a proposed action are expected to be **minor** due to the minimal number of projected onshore pipelines, the minimal contribution to vessel traffic and to the need for maintenance dredging, and the mitigating measures that would be used to further reduce or avoid these impacts. The greater threat from an oil spill to coastal beaches is from a coastal spill as a result of a nearshore vessel accident or pipeline rupture, and cleanup activities. Overall, impacts to coastal barrier beaches and dunes from oil spills associated with OCS oil- and gas-related activities related to a proposed action would be expected to be **minor** because of the distance of most of the resulting activities from the coast, expected weathering of spilled oil, projected low probability of large spills near the coast, and available cleanup techniques.

Cumulative impacts to coastal barrier beaches and dunes are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in Chapter 4.3.2 of the 2017-2022 GOM Multisale EIS and other human and natural impacts. Cumulative OCS oil- and gas-related spills resulting from all past and present leasing activities, including the millions of barrels that entered the Gulf of Mexico from the *Deepwater Horizon* oil spill, are estimated to have had a **major** impact on coastal barrier beaches and dunes. However, the incremental increase in impacts from reasonably foreseeable oil spills related to a proposed action is expected to be **minor**. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Efforts to stabilize the GOM shoreline through the construction of manmade structures can deprive natural restoration of the barrier beaches, i.e., sediment nourishment and sediment transport, which has adversely impacted coastal beach landscapes. Storms will continue to impact the coastal habitats and have differing impacts. The *incremental contribution* of a proposed action to the cumulative impacts on coastal barrier beaches and dunes is expected to be ***minor***. Under Alternative E, the cancellation of a proposed lease sale, the resulting additional impacts to coastal barrier beaches and dunes would be **negligible**; however, cumulative impacts from all sources, including OCS oil- and gas-related and non-OCS oil- and gas-related sources, would remain. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of coastal barrier beaches and associated dunes can be found in **Chapter 4.3.2**.

Deepwater Benthic Communities

BOEM defines "deepwater benthic communities" as including both chemosynthetic communities (chemosynthetic organisms plus seep-associated fauna) and deepwater coral communities (deepwater coral plus associated fauna). These communities are typically found in water depths of 984 ft (300 m) or deeper throughout the GOM, although deepwater benthic habitats are relatively rare compared with ubiquitous soft bottom habitats.

The OCS oil- and gas-related impact-producing factors for deepwater benthic communities can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) noncatastrophic oil spills. These impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. However, impacts from individual routine activities and accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Moreover, use of the expected site-specific plan reviews/mitigations will distance activities from deepwater benthic communities, greatly diminishing the potential effects. Therefore, at the regional, population-level scope of this analysis, and assuming adherence to all expected regulations and mitigations, the incremental contribution would be expected to be **negligible** for any of the action alternatives. Impacts from accidental events would be expected to be **negligible** to **minor** for any of the action alternatives. The expected OCS oil- and gas-related activities from a proposed action would also *contribute incrementally* to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative effects experienced by deepwater benthic communities, but only by a ***negligible*** amount. Under Alternative E, the potential for impacts would be **none** because new impacts to deepwater benthic communities related to a cancelled lease sale would be avoided entirely. The overall OCS oil- and gas-related cumulative impacts to deepwater benthic communities are estimated to be **negligible** to **minor**. Non-OCS oil- and gas-related activities such as commercial fishing (currently negligible) and shifting baseline environmental conditions related to climate change (currently negligible but likely to increase to major over time should current trends continue or worsen) could cause more noticeable impacts on deepwater benthic communities over the next 50 years. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of deepwater benthic communities can be found in **Chapter 4.4**.

***Sargassum* and Associated Communities**

Sargassum in the GOM is comprised of *S. natans* and *S. fluitans*, and is characterized by a brushy, highly branched thallus with numerous leaf-like blades and berrylike pneumatocysts. The *Sargassum* cycle is truly expansive, encompassing most of the western Atlantic Ocean and the Gulf of Mexico with the growth, death, and decay of these plant and epiphytic communities, which may play a substantial role in the global carbon cycle. Several impacting factors can affect *Sargassum*, including vessel-related operations, oil and gas drilling discharges, operational discharges, accidental spills, non-OCS oil- and gas-related vessel activity, and coastal water quality. Routine vessel operations and accidental events that occur during drilling operations or vessel operations, and oiling due to an oil spill were the impact-producing factors that could be reasonably expected to impact *Sargassum* populations in the GOM. All of these impact-producing factors would result in the death or injury to the *Sargassum* plants or to the organisms that live within or around the plant matrix. However, the unique and transient characteristics of the life history of *Sargassum* and the globally widespread nature of the plants and animals that use the plant matrix buffer against impacts that could occur at any given location. Impacts to the overall population of the *Sargassum* community are therefore expected to be **negligible** from either routine activities or reasonably foreseeable accidental events for any of the action alternatives. The *incremental contribution* of a proposed action on the population of *Sargassum* would be ***negligible*** when considered in the context of cumulative impacts to the population. Under Alternative E, a proposed lease sale would be cancelled and the potential for impacts from routine activities and accidental events would be **none**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. Impacts from changing water quality would be much more influential on *Sargassum* than OCS development and would still occur without the presence of OCS oil- and gas-related activities. An analysis of *Sargassum* and associated communities can be found in **Chapter 4.5**.

Live Bottoms

Topographic Features

Defined topographic features (**Chapter 4.6.1**) are a subset of GOM live bottom habitats that are large enough to have an especially important ecological role, with specific protections defined in the proposed Topographic Features Stipulation. Within the Gulf of Mexico, BOEM has identified 37 topographic features where some degree of protection from oil and gas development may be warranted based on geography and ecology. Of all the possible impact-producing factors, it was determined that bottom-disturbing activities associated with drilling, exploration, and vessel operations were the only impact-producing factors from routine activities that could be reasonably expected to substantially impact topographic features. The impact-producing factors resulting from accidental events include bottom-disturbing activities from drilling, exploration, and vessel operations, as well as the release of sediments and toxins during drilling operations. Oil-spill response activities were also considered to be a source of potential impacts to topographic features.

Adherence to the Topographic Features Stipulation (a required mitigation as a result of the Five-Year Program's Record of Decision) is analyzed in each action alternative and is detailed in Appendix D of the 2017-2022 GOM Multisale EIS. Application of the Topographic Features Stipulation would assist in preventing or at least minimizing potential impacts to topographic feature communities by increasing the distance of OCS oil- and gas-related activities from these features. The historical application of this stipulation has resulted in **negligible** impacts of a proposed action to topographic features from routine activities and accidental events. The *incremental contribution* of a proposed action to the overall cumulative impacts is also expected to be ***negligible*** with adherence to the required Topographic Features Stipulation. Under Alternative E, the potential for new incremental impacts to topographic features from a cancelled lease sale would be **none** because they would be avoided entirely. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. Impacts ranging from **negligible** to **moderate** may still be expected from non-OCS oil- and gas-related activities such as fishing, pollution, and climate change; however, the incremental impact of the proposed activities should not result in a meaningful augmentation of the overall expected impacts. An analysis of topographic features can be found in **Chapter 4.6.1**.

Pinnacles and Low-Relief Features

The Pinnacle Trend is an approximately 64 x 16 mile (103 x 26 kilometer) high-relief area in water depths ranging from approximately 200 to 650 ft (60 to 200 m). It is in the northeastern portion of the CPA at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon (**Figures 2-4 and 4-2**). Outside of the Pinnacle Trend area, low-relief live bottom epibenthic communities occur in isolated locations in shallow waters (<984 ft; 300 m) throughout the GOM, wherever there exists suitable hard substrate and other physical conditions (e.g., depth, turbidity, etc.), allowing for community development. Hard bottom habitats occur throughout the GOM but are relatively rare compared with ubiquitous soft bottoms. The impact-producing factors for pinnacles and low-relief live bottom features and associated communities can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) oil spills. These impact-producing factors have the potential to damage individual pinnacle and low-relief feature habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. The Live Bottom Stipulation (which is a required mitigation as a result of the Five-Year Program's Record of Decision), along with site-specific reviews of permit applications and associated distancing requirements, would mitigate potential impacts to the communities as a result of both routine activities and accidental events. At the broad geographic and temporal scope of this analysis, and assuming adherence to all expected lease stipulations and typically applied regulations and mitigations, routine activities are expected to have largely localized and temporary effects. Although accidental events have the potential to cause severe damage to specific pinnacle and low-relief feature communities, the number of such events is expected to be very small. Therefore, at the regional, population-level scope of this analysis, the *incremental contribution* of impacts from reasonably foreseeable routine activities and accidental activities to the overall cumulative impacts is expected to be ***negligible to minor***. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS oil- and gas-related cumulative impacts experienced by pinnacle and low-relief feature habitats. Under Alternative E, the potential for impacts to pinnacle and low-relief feature communities related to a cancelled lease sale would be **none** because new impacts would be avoided entirely. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. The OCS oil- and gas-related cumulative impacts to live bottom communities are estimated to be **negligible** to **minor**. A full analysis of pinnacles and low-relief features can be found in **Chapter 4.6.2**.

Fish and Invertebrate Resources

The distribution of fishes and invertebrates varies widely, and species may be associated with different habitats at various life stages, which is discussed further in Chapter 4.7 of the 2017-2022 GOM Multisale EIS. The impact-producing factors affecting these resources are anthropogenic sound, bottom-disturbing activities, habitat modification, and accidental oil spills. The impacts from routine activities, excluding infrastructure emplacement, would be expected to be **negligible** or **minor** due to short-term localized effects. The installation of OCS oil- and gas-related infrastructure constitutes a long-term modification of the local habitat and is hypothesized to have resulted over the life of the program in **moderate** changes in the distribution of some species. Although this effect is not necessarily adverse and infrastructure is expected to be decommissioned and sites restored to natural habitat, the cumulative impact over the life of the OCS Program extensively pertains to time and space. Accidental spills have been historically low-probability events and are typically small in size. The expected impact to fishes and invertebrate resources from accidental oil spills is **negligible**. Commercial and recreational fishing are expected to have the greatest direct effect on fishes and invertebrate resources, resulting in impact levels ranging from **negligible** for most species to potentially **moderate** for some targeted species (e.g., hogfish spp., gray triggerfish [*Balistes capriscus*], and greater amber jack [*Seriola dumerili*]). The analysis of routine activities and accidental events indicates the *incremental contribution* to the overall cumulative impacts on fishes and invertebrate resources as a result of a single proposed lease sale would be ***minor***. Under Alternative E, the cancellation of a proposed lease sale, the expected impacts on fish and invertebrate resources would be **none**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of fish and invertebrate resources can be found in **Chapter 4.7**.

Birds

The affected species of birds include both terrestrial songbirds and many groups of waterbirds. Routine impacts to coastal, marine, and migratory birds that were considered include routine discharges and wastes, noise, platform severance with explosives (barotrauma), geophysical surveys with airguns (barotrauma), platform presence and lighting, and pipeline landfalls. The impacts to birds from routine OCS oil-and gas-related activities are similar wherever they may occur in the GOM, and all are considered **negligible** to **minor**. Negligible to minor impacts would not affect a substantial number of birds. Any impacts would be acute and reversible. As used here, acute means short-term, as it does in the context of short-term toxicity exposure and tests. Further, no injury to or mortality of a small number of individuals or a small flock would occur. Accidental impacts to birds are caused by oil spills, spill cleanup activities, and emergency air emissions. Seabirds may not always experience the greatest impacts from a spill, but it may take longer for populations to recover because of their unique population ecology (demography). Some species of seabirds, such as gulls, have larger clutches (laughing gulls usually have 3 eggs per clutch except in the tropics) and may recover quite quickly. However, many species of seabirds can have a clutch size of just one egg, and they have relatively long life spans and often have delayed age at first breeding. Because of the latter case, impacts on seabirds from overall accidental events would be expected to be **moderate**. Impacts from overall accidental events on other waterbirds farther inshore would also be expected to be **moderate** because of the extensive overlap of their distributions with oiled inshore areas and shorelines expected from a large oil spill (≥1,000 barrels [bbl]). Moderate impacts would affect a substantial abundance of birds.

The *incremental contribution* of a proposed action to the overall cumulative impacts is considered ***moderate***, but only because of the potential impacts that could result from a large oil spill (≥1,000 bbl). This conclusion is based on the increment of a proposed action compared with all cumulative OCS oil- and gas-related and non-OCS oil- and gas-related impacts. Alternative E would offer no new lease blocks for exploration and development; therefore, incremental impacts to birds would be **none**. However, there would be continuing impacts associated with the existing OCS oil- and gas-related activities from previously permitted activities and previous lease sales. An analysis of birds can be found in **Chapter 4.8**.

Protected Species

Marine Mammals

The Gulf of Mexico marine mammal community is diverse and distributed throughout the GOM, with the greatest abundances and diversity of species inhabiting oceanic and OCS waters. The major potential impact-producing factors affecting marine mammals in the GOM as a result of cumulative past, present, and reasonably foreseeable OCS oil- and gas-related activities are decommissioning activities, operational discharges, G&G activities, noise, transportation, marine debris, and accidental oil spills and spill-response activities. Accidental events involving large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations inhabiting GOM waters. While accidental events cannot be predicted and have the potential to impact marine mammal species, the number of such events is expected to be very small based on Oil Spill Risk Analysis.

Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative effects experienced by marine mammal populations. At the regional, population-level scope of this analysis, impacts from reasonably foreseeable routine activities and accidental events could be **negligible** to **moderate** for any of the action alternatives. However, the *incremental contribution* of a proposed action to cumulative impacts to marine mammal populations, depending upon the affected species and their respective population estimate, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response; non-OCS oil- or gas-related activities; and the minimization of the OCS oil- or gas-related impacts through lease stipulations and regulations, would be expected to be ***negligible***. Under Alternative E, the cancellation of a proposed lease sale, the impacts on marine mammals within the Gulf of Mexico would be **none**. However, cumulative impacts from previous lease sales and non-OCS oil- and gas-related activities would remain. An analysis of marine mammals can be found in **Chapter 4.9.1**.

Sea Turtles

Five ESA-listed sea turtle species are present throughout the northern GOM year-round; however, only Kemp's ridley and loggerhead sea turtles commonly nest on beaches in the GOM during the nesting season. Due to the expected implementation of mitigations (e.g., BOEM and BSEE proposed compliance with Notices to Lessees and Operators under the proposed Protected Species Stipulation and conditions of approval on postlease activities), routine activities (e.g., noise or transportation) and accidental events (e.g., oil spills) related to a proposed action are not expected to have long-term adverse effects on the population size or productivity of any sea turtle species or populations in the northern GOM. Lethal effects could occur from chance collisions with OCS oil- and gas-related service vessels or ingestion of accidentally released plastic materials from OCS oil- and gas-related vessels and facilities. Most routine activities and accidental events as a result of a proposed action are therefore expected to have **negligible** to **moderate** impacts. For example, a minor impact might be a behavioral change in response to noise while a moderate impact might be a spill contacting an individual and causing injury or mortality.

Historically, intense harvesting of eggs, loss of suitable nesting beaches, and fisheries-related mortality led to the rapid decline of sea turtle populations. Anthropogenic actions continue to pose the greatest threat to sea turtles since their listing under the Endangered Species Act (ESA), as well as different natural threats including climate change, disease, and natural disasters. The *incremental contribution* of a proposed action to the cumulative impacts on sea turtles would be expected to be ***negligible***. Population-level impacts are not anticipated. Under Alternative E, the cancellation of a proposed lease sale, the impacts on sea turtles within the Gulf of Mexico would be **none**. However, cumulative impacts from previous lease sales and non-OCS oil- and gas-related activities would remain. An analysis of sea turtles can be found in **Chapter 4.9.2**.

Beach Mice

The four subspecies of beach mouse (*Peromyscus polionotus* ssp.) are small coastal rodents that are only found along beaches in parts of Alabama and northwest Florida, and are federally listed as endangered. Beach mice rely on dune systems as favorable habitat for foraging and maintaining burrows. Due to the distance between beach mouse habitat and OCS oil- and gas-related activities, impacts from routine activities are not likely to affect beach mouse habitat except under very limited situations. Pipeline emplacement or construction, for example, could cause temporary degradation of beach mouse habitat; however, these activities are not expected to occur in areas of designated critical habitat. Accidental oil spills and associated spill-response efforts are not likely to impact beach mice or their critical habitat because the species live above the intertidal zone where contact is less likely. Habitat loss from non-OCS oil- and gas-related activities (e.g., beachfront development) and predation have the greatest impacts to beach mice. Overall, the *incremental contribution* of impacts from reasonably foreseeable routine activities and accidental events to the overall cumulative impacts on beach mice is expected to be ***negligible***. Under Alternative E, the cancellation of a proposed lease sale, the impacts on beach mice would be **none**. However, cumulative impacts from previous lease sales and other non-OCS oil- and gas-related activities would remain. An analysis of beach mice can be found in **Chapter 4.9.3**.

Protected Birds

Protected birds are those species or subspecies listed under the ESA by the U.S. Fish and Wildlife Service (FWS) as threatened or endangered due to the decrease in their population sizes or loss of habitat; therefore, a proposed action could have a greater impact. BOEM is undergoing consultation with FWS to minimize the potential impacts to ESA-listed species. Impacts from routine activities, which include discharges and wastes affecting air and water quality, noise, and possibly artificial lighting, would be **negligible** to protected birds. The listed bird species considered are typically coastal birds and would not be exposed to much of the OCS oil- and gas-related activities. Waste discharges to air or water produced as a result of routine activities are regulated by the U.S. Environmental Protection Agency and BOEM, and these discharges are subject to limits to reduce potential impacts; therefore, due to precautionary requirements and monitoring, the impacts to protected birds would be **negligible**. The major impact-producing factors resulting from accidental events associated with a proposed action that may affect protected birds include accidental oil spills and response efforts. In the case of an accidental oil spill, impacts would be **negligible** to **moderate** depending on the magnitude and time and place of such an event. Major impacts could occur if a large oil spill occurred with direct contact to a protected bird species or if the habitat became contaminated, resulting in mortality of a listed species. Marine debris produced by OCS oil- and gas-related activities as a result of accidental disposal into the water may affect protected birds by entanglement or ingestion. Due to the regulations prohibiting the intentional disposal of items, impacts would be expected to be **negligible**; however, impacts may scale up to **moderate** if the accidental release of marine debris caused mortality of a listed bird.

Overall, BOEM would expect **negligible** to **moderate** impacts to protected birds considering routine activities, accidental events, and cumulative impacts. Due to the precautionary requirements and monitoring discussed in **Chapter 4.9.4**, the *incremental impacts* to protected birds would be ***negligible*** for any of the action alternatives (i.e., Alternatives A-D). Under Alternative E, the cancellation of a proposed lease sale, the additional incremental impacts to ESA-protected birds or their habitats would be **none**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of protected birds can be found in **Chapter 4.9.4**.

Protected Corals

Elkhorn, staghorn, boulder star, lobed star, and mountainous star corals are listed by the National Marine Fisheries Service (NMFS) as threatened due to the decrease in their population sizes; therefore, the relative impacts from a proposed action on a particular group of coral colonies could have disproportionately higher population-level effects than what might be experienced by other non-listed coral species. BOEM understands this and therefore consults with NMFS to minimize any potential impacts to these species. Though the listed species are protected (i.e., given ESA status), they could experience the same types of potential impact-producing factors from a proposed action as other coral species. Without effective mitigations, routine activities and accidental events resulting from a proposed action could directly impact coral habitats within the GOM.

The site-specific survey information required for postlease reviews of permit applications would allow BOEM to identify and protect live bottom features (which protected corals may inhabit) from potential harm by proposed OCS oil- and gas-related activities by requiring that bottom-disturbing activity be distanced from live bottom features. Assuming adherence to the expected lease stipulations and other postlease, protective restrictions and mitigations, the routine activities related to a proposed action could have short-term localized and temporary effects on protected corals, if any. While accidental events have the potential to cause severe damage to specific coral communities, the number of such events is expected to be small, and any impacts would be reduced or prevented by the lease stipulations and postlease distancing requirements. Furthermore, the OCS lease blocks in the EPA that are closest to ESA-defined critical habitat areas for listed corals are not being offered in a proposed lease sale due to the current leasing moratorium and are therefore too distant to be reasonably affected by routine activities or accidental events. In addition, many of the protected corals occur within the Flower Garden Banks National Marine Sanctuary, which under the current boundaries is not proposed for future leasing under any of the alternatives in this Supplemental EIS or the 2017-2022 Gulf of Mexico Multisale EIS. Therefore, the *incremental contribution* of activities resulting from a proposed action to the overall cumulative impacts on protected corals is expected to be ***negligible***. Proposed OCS oil- and gas-related activities would contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative impacts experienced by corals. The non-OCS oil- and gas-related cumulative impacts to protected corals are expected to be dramatically greater than any impacts related to OCS oil- and gas-related activities. Under Alternative E, the cancellation of a proposed lease sale, the impacts on protected corals would be **none**. However, cumulative impacts from previous lease sales and non-OCS oil- and gas-related activities would remain. An analysis of protected corals can be found in **Chapter 4.9.5**.

Commercial Fisheries

A proposed action could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine activities such as seismic surveys, drilling activities, and service-vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts depending on the location and species. For example, structure emplacement prevents trawling in the associated area and, thus, could impact the shrimp fishery. On the other hand, production platforms can facilitate fishing for reef fish such as red snapper and groupers. The eventual removal of production platforms would reverse these positive and negative impacts. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. A proposed action would be relatively small when compared with the overall OCS Program, State oil and gas activities, overall vessel traffic, tropical storms/hurricanes, economic factors, Federal and State fisheries management strategies, and other non-OCS oil- and gas-related factors. Therefore, the *incremental contribution* of a proposed action to the cumulative impacts to commercial fisheries would range from ***beneficial (low)*** *to* ***minor*** adverse effects for any of the action alternatives. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access. Alternative E would prevent these impacts from occurring, except for potential **negligible** impacts arising from adjustments to incomes in the economy. Under Alternative E, the cancellation of a proposed lease sale, fisheries would still be subject to the impacts from the OCS Program, as well as the impacts from non-OCS oil- and gas-related activities. An analysis of commercial fisheries can be found in **Chapter 4.10**.

Recreational Fishing

The Gulf of Mexico's extensive estuarine habitats (**Chapter 4.3.1**), live bottom habitats (**Chapter 4.6**), and artificial substrates (including artificial reefs, shipwrecks, and oil and gas platforms) support several valuable recreational fisheries. Alternatives A-D can affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternatives A-D on fish populations are presented in **Chapter 4.7**. Vessel traffic can cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect will be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, can cause fishing closures and can affect the aesthetics of fishing in an area. However, accidental events that could arise would likely be small and localized. Alternatives A-D should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, tropical storms/hurricanes, economic factors, and Federal and State fisheries management strategies. The *incremental impacts* of Alternatives A-D on recreational fisheries are expected to be ***beneficial (low)*** *to* ***minor***. Alternative E, the cancellation of a proposed lease sale, would cause some economic adjustments (refer to **Chapter 4.14.2**), which could cause **negligible** impacts to recreational fishing activities. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of recreational fishing can be found in **Chapter 4.11**.

Recreational Resources

Alternatives A-D would contribute to the negligible to minor space-use conflicts (from vessel traffic) and visual impacts (from the visibility of OCS structures) that arise due to the broader OCS

Program. Structure emplacements can have **beneficial (low)** impacts on recreational fishing and diving because platforms often act as artificial reefs, but the eventual removal of these structures would lead to **negligible** to **minor** negative impacts. Oil spills can have a **negligible** to **minor** negative affect on beaches and other coastal recreational resources. Alternatives A-D should also be viewed in light of of the overall OCS Program, as well as various non-OCS oil- and gas-related factors, such as beach/wetlands erosion, beach disruptions, economic factors, and activities, that can cause space-use conflicts and aesthetic impacts such as commercial and military activities. Because of the relatively small contribution of any given lease sale under any of the proposed action alternatives (i.e., Alternatives A-D) to the overall OCS Program, in addition to other non-OCS oil- and gas-related activities, the *incremental impacts* are expected to be ***beneficial (low)*** *to* ***minor*** adverse effects. Under Alternative E, the cancellation of a proposed lease sale, there could be **negligible** impacts to recreational resources due to the small economic adjustments. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of recreational resources can be found in **Chapter 4.12**.

Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation (30 CFR § 250.105). Archaeological resources are primarily impacted by any activity that directly disturbs or has the potential to disturb the seafloor. For the OCS Program, this includes the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement and installation; the use of seismic receiver nodes and cables; the dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; post-decommissioning activities, including trawling clearance; and the masking of archaeological resources from industry-related infrastructure and debris.

Regardless of which planning area a proposed lease sale is held, the greatest potential impact to an archaeological resource as a result of a proposed action under any of the action alternatives is site-specific and would result from direct contact between an offshore activity or accidental event and a site. A proposed action's postlease activities, including the drilling of wells and installation of platforms, installation of pipelines, anchoring, the removal of platforms and other structures installed on the seafloor, and site clearance activities, as well as accidental events such as loss of debris, may result in **negligible** to **major** impacts to archaeological sites.

Major impacts could potentially occur if the mitigations described in **Chapter 4.13** were not applied to postlease activities. With the identification, evaluation, and avoidance or mitigation of archeological resources, the *incremental contribution* of a proposed action is expected to result in ***negligible***, long-term cumulative impacts to archaeological resources; however, if an archaeological site were to be impacted, impacts may range from **negligible** to **major**. Under Alternative E, the cancellation of a proposed lease sale, the impact-producing factors discussed in **Chapter 4.13** would not take place for that proposed lease sale; therefore, the impacts would be **none**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of archaeological resources can be found in **Chapter 4.13**.

Human Resources and Land Use (Including Environmental Justice)

Land Use and Coastal Infrastructure

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore network of coastal infrastructure that includes hundreds of large and small companies. Because OCS oil- and gas-related activities are supported by this long-lived, expansive onshore network, routine operations associated with a proposed action are not expected to produce any major impacts to land use and coastal infrastructure. Potential impacts from routine operations could range from **negligible** to **moderate**, depending on the location, scale, and type of activity. The impacts of reasonably foreseeable accidental events such as oil spills, chemical and drilling fluid spills, and vessel collisions are not likely to last long enough to adversely affect overall land use or coastal infrastructure in the analysis area and would therefore be **negligible** to **moderate**. The cumulative analysis includes impacts that could result from a proposed lease sale combined with baseline conditions, all past, present, and future OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions that are external to OCS oil- and gas-related activities. Activities relating to all past, present, and future OCS oil- and gas-related activities are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks. Non-OCS oil- and gas-related activities contribute substantially to the cumulative impacts on land use and coastal infrastructure, while only a ***minor*** *incremental contribution* is expected for a proposed action.

For any of the action alternatives, the cumulative impacts on land use and coastal infrastructure could range from **beneficial** to **moderate** for OCS oil- and gas-related activities and **beneficial** to **major** for non-OCS oil- and gas-related activities depending on the specifics of each situation, whether the impacts are measurable, how long the impacts would last, and the size of the affected geographic area as defined in **Chapter 4.14.1**. Alternative E would result in no lease sale and, thus, the direct impacts as a result of a proposed lease sale would be **none**, and there would be no incremental contribution of impacts to land use and coastal infrastructure beyond a temporary negative economic impact for the oil and gas industry and coastal states (such as Louisiana), which are more dependent on oil and gas revenues. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of land use and coastal infrastructure can be found in **Chapter 4.14.1**.

Economic Factors

A proposed lease sale would lead to **beneficial (low)** impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. A proposed lease sale could also lead to negative economic impacts (**negligible** to **minor**) arising from accidental events and disruptions to other industries. There would be some differences in economic impacts among the alternatives, corresponding to the differences in the scales and distributions of likely activities. Chapter 4.14.2 of the 2017-2022 GOM Multisale EIS presents detailed estimates of the economic impacts of the alternatives. The alternatives should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the *incremental economic impacts* of a proposed action are forecast to be ***beneficial***, although there would be some ***minor*** adverse impacts . Alternative E, the cancellation of a proposed lease sale, would negatively impact firms and employees that depend on recurring leases; therefore, the impacts of Alternative E would be **negligible** to **minor**, with some partially offsetting **beneficial** impacts. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. An analysis of economic factors can be found in **Chapter 4.14.2**.

Social Factors (Including Environmental Justice)

Potential social impacts resulting from a proposed action would occur within the larger socioeconomic context of the GOM region. The affected environment of the analysis area is quite large geographically and in terms of population (133 counties and parishes with over 22.7 million residents). The impacts from routine activities related to a proposed action are expected to be **negligible** to **moderate**, widely distributed, and to have little impact because of the existing extensive and widespread support system for the petroleum industry and its associated labor force. Outside of a low-probability catastrophic oil spill, which is not reasonably foreseeable and not part of a proposed action, any potential accidental events are not likely to be of sufficient scale or duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area and would therefore range from **negligible** to **moderate**. In the cumulative analysis, impacts from OCS oil- and gas-related activities would range from **beneficial** to **moderate**. Non-OCS oil- and gas-related factors, which include all human activities, natural events, and processes, actually contribute more to cumulative impacts than do factors related to OCS oil- and gas-related activities alone because of the analysis area's complex socioeconomic framework and result in **beneficial** to **major** impacts. The *incremental contribution* of a proposed action to cumulative impacts would be ***minor***. Alternative E would result in no lease sale and, thus, the overall incremental impacts as a result of Alternative E would be **none**. Cumulative impacts of current and past activities (OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative.

Coastal populations experience cumulative impacts that include all human activities and natural processes and events. The cumulative analysis includes impacts that could result from a proposed lease sale combined with baseline conditions, all past, present, and future OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions that are external to OCS oil- and gas-related activities. Within this divided analytical framework of OCS oil-and gas-related and non-OCS oil- and gas-related impacts, the largest quantity of impact-producing factors for coastal populations occur as non-OCS oil- and gas-related impacts because OCS oil- and gas-related activities form a very small part of the greater, complex socioeconomic structure in the GOM. The *incremental contribution* of a proposed action to cumulative impacts of a single proposed lease sale would be ***minor*** for communities and people in the Gulf Coast region.

Environmental Justice Determination: The oil and gas industry in the GOM region is expansive and long-lived over several decades with substantial infrastructure in place to support both onshore and offshore activities. BOEM's scenario estimates call for 0-1 new gas processing plant and 0-1 new pipeline landfall over the 50-year life of a single proposed action. Impacts to GOM populations from a proposed action would be immeasurable for environmental justice since these low-income and minority communities are located onshore, distant from Federal OCS oil- and gas-related activities. Also, since these vulnerable populations are located within the larger context of onshore and State-regulated nearshore oil and gas activities that are connected to downstream infrastructure over which BOEM has no regulatory authority, BOEM has determined that a proposed action would not produce environmental justice impacts in the GOM region. An analysis of social factors and an environmental justice determination can be found in **Chapter 4.14.3**.

APPENDICES

To improve the readability of this Supplemental EIS, more detailed supporting information has been placed in the appendices, which include a Memorandum of Agreement between BOEM and the National Park Service, meteorological information used for the air quality modeling, description of emissions generation, and photochemical modeling.

Appendix A is the Memorandum of Agreement between BOEM and the National Park Service; it outlines the roles and responsibilities for both agencies during the preparation of this Supplemental EIS.

Appendix B details the meteorological information used for the air quality modeling described in **Chapter 4.1**. Parameters such as wind speed, wind direction, air temperature, and humidity are required by models to determine the rate that pollutants disperse and react in the atmosphere. This appendix details the modeling performance evaluation of a Weather and Research Forecast model for 2012 used in conducting the air quality modeling summarized in **Chapter 4.1**.

Appendix C describes how the emissions were generated for the Cumulative and Visibility Impact Analysis Emissions Inventory used in conducting the air quality modeling summarized in **Chapter 4.1**.

Appendix D provides the photochemical modeling, evaluation of the modeling, and results of the air quality modeling summarized in **Chapter 4.1**.

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ABBREVIATIONS AND ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
μg	microgram
μm	micrometer
2017-2022 GOM Multisale EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement*
2D	two dimensional
3D	three dimensional
ac	acre
Agreement	Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico
API	American Petroleum Institute
Area ID	Area Identification
AQRV	air quality-related value
bbl	barrel
Bbbl	billion barrels
Bcf	billion cubic feet
BBO	billion barrels of oil
BOE	billion barrels of oil equivalent
BOEM	Bureau of Ocean Energy Management
B.P.	Before Present
BSEE	Bureau of Safety and Environmental Enforcement
BTEX	benzene, toluene, ethylbenzene, and xylene
Call	Call for Information
CAMx	Comprehensive Air-quality Model with extensions
CD	Consistency Determination
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CG	Coast Guard (also: USCG)
CH_4	methane
CMAQ	Community Multiscale Air Quality
CMP	Coastal Management Program
CO	carbon monoxide
CO_2	carbon dioxide
CO_2-e	CO_2-equivalent
COE	Corps of Engineers (U.S. Army)
CPA	Central Planning Area
CZMA	Coastal Zone Management Act
dB re: 1μPa	decibels referenced 1 microPascal

DOCD	development operations coordination document
DOI	Department of the Interior (U.S.) (also: USDOI)
DOT	Department of Transportation (U.S.) (also: USDOT)
DPP	development and production plan
EFH	essential fish habitat
e.g.	for example
EIA	Economic Impact Area
EIS	environmental impact statement
EP	exploration plan
EPA	Eastern Planning Area
ESA	Endangered Species Act of 1973
et al.	and others
et seq.	and the following
Five-Year Program	*2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (also: 2017-2022 Five-Year Program)
Five-Year Program EIS	*Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022, Final Programmatic Environmental Impact Statement*
FPSO	floating production, storage, and offloading system
FR	*Federal Register*
ft	feet
FWS	Fish and Wildlife Service
G&G	geological and geophysical
GOADS	Gulfwide Offshore Activity Data System
GOM	Gulf of Mexico
GWEI	Gulfwide Emission Inventory
H_2S	hydrogen sulfide
ha	hectare
HRG	high-resolution geophysical
Hz	Hertz
i.e.	that is
km	kilometer
LA	Louisiana
LCA	Louisiana Coastal Area
LNG	liquefied natural gas
LOOP	Louisiana Offshore Oil Port
m	meter
MAG-PLAN	MMS Alaska-GOM Model Using IMPLAN
MARAD	Maritime Administration (U.S. Department of Transportation)
MATS	Modeled Attainment Test Software
mg/L	milligrams/liter
mi	mile
mm	millimeter
MMbbl	million barrels

MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MSCVAFF	Mississippi Coalition for Vietnamese-American Fisher Folks and Families
N.	north
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	nautical-mile
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
O_3	ozone
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OSAT	Operational Science Advisory Team
OSHA	Occupational Safety and Health Administration
OSRA	Oil Spill Risk Analysis
OSRP	oil-spill response plan
OSV	offshore supply/service vessel
Pb	lead
PBR	Potential Biological Removal
PDARP/PEIS	*Deepwater Horizon Oil Spill: Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement*
PM	particulate matter
$PM_{2.5}$	particulate matter less than or equal to 2.5 μm
PM_{10}	particulate matter less than or equal to 10 μm
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
ROD	Record of Decision
Secretary	Secretary of the Interior
SO_2	sulphur dioxide
SO_x	sulphur oxides

Tcf	trillion cubic feet
Trustees	Natural Resource Damage Assessment Trustees
U.S.	United States
U.S.C.	United States Code
UME	unusual mortality event
USCG	U.S. Coast Guard (also: CG)
USDHS	U.S. Department of Homeland Security
USDOC	U.S. Department of Commerce
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U.S. Department of Transportation (also: DOT)
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VGP	Vessel General Permit
VOC	volatile organic compound
VSP	vertical seismic profiling
W.	west
WPA	Western Planning Area
WRF	Weather and Research Forecasting
yr	year

CONVERSION CHART

To convert from	To	Multiply by
centimeter (cm)	inch (in)	0.3937
millimeter (mm)	inch (in)	0.03937
meter (m)	foot (ft)	3.281
meter^2 (m^2)	foot^2 (ft^2)	10.76
meter^2 (m^2)	yard^2 (yd^2)	1.196
meter^2 (m^2)	acre (ac)	0.0002471
meter^3 (m^3)	foot^3 (ft^3)	35.31
meter^3 (m^3)	yard^3 (yd^3)	1.308
kilometer (km)	mile (mi)	0.6214
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
hectare (ha)	acre (ac)	2.47
liter (L)	gallons (gal)	0.2642
degree Celsius (°C)	degree Fahrenheit (°F)	°F = (1.8 x °C) + 32
1 barrel (bbl) = 42 gal = 158.9 L = approximately 0.1428 metric tons 1 nautical mile (nmi) = 1.15 mi (1.85 km) or 6,076 ft (1,852 m) tonnes = 1 long ton or 2,240 pounds (lb)		

CHAPTER 1

THE PROPOSED ACTION

What's in This Chapter?

- The Bureau of Ocean Energy Management (BOEM) has issued the *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (Five-Year Program). It sets forth a schedule for 10 proposed regionwide Gulf of Mexico lease sales spaced evenly throughout the 5-year period.
- The *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS) is an EIS that provides the environmental review foundation for all 10 proposed GOM lease sales in the Five-Year Program schedule.
- This Supplemental EIS has been prepared to inform decisions for the proposed 2018 GOM lease sales in the Five-Year Program. It tiers from and updates the 2017-2022 GOM Multisale EIS and contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale (e.g., Lease Sale 250), but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program.
- The proposed action in this Supplemental EIS is to hold a regionwide lease sale in the GOM according to the schedule of proposed lease sales set forth by the Five-Year Program.
- The purpose of a proposed lease sale in this Supplemental EIS is to offer for lease those areas in the Gulf of Mexico (GOM) that may contain economically recoverable oil and gas resources in accordance with the Outer Continental Shelf Lands Act (OCSLA), subject to environmental safeguards.
- The need for a proposed lease sale in this Supplemental EIS is to manage the development of Outer Continental Shelf (OCS) energy resources in an environmentally and economically responsible manner. Oil and gas from the Gulf of Mexico OCS would contribute to meeting domestic demand and enhance national economic security.
- This Supplemental EIS explains the environmental considerations used to assess the potential environmental consequences of a proposed lease sale and its alternatives, as well as the potential mitigations that could minimize or avoid those consequences.
- The decision on whether and how to proceed with proposed Lease Sale 250 will be made following the completion of this National Environmental Policy Act (NEPA) analysis. A separate decision will be made for proposed Lease Sale 251 and the remaining proposed regionwided lease sales scheduled in the Five-Year Program.

1 THE PROPOSED ACTION

1.0 INTRODUCTION

This Supplemental EIS contains analyses of the potential environmental impacts that could result from a single proposed lease sale (e.g., Lease Sale 250), but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program.

This Supplemental Environmental Impact Statement (EIS) addresses a proposed Federal action – a regionwide lease sale. This Supplemental EIS is expected to be used to inform decisions on proposed Outer Continental Shelf (OCS) oil and gas Lease Sales 250 and 251 in the Gulf of Mexico, as scheduled in the *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (Five-Year Program; USDOI, BOEM, 2016a). This Supplemental EIS is expected to be used to inform decisions for each of the two lease sales scheduled in 2018 and to be used and supplemented as necessary for decisions on future Gulf of Mexico proposed regionwide lease sales. This Supplemental EIS contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale in the Gulf of Mexico as scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program. This Supplemental EIS tiers from and updates the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS; USDOI, BOEM, 2017a) and incorporates by reference all of the relevant material in the 2017-2022 GOM Multisale EIS. The decision on whether and how to proceed with proposed Lease Sale 250 will be made following the completion of this National Enviornmental Policy Act (NEPA) analysis. A separate decision will be made for the second lease sale of 2018, i.e., proposed Lease Sale 251. Decisions on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional NEPA review that may update this Supplemental EIS as necessary.

This Supplemental EIS tiers from and updates the Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement *(2017-2022 GOM Multisale EIS).*

The Bureau of Ocean Energy Management (BOEM) has issued the Five-Year Program (USDOI, BOEM, 2016a). The Five-Year Program proposes 10 regionwide Gulf of Mexico (GOM) oil and gas lease sales. Five regionwide lease sales are tentatively scheduled in August of each year from 2017 through 2021 and five regionwide lease sales are tentatively scheduled in March of each year from 2018 through 2022. The lease sales proposed in the GOM in the Five-Year Program are regionwide lease sales comprised of the Western, Central, and a small portion of the Eastern Planning Areas (WPA, CPA, and EPA, respectively) not subject to Congressional moratorium. These planning areas are located off the States of Texas, Louisiana, Mississippi, Alabama, and Florida (**Figure 1-1**).

2017-2022 Schedule of Proposed Gulf of Mexico OCS Region Lease Sales	
Lease Sale Number	Year
249	2017
250 and 251	2018
252 and 253	2019
254 and 256	2020
257 and 259	2021
261	2022

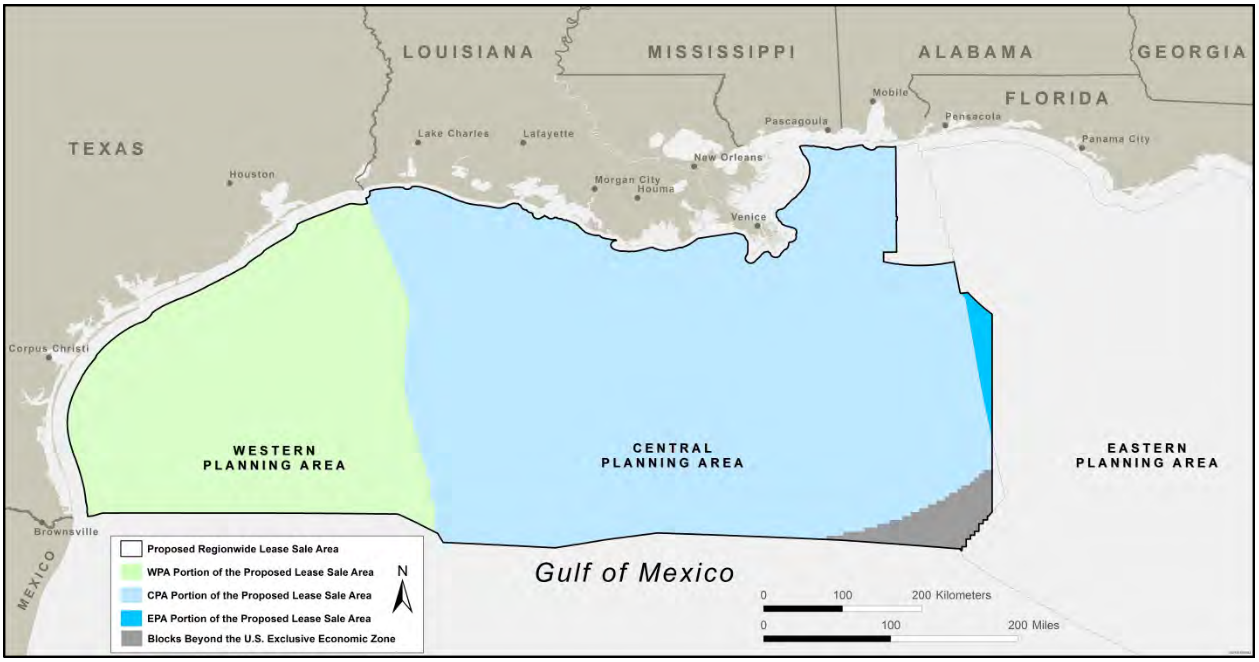


Figure 1-1. Proposed Regionwide Lease Sale Area Combining the Western, Central, and Eastern Planning Areas.

The development of the Five-Year Program initiates region-specific NEPA reviews for each of the proposed lease sales. Region-specific reviews are conducted by Program Area, and this Supplemental EIS contains analyses for the Gulf of Mexico OCS Region. Even though the Five-Year Program includes regionwide lease sales for the GOM, any individual lease sale could still be scaled back during the prelease sale process, including for example, to employ the separate planning area model used in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program*: *2012-2017* (2012-2017 Five-Year Program; USDOI, BOEM, 2012), should circumstances warrant. For more detail on the Five-Year Program and its relationship to the individual lease sale consultation and decision process, refer to Chapter 1.3.1 of the 2017-2011 GOM Multisale EIS.

The Proposed Action

> *The proposed action is to hold a lease sale in the GOM according to the schedule of proposed lease sales set forth by the Five-Year Program.*

The proposed action evaluated in this Supplemental EIS is to hold a regionwide lease sale in the GOM according to the schedule of proposed lease sales set forth by the Five-Year Program. This Supplemental EIS has been prepared to inform decisions for the proposed 2018 GOM lease sales and analyzes a single proposed action (i.e., a single proposed lease sale in the Gulf of Mexico) as scheduled in the Five-Year Program. Since each of the 10 proposed lease sales in the GOM region are very similar and occur in close timeframes, BOEM prepared an EIS for a proposed action, looking at the 10 proposed lease sales in the Five-Year Program cumulatively (i.e., the 2017-2022 GOM Multisale EIS). The analysis in the 2017-2022 GOM Multisale EIS will be used to inform each of the 10 proposed lease sale decisions. This Supplemental EIS tiers from and updates the 2017-2022 GOM Multisale EIS and contains analyses of the potential environmental impacts that could result from a single proposed lease sale (e.g., Lease Sale 250), but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program. However, pursuant to the OCSLA's staged leasing process, BOEM must make an individual decision on whether and how to proceed with each proposed lease sale. Therefore, in order to make an informed decision on a single proposed lease sale, the analyses contained in this Supplemental EIS examine impacts from a single proposed lease sale (e.g., Lease Sale 250). The decision on whether and how to proceed with proposed Lease Sale 250, which is the first GOM lease sale proposed for 2018, will be made following the completion of this NEPA analysis. A separate decision will be made for proposed Lease Sale 251, which is the second GOM lease sale proposed for 2018. Decisions on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional NEPA review that may update this Supplemental EIS as necessary.

1.1 PURPOSE OF THE PROPOSED ACTION

> *"It is hereby declared to be the policy of the United States that ... the Outer Continental Shelf is a vital national resource held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs."*
>
> OCSLA, 43 U.S.C. §§ 1331 *et seq.*

The Outer Continental Shelf Lands Act of 1953, as amended (43 U.S.C. §§ 1331 *et seq.*), hereafter referred to as OCSLA, establishes the Nation's policy for managing the vital energy and mineral resources of the OCS. Section 18 of OCSLA requires the Secretary to prepare and maintain a schedule of proposed OCS oil and gas lease sales determined to "best meet national energy needs for the 5-year period following its approval or reapproval" (43 U.S.C. § 1344). The Five-Year Program establishes a schedule that the U.S. Department of the Interior (USDOI or DOI) will use as a basis for considering where and when leasing might be appropriate over a 5-year period.

The purpose of the proposed Federal action addressed in this Supplemental EIS (i.e., a proposed regionwide lease sale) is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with OCSLA, which specifically states that these areas "should be made available for expeditious and orderly development, subject to environmental safeguards" (OCSLA, 43 U.S.C. §§ 1331 *et seq.*). Each individual proposed lease sale would provide qualified bidders the opportunity to bid upon and lease available acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. This Supplemental EIS will determine the potential environmental impacts that could result from a single proposed lease sale (e.g., Lease Sale 250) scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary for each remaining Federal action (lease sale) scheduled in the Five-Year Program.

1.2 NEED FOR THE PROPOSED ACTION

The need for the proposed action (i.e., a proposed regionwide lease sale) is to manage the development of the OCS energy resources in an environmentally and economically responsible manner, as required under Section 18 of the OCSLA. Oil serves as the feedstock for liquid hydrocarbon products, including gasoline, aviation and diesel fuel, and various petrochemicals. Oil from the Gulf of Mexico OCS contributes to meeting domestic demand and enhances national economic security. Since the U.S. is expected to continue to rely on oil and natural gas to meet its energy needs, each proposed action would contribute to meeting domestic demand and to reducing the need for imports of these resources. Refer to Chapter 1.2 of the 2017-2022 GOM Multisale EIS for details on petroleum consumption and energy needs in the United States, as well as the Gulf of Mexico OCS region's resource potential.

1.3 OCS OIL AND GAS PROGRAM PLANNING AND DECISION PROCESS

BOEM produces NEPA documents for each of the major stages of energy development planning. These documents include an overarching Five-Year Program EIS for the Five-Year Program, NEPA review for the individual decisions on oil and gas lease sales, and site-specific reviews for the approval of exploration, development and production, and decommissioning plans and permits (**Figure 1-2**). This Supplemental EIS is a NEPA review for the individual decision on an oil and gas lease sale.

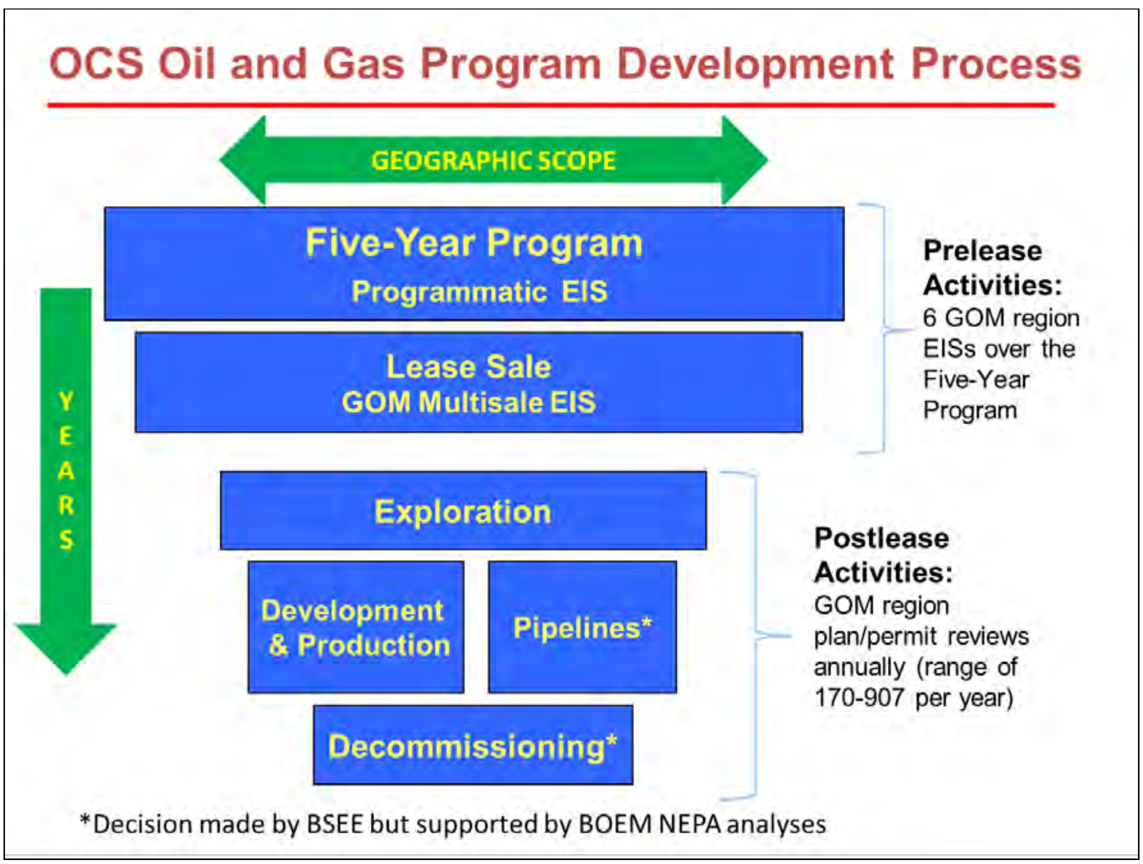


Figure 1-2. OCS Oil and Gas Program Development Process.

1.3.1 Prelease Process

BOEM has a two-stage Federal offshore prelease sale planning process:

(1) develop a Five-Year Program of proposed offshore lease sales for the OCS Program; and

(2) conduct an individual lease sale consultation and decision process for each lease sale scheduled in the approved Five-Year Program.

Due to the staged decisionmaking process in OCSLA, BOEM does a staged or tiered process in which NEPA documents are prepared that cover potential impacts associated with the various stages of the OCSLA process. This includes analyses at the Five-Year Program stage, proposed lease sale stage, exploration or development and production plan stage, and various permitting stages, including, but not limited to, drilling and decommissioning. At the lease sale stage, this is typically done through an EIS, which analyzes the potential impacts of postlease activities. However, at the lease issuance stage, no activities beyond certain ancillary activities (e.g., geological and geophysical operations, data collection, and geotechnical evaluations) are actually authorized by the lease; therefore, there are few environmental impacts reasonably expected from the lease sale itself. Nonetheless, BOEM has chosen in its discretion to prepare an EIS at this stage to analyze the potential environmental impacts that could result if exploration, development, production, and decommissioning activities eventually occur, in order to provide the context and setting of future proposed actions and to better understand the potential impacts associated with these types of activities as well as cumulative impacts on GOM resources.

The 2017-2022 GOM Multisale EIS analyzes GOM lease sales included in the Five-Year Program's schedule of proposed lease sales, and its relationship (tiering and supplementing) and timing with its respective proposed actions (lease sales) are illustrated in **Figure 1-3** below. BOEM plans to prepare supplemental EISs on a calendar-year basis as illustrated in **Figure 1-3**. Respective NEPA documents will be completed before decisions are made on the subsequent lease sales. This Supplemental EIS is the first of these yearly supplements and will be used to make a decision for lease sales proposed for 2018. The analyses in this Supplemental EIS may be applied and supplemented as necessary to inform decisions for each of the remaining proposed regionwide lease sales scheduled in the Five-Year Program.

Also, as described in the Five-Year Program, any individual lease sale could still be scaled back during the prelease sale process to offer a smaller area should circumstances warrant. For example, an individual lease sale could offer an area that conforms more closely to the separate planning area model used in the 2012-2017 Five-Year Program. Therefore, the analyses in this Supplemental EIS also includes alternatives similar to past WPA, CPA, and EPA lease sale environmental reviews.

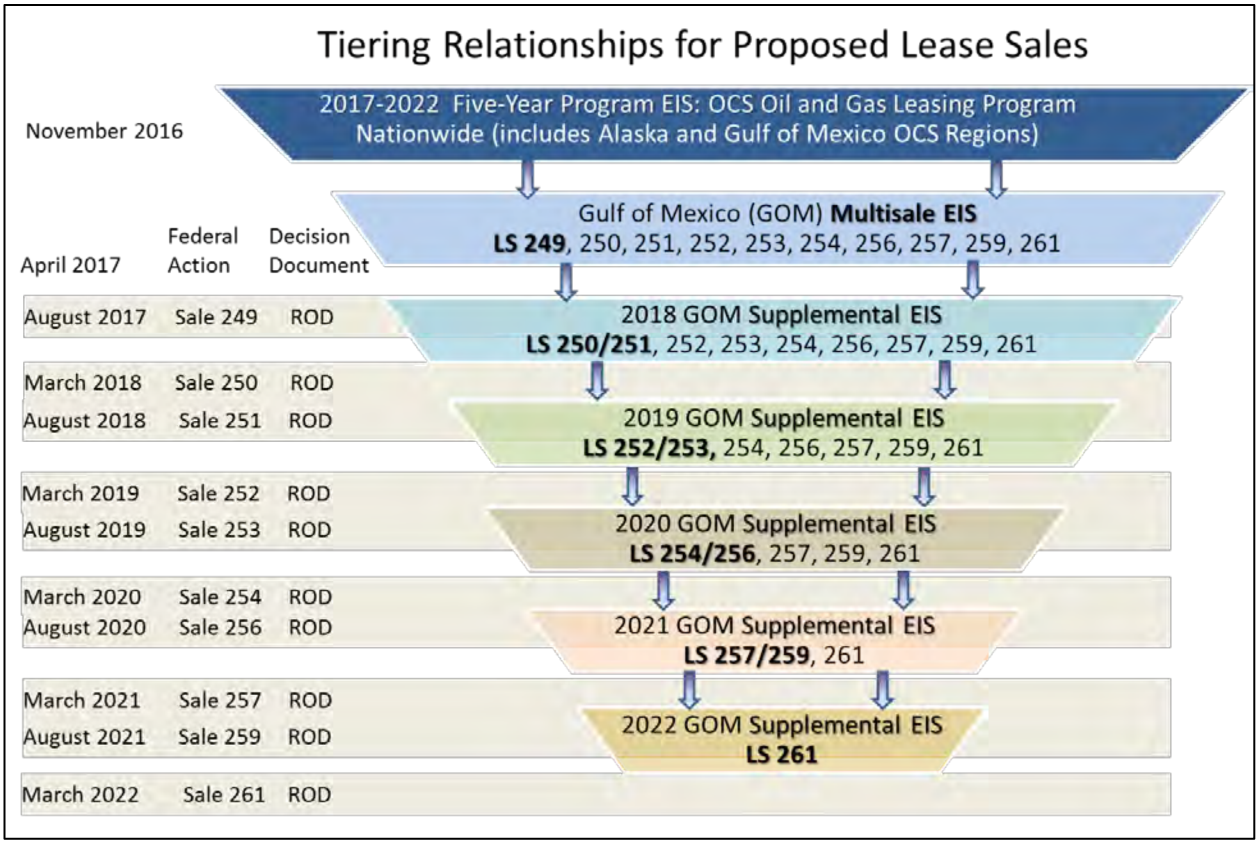


Figure 1-3. BOEM's Planned Supplemental Approach Showing the Tiering Relationships for Proposed Gulf of Mexico Lease Sales.

Each planned subsequent Supplemental EIS from the above figure will update the potential environmental effects of oil and natural gas leasing, exploration, development, and production in the GOM and will update the cumulative impacts from the most recent NEPA analysis, as necessary. The baseline conditions in the GOM will be updated to reflect the most recent technical and scientific information available. As shown in **Figure 1-3**, a new Supplemental EIS cycle is currently planned to be prepared every calendar year (e.g., 2019, 2020, 2021, and 2022), and a separate decision would be made for each of the remaining proposed lease sales in the Five-Year Program. A decision on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional NEPA review that may update the previous Supplemental EIS, as necessary. Using this approach allows for subsequent NEPA analyses to focus on potential changes in each of the proposed lease sales and on any new issues and information that may have become available since the publication of the previous NEPA document.

This Supplemental EIS supplements, tiers from, updates, summarizes, and incorporates by reference all of the relevant analyses from the Five-Year Program EIS and 2017-2022 GOM Multisale EIS, which are referenced below.

- November 2016 – *Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022—Final Programmatic Environmental Impact Statement* (Five-Year Program EIS; USDOI, BOEM, 2016b)
- March 2017 – *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS; USDOI, BOEM, 2017a)

This Supplemental EIS will

- update the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the GOM since publication of the 2017-2022 GOM Multisale EIS;
- analyze the potential impacts of a proposed action on the marine, coastal, and human environments;
- assist decisionmakers in making informed, future decisions regarding the approval of operations, as well as leasing; and
- focus on the potential environmental effects of oil and natural gas leasing, exploration, development, and production in the areas that were identified through the Area Identification (Area ID) procedure for the 2017-2022 GOM Multisale EIS as the proposed lease sale area. In addition to the No Action Alternative (i.e., cancel a proposed lease sale), other alternatives may be considered for the proposed lease sale, such as deferring certain areas from a proposed lease sale.

1.3.2 Gulf of Mexico Postlease Activities

BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) are responsible for managing, regulating, and monitoring oil and natural gas exploration, development, and production operations on the OCS to promote the orderly development of mineral resources in a safe and environmentally sound manner. BOEM's regulations for oil, gas, and sulphur lease operations are specified in 30 CFR parts 550, 551, 554, and 556. The BSEE's regulations for oil, gas, and sulphur operations are specified in 30 CFR parts 250 and 254. Refer to Appendix A of the 2017-2022 GOM Multisale EIS for descriptions of postlease activities, including the following: geological and geophysical (G&G) surveys; exploration and development plans; permits and applications; inspection and enforcement; pollution prevention, oil-spill response plans and financial responsibility; air emissions; flaring and venting; hydrogen sulfide contingency plans; archaeological resources regulation; coastal zone management consistency review and appeals for postlease activities; best available and safest technologies, including at production facilities; personnel training and education; structure removal and site clearance; marine protected species NTLs; and the Rigs-to-Reefs program.

All plans for OCS oil- and gas-related activities (e.g., exploration and development plans) go through rigorous BOEM review and approval to ensure compliance with established laws and regulations before any project-specific activities can begin on a lease. Mitigating measures are incorporated and documented in plans submitted to BOEM. These measures may be implemented through, among other things, lease stipulations and project-specific requirements or conditions of approval. Conditions of approval are based on BOEM's and BSEE's technical and environmental evaluations of the proposed operations. Conditions may be applied to any OCS plan, permit, right-of-use and easement, or pipeline right-of-way grant.

Mitigating 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, deepwater benthic communities, artificial reefs, operations in hydrogen sulfide (H_2S)-prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features. Refer to Appendix B of the 2017-2022 GOM Multisale EIS ("Commonly Applied Mitigating Measures") for more information on the mitigations that BOEM and BSEE often apply to permits and approvals. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

BOEM and BSEE issue Notices to Lessees and Operators (NTLs) to provide clarification, description, or interpretation of a regulation; guidelines on the implementation of a special lease stipulation or regional requirement; or convey administrative information. A detailed listing of the current Gulf of Mexico OCS Region's NTLs is available through BOEM's Gulf of Mexico OCS Region's website at http://boem.gov/Regulations/Notices-Letters-and-Information-to-Lessees-and-Operators.aspx or through the Region's Public Information Office at 504-736-2519 or 1-800-200-GULF. A detailed listing of BSEE's Gulf of Mexico OCS Region's current NTLs is available through BSEE's website at https://www.bsee.gov/guidance-and-regulations/guidance/notice-to-lessees.

1.4 THE DECISION TO BE MADE

This Supplemental EIS has been prepared to inform decisions for the proposed 2018 GOM lease sales. After completion of the NEPA process for this Supplemental EIS, a decision will be made for proposed Lease Sale 250, which is scheduled for March 2018 (i.e., prepare a Record of Decision for proposed Lease Sale 250). A second NEPA review will be conducted for proposed Lease Sale 251, which is scheduled for August 2018, to consider any relevant new information; a second Record of Decision will be prepared for proposed Lease Sale 251. As discussed in **Chapter 1.4.1**, individual decisions will be made on each subsequent proposed lease sale in the Five-Year Program after completion of the appropriate NEPA review and supplementation of the EIS if necessary.

The decision on whether and how to proceed with proposed Lease Sale 250 will be made following the completion of this NEPA analysis. A separate decision will be made for Lease Sale 251.

1.5 Regulatory Framework

Federal laws mandate the OCS leasing program (i.e., OCSLA) and the environmental review process (e.g., NEPA). These regulations are intended to encourage orderly, safe, and environmentally responsible development of oil, natural gas, alternative energy sources, and other mineral resources on the OCS. BOEM consults with numerous federally recognized Indian Tribes and Federal and State departments and agencies that have authority to govern and maintain ocean resources pursuant to other Federal laws. For more information on BOEM's consultation partners for specific Federal regulations, specific consultation and coordination processes with federally recognized Indian Tribes, and Federal, State, and local agencies, refer to Chapter 1.5 of the 2017-2022 GOM Multisale EIS. In addition, a detailed description of major Federal laws and Executive Orders that are relevant to the OCS leasing process is provided in the *OCS Regulatory Framework* white paper, which can be found on BOEM's website (Cameron and Matthews, 2016).

1.6 Other OCS Oil- and Gas-Related Activities

BOEM and BSEE have programs and activities that are OCS-related but not specific to the oil and gas leasing process or to the management of exploration, development, and production activities. These programs include environmental and technical studies, cooperative agreements with other Federal and State agencies for NEPA work, joint jurisdiction over cooperative efforts, inspection activities, and regulatory enforcement. BOEM also participates in industry research efforts and forums. The information collected through these efforts is used in support of the BOEM NEPA documents that inform Agency decisions. Chapter 1.6 of the 2017-2022 GOM Multisale EIS contains descriptions of the other OCS oil- and gas-related activities, including the Environmental Studies Program, Technology Assessment Program, oil-spill response research, and interagency agreements.

1.7 Other Pertinent Environmental Reviews or Documentation

BOEM is aware of other environmental reviews and studies relevant to the resources under consideration in this Supplemental EIS. Notices of Availibility were published in the *Federal Register* for the following reviews: BOEM's *Gulf of Mexico OCS Proposed Geological and Geophysical Activities Programmatic Western, Central, and Eastern Planning Areas Draft Programmatic Environmental Impact Statement* (USDOI, BOEM, 2016c), NOAA's *Flower Garden Banks National Marine Sanctuary Expansion Draft Environmental Impact Statement* (USDOC, NOAA, ONMS, 2016), and the Natural Resource Damage Assessment Trustees' (Trustees) *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (PDARP/PEIS; Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). For more details on these documents, refer to Chapter 1.7 of the 2017-2022 GOM Multisale EIS.

In addition, supporting technical information in previous NEPA reviews have been developed as standalone technical reports and are summarized and incorporated by reference as appropriate. These include the OCS regulatory framework and improvements since the *Deepwater Horizon* explosion, oil spill, and response; the catastrophic spill event analysis (USDOI, BOEM, 2017b); and the essential fish habitat assessment (USDOI, BOEM, 2016d). Subsequent updates to this information have been minimal and, therefore, BOEM has prepared separate technical reports, which will be updated as needed. These reports can be found on BOEM's website at http://www.boem.gov/nepaprocess/. This approach is conducive to reducing the size of this Supplemental EIS and future NEPA documents.

1.8 FORMAT AND ORGANIZATION OF THIS SUPPLEMENTAL EIS

In an effort to thoroughly explain all the environmental consideration and mitigations that are involved in BOEM's assessment of the potential environmental consequences of OCS oil- and gas-related activities, BOEM recognizes that past NEPA reviews have become encyclopedic in nature. To more closely align with CEQ's guidance regarding EIS format, a major goal in preparing this Supplemental EIS includes increasing the readability of the document for decisionmakers and the public, and shortening the document by providing relevant and appropriate information needed to assess the effects of the proposed actions and alternatives. A major focus for preparing this Supplemental EIS has been on clear and concise writing, using graphics to emphasize major concepts where appropriate, and referencing more detailed and technical supporting information in appendices from the 2017-2022 GOM Multisale EIS and incorporating those appendices by reference. The remaining chapters in this Supplemental EIS are described below.

- **Chapter 2** describes the proposed action, including the potential lease sale options and the alternatives, being analyzed in this Supplemental EIS; discusses the potential mitigating measures (pre- and postlease), including the proposed stipulations, and the issues considered and not considered in the analysis; and discusses the deferred alternatives and provides a broad comparison of impacts by alternative.
- **Chapter 3** describes all the potentially occurring actions associated with a proposed regionwide lease sale in the Five-Year Program and the cumulative activities that provide a framework for detailed analyses of the potential impacts analyzed in **Chapter 4**. Exploration and development scenarios describe the infrastructure and activities that could potentially affect the biological, physical, and socioeconomic resources in the GOM. It is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. It also includes a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors.
- **Chapter 4** describes the affected environment and the potential impacts of a proposed regionwide lease sale and each alternative by resource. Analysis of the alternatives includes routine activities, accidental events, cumulative impact analysis, incomplete or unavailable information, and conclusions for each resource.

- **Chapter 5** describes the consultation and coordination efforts used in preparing this Supplemental EIS. This includes a description of the scoping process and summary of scoping comments, activities, and results; cooperating agencies; distribution of the EIS; consultations with Federal and State agencies under the Coastal Zone Management Act, Endangered Species Act, the Magnuson-Stevens Fishery Conservation and Management Act, and the National Historic Preservation Act; and government-to-government consultation and coordination.
- **Chapter 6** includes all the citations referred to throughout this Supplemental EIS.
- **Chapter 7** is a list of all the preparers of this Supplemental EIS.
- **Chapter 8** is a glossary of terms.
- Finally, to improve the readability of this Supplemental EIS, more detailed supporting information has been placed in the **Appendices**.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

What's In This Chapter?

- Alternative A: A single proposed regionwide lease sale offering all available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area with exceptions as outlined in **Chapter 2.2.1**.
- Alternative B: A single proposed lease sale offering all available unleased blocks within the CPA and EPA, but not within the WPA portion of the proposed lease sale area with exceptions.
- Alternative C: A single proposed lease sale offering all available unleased blocks within the WPA, but not within the CPA/EPA portions of the proposed lease sale area with one exception.
- Alternative D: Alternative A, B, or C with the option to exclude any available unleased blocks subject to the Topographic Features Stipulation, Live Bottom (Pinnacle Trend) Stipulation, and/or Blocks South of Baldwin County, Alabama, Stipulations.
- Alternative E: Cancellation of a single proposed lease sale.
- The pre- and postlease mitigating measures being analyzed are presented.
- The issues analyzed and those not considered within this Supplemental EIS are presented.
- A comparison of the potential impacts to each resource by alternative is presented.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.0 INTRODUCTION

This Supplemental EIS addresses a proposed Federal action – a regionwide lease sale. This Supplemental EIS is expected to be used to inform decisions for proposed oil and gas Lease Sales 250 and 251 in the Gulf of Mexico OCS (**Figure 1-1**), as scheduled in the Five-Year Program (USDOI, BOEM, 2016a). This Supplemental EIS is expected to be used to inform decisions for each of the two proposed lease sales scheduled in 2018 and to be used and supplemented as necessary for decisions for each of the remaining proposed regionwide lease sales scheduled in the Five-Year Program. This Supplemental EIS contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale in the Gulf of Mexico as scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program. The decision on whether and how to proceed with proposed Lease Sale 250 will be made following the completion of this NEPA analysis. A separate decision will be made for the second proposed lease sale in 2018, i.e., Lease Sale 251. The proposed action (proposed lease sale) assumes compliance with applicable regulations and lease stipulations in place at the time a ROD is signed for a proposed action. Four action alternatives (Alternatives A-D) and a No Action Alternative (Alternative E) are described, including a comparison of impacts by alternative.

Agencies are encouraged to tier their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues appropriate for decision at each level of environmental review.

2.1 SUPPLEMENTAL EIS NEPA ANALYSIS

The planned supplemental approach for regionwide lease sales is intended to focus the NEPA/EIS process on updating subsequent lease sale NEPA reviews as necessary to address any relevant significant new information and/or issues since publication of the previous lease sale NEPA documents from which it tiers (**Figure 1-6**). Since proposed GOM Lease Sales 250, 251, 252, 253, 254, 256, 257, 259, and 261 and their projected activities are very similar, the impacts from a single proposed regionwide lease sale (e.g., Lease Sale 250) examined in this Supplemental EIS may be applied to the remaining proposed GOM lease sales scheduled in the Five-Year Program, as authorized under 40 CFR § 1502.4, which allows related or similar proposals to be analyzed in one EIS. Proposed Lease Sales 250, 251, 252, 253, 254, 256, 257, 259, and 261 were also considered in the cumulative analysis of the 2017-2022 GOM Multisale EIS. This Supplemental EIS tiers from, updates, summarizes, and incorporates by reference the 2017-2022 GOM Multisale EIS. Proposed GOM Lease Sales 250, 251, 252, 253, 254, 256, 257, 259, and 261 are expected to be within the scenario ranges summarized in **Chapter 3** of this Supplemental EIS and as discussed in Chapter 3 of the 2017-2022 GOM Multisale EIS.

This Supplemental EIS is expected to be used to inform decisions for the two proposed lease sales scheduled in 2018 and to be used and supplemented as necessary for decisions for each of the remaining proposed regionwide lease sales scheduled in the Five-Year Program. At the completion of the NEPA process for this Supplemental EIS, a decision will be made on whether and how to proceed with proposed GOM Lease Sale 250, which is scheduled for March 2018. A second NEPA review will be conducted for proposed Lease Sale 251, which is scheduled for August 2018, to consider any relevant new information, and a second Record of Decision will be published for proposed Lease Sale 251. A new Supplemental EIS cycle is currently planned to be prepared every calendar year (e.g., 2019, 2020, 2021, and 2022), and a separate decision would be made for each of the remaining proposed lease sales scheduled in the Five-Year Program. Informal and formal consultation with other Federal agencies, the affected States, federally recognized Indian Tribes, nongovernmental organizations, and the public is being conducted as appropriate to integrate to the fullest extent possible environmental impact analyses with other environmental review laws and Executive Orders.

2.2 ALTERNATIVES, MITIGATING MEASURES, AND ISSUES

Through the scoping efforts for this Supplemental EIS and the prior 2017-2022 GOM Multisale EIS, numerous issues and topics were identified for consideration. During the scoping period for the prior 2017-2022 Multisale EIS, a number of alternatives or deferral options were suggested and examined for inclusion in Chapter 2.2.2 of the 2017-2022 GOM Multisale EIS. Those alternative and deferral options were also reexamined during the preparation of this Supplemental EIS. These suggestions included additional deferrals, policy changes, and suggestions beyond the scope of this Supplemental EIS. BOEM has not identified any new significant information that changes its conclusions in the prior 2017-2022 GOM Multisale EIS or that indicates that the proposed alternatives or deferral options are appropriate for further in-depth analysis. The justifications for not carrying those suggestions through detailed analyses in this Supplemental EIS are the same as those used in the 2012-2017 GOM Multisale EIS.

The analyses of environmental impacts from the proposed alternatives summarized below and described in detail in **Chapter 4** are based on the development scenario, which is a set of assumptions and estimates on the amounts, locations, and timing for OCS oil and gas exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapter 3**.

2.2.1 What are the Alternatives that BOEM is Considering for Each Proposed Lease Sale?

The discussions below outline the alternatives that are considered for this environmental analysis. All available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area, with the exceptions as outlined for each alternative below, are being offered for lease. The mitigating measures (pre- and postlease), including the proposed stipulations, are fully described in Chapter 2 and Appendix D of the 2017-2022 GOM Multisale EIS.

2.2.1.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Alternative A would allow for a proposed regionwide lease sale encompassing all three planning areas within the U.S. portion of the Gulf of Mexico OCS. This is BOEM's preferred alternative. This alternative would offer for lease all available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]);

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(3) whole and partial blocks within the current boundary of the Flower Garden Banks National Marine Sanctuary.

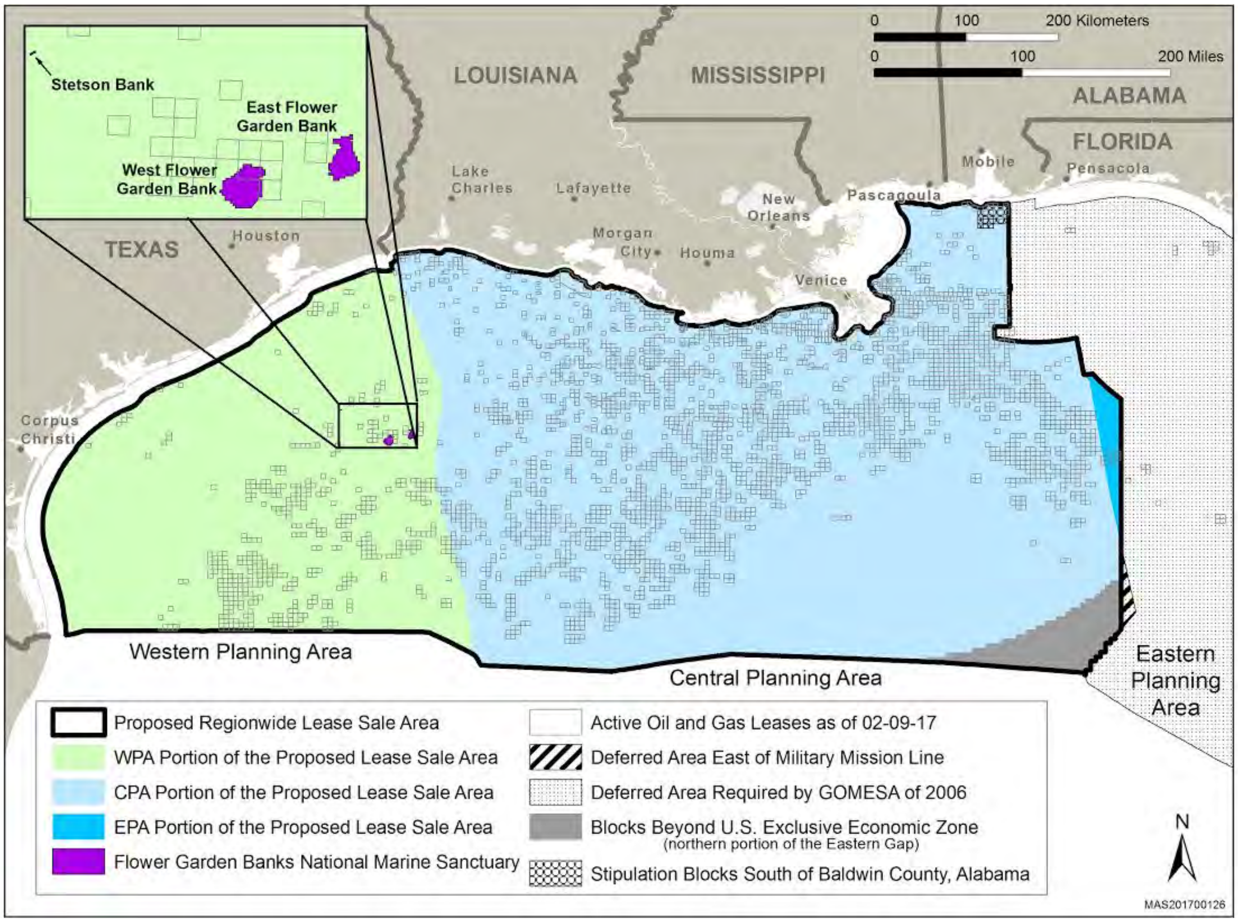


Figure 2-1. Proposed Regionwide Lease Sale Area, Encompassing the Available Unleased Blocks within All Three Planning Areas (a total of approximately 91.93 million acres with approximately 75.7 million acres available for lease as of February 2017).

A proposed regionwide lease sale would include all three BOEM planning areas encompassing a total of approximately 91.93 million acres with approximately 75.7 million acres available for lease as of February 2017. Leasing information related to all three planning areas is updated monthly and can be found on BOEM's website at http://www.boem.gov/Gulf-of-Mexico-Region-Lease-Map/.

In general, a regionwide lease sale would represent 1.2-4.2 percent of the total OCS Program production in the GOM based on barrels of oil equivalent resource estimates (refer to **Chapter 3.1.2**). The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a typical proposed regionwide lease sale are 0.211-1.118 billion barrels of oil (BBO) and 0.547-4.424 trillion cubic feet (Tcf) of gas (refer to **Table 3-5**).

2.2.1.2 Alternative B—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B would allow for a proposed lease sale encompassing the CPA and EPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 2-2**). Available blocks within the WPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the CPA and EPA portions of the proposed lease sale area for oil and gas operations, with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006; and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

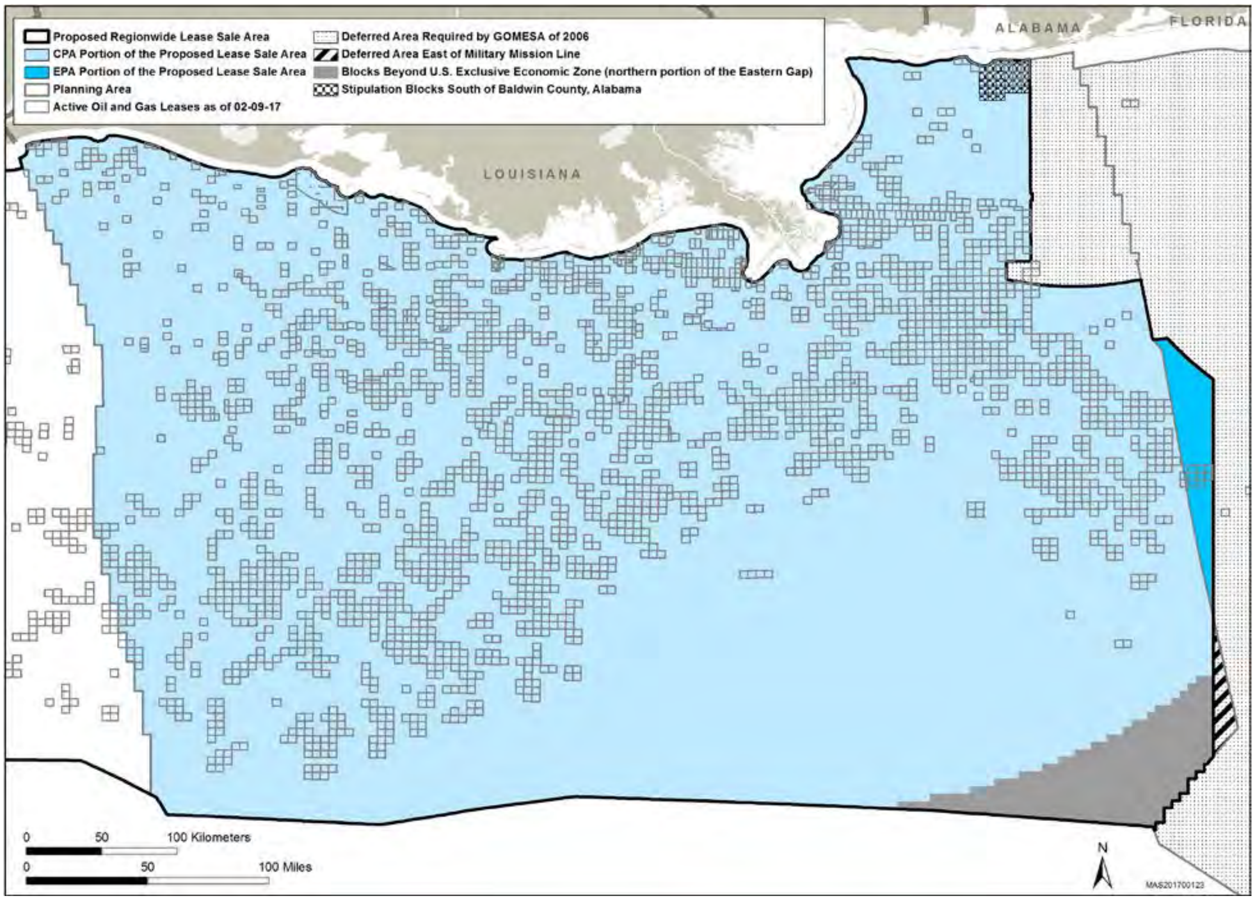


Figure 2-2. Proposed Lease Sale Area for Alternative B, Excluding the Available Unleased Blocks in the WPA (a total of approximately 63.35 million acres with approximately 49.8 million acres available for lease as of February 2017).

In general, a lease sale that would include all available unleased blocks in the CPA and EPA would represent approximately 1.0-3.6 percent of the total OCS Program production in the GOM based on barrels of oil equivalent resource estimates (refer to **Table 3-2**). The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale under Alternative B are 0.185-0.970 BBO and 0.441-3.672 Tcf of gas (refer to **Table 3-5**).

2.2.1.3 Alternative C—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C would allow for a proposed lease sale encompassing the WPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 2-3**). Available blocks within the CPA and EPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the WPA portion of the proposed lease sale area for oil and gas operations, with the following exception:

(1) whole and partial blocks within the current boundary of the Flower Garden Banks National Marine Sanctuary.

The proposed Alternative C lease sale area encompasses virtually all of the WPA's approximately 28.58 million acres as that planning area is described as a subset of Alternative A. In general, a lease sale that would include all available unleased blocks in the WPA would represent approximately 0.2-0.6 percent of the total OCS Program production in the GOM based on barrels of oil equivalent resource estimates (refer to **Table 3-2**). The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale offering only WPA available blocks are 0.026-0.148 BBO and 0.106-0.752 Tcf of gas (refer to **Table 3-5**).

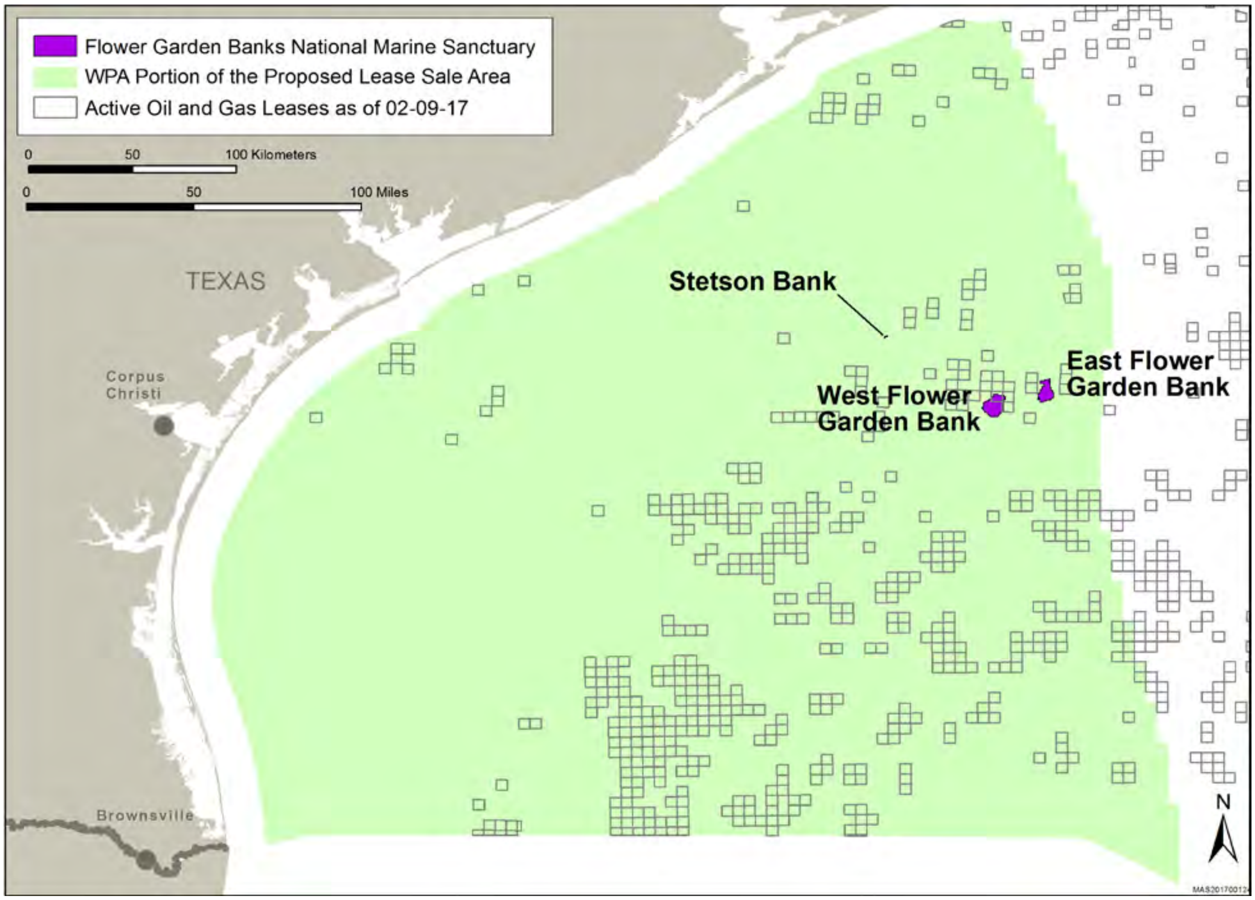


Figure 2-3. Proposed Lease Sale Area for Alternative C, Excluding the Available Unleased Blocks in the CPA and EPA (a total of approximately 28.58 million acres with approximately 25.9 million acres available for lease as of February 2017).

2.2.1.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D could be combined with any of the action alternatives above (i.e., Alternatives A, B, or C) and would allow the flexibility to offer leases under any alternative with additional exclusions. Under Alternative D, the decisionmaker could exclude from leasing any available unleased blocks subject to any one and/or a combination of the following stipulations:

- Topographic Features Stipulation;
- Live Bottom (Pinnacle Trend) Stipulation; and
- Blocks South of Baldwin County, Alabama, Stipulation (not applicable to Alternative C).

This alternative considered blocks subject to these stipulations because these areas have been emphasized in scoping, can be geographically defined, and adequate information exists regarding their ecological importance and sensitivity to OCS oil- and gas-related activities. Figure 2-5 of the 2017-2022 GOM Multisale EIS illustrates one example of the blocks that could be excluded under this alternative (shaded in blue).

A total of 207 blocks within the CPA and 160 blocks in the WPA are affected by the Topographic Features Stipulation (**Figure 2-4**). There are currently no identified topographic features protected under this stipulation in the EPA. The Live Bottom Stipulation covers the pinnacle trend area of the CPA, affecting a total of 74 blocks (**Figure 2-4**). More details on the blocks affected by the Topographic Features Stipulation and the Pinnacle Trend blocks subject to the Live Bottom Stipulation can be found at http://www.boem.gov/Biologically-Sensitive-Areas-List/. Maps indicating the areas affected by the Topographic Features Stipulation can be found at http://www.boem.gov/Topographic-Features-Stipulation-Map-Package/.

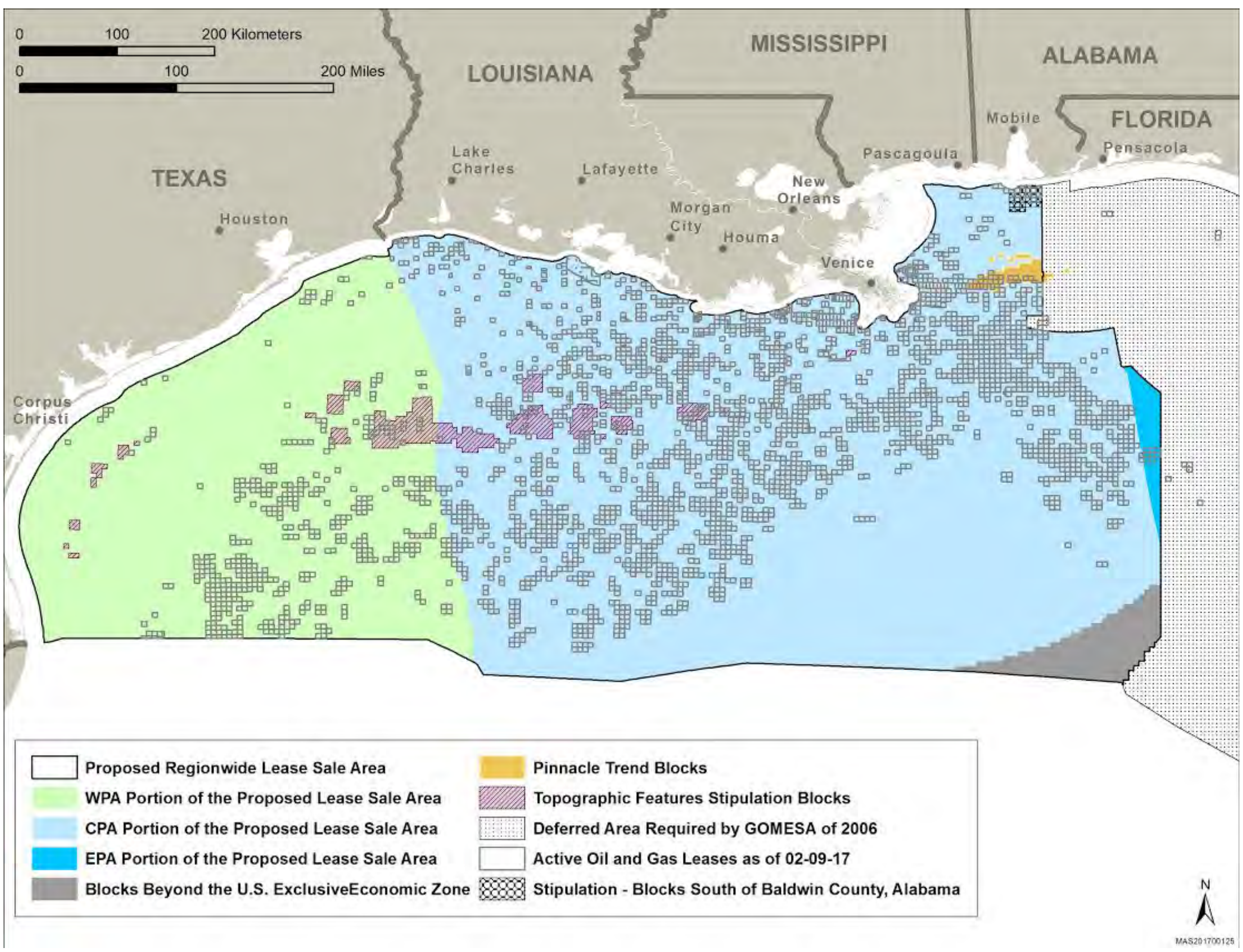


Figure 2-4. Identified Topographic Features, Pinnacle Trend, and Blocks South of Baldwin County, Alabama, Stipulation Blocks in the Gulf of Mexico.

As of the publication of this Supplemental EIS, the Blocks South of Baldwin County, Alabama, Stipulation (herein referred to as the Baldwin County Stipulation Blocks) applies to a total of 32 blocks (Mobile Blocks 826-830, 869-874, 913-918, 957-962, 1001-1006, and Viosca Knoll Blocks 33-35) within 15 mi (24 km) of Baldwin County, Alabama (representing less than 1% of the total number of blocks to be offered under Alternative A or B). The intent of a proposal excluding these blocks would be to mitigate the visual impacts of concern raised by the Governor of Alabama on previous EISs, as well as in the 2017-2022 Five-Year Program from which the 2017-2022 GOM Multisale EIS and this Supplemental EIS tier. The stipulation, however, has been continually adopted in annual CPA lease sales since 1999 and has effectively mitigated visual impact. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures (refer to Appendix D of the 2017-2022 GOM Multisale EIS) while still allowing leasing and OCS oil- and gas-related operations in the area, which could not occur with the no-leasing buffer. If any of the action alternatives are selected, BOEM expects this stipulation to be analyzed and decided on at the lease sale stage; therefore, visual impacts would be reduced to the greatest extent practicable should the stipulation be applied.

Alternative D, if adopted, would prevent any OCS oil- and gas-related activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from OCS oil- and gas-related activities, which otherwise could be conducted within the blocks. Under Alternative D, the number of blocks that would become unavailable for lease represents only a small percentage of the total number of blocks to be offered under Alternative A, B, or C (<4%, even if blocks subject to all three stipulations were excluded). Therefore, Alternative D could reduce offshore infrastructure and activities, but Alternative D may (and BOEM believes more reasonable to expect) only delay activity or shift the location of offshore infrastructure and activities farther from these sensitive zones and not lead to a reduction in overall offshore infrastructure and activities. The regional impact levels for all resources, except for the topographic features and live bottoms, would be similar to those described under Alternative A, B, or C. All of the assumptions (including the proposed stipulations and other potential mitigating measures designed to reduce environmental risk) and estimates would remain the same as described for Alternatives A, B, or C. The exclusion of this small subset of available unleased blocks could reduce exploration, development, and production flexibility and, therefore, could result in adverse economic effects (e.g., reduced royalties). A detailed discussion of the development scenario and related impact-producing factors is included in **Chapter 3**.

2.2.1.5 Alternative E—No Action

Alternative E is the cancellation of a single proposed GOM lease sale within the Five-Year Program. The opportunity for development of the estimated oil and gas that could have resulted from a proposed action (i.e., a single proposed lease sale) or alternative to the proposed action, as described above, would be precluded or postponed to a future lease sale. Any potential environmental impacts resulting from a proposed lease sale would not occur. Activities related to previously issued leases and permits (as well as those that may be issued in the future under a separate decision) related to the OCS oil and gas program would continue. If a lease sale were to be cancelled, the resulting development of oil and gas would most likely be postponed to a future lease sale; therefore, the overall level of OCS oil- and gas-related activity would only be reduced by a small percentage, if any. Therefore, the cancellation of a proposed lease sale would not significantly change the environmental impacts of overall OCS oil- and gas-related activity. However, the cancellation of a proposed lease sale may result in direct economic impacts to the individual companies and revenues collected by the Federal Government (and thus revenue disbursements to the States) could also be adversely affected. If future lease sales were to occur, the impacts from the cancellation of a single lease sale to individual companies and Federal revenues would likely be minor. The Five-Year Program EIS discusses the impacts of cancelling all proposed GOM lease sales included in the Five-Year Program.

2.2.2 What Other Alternatives and Deferrals Has BOEM Considered But Not Analyzed in Detail?

Chapter 2.2.3 of the 2017-2022 GOM Multisale EIS includes a detailed description of alternatives previously considered but not analyzed in detail in this Supplemental EIS, including the following:

- previous multisale approach, which consisted of a total of 12 proposed lease sales, including 5 annual proposed lease sales in the WPA, 5 annual proposed lease sales in the CPA, and 2 proposed lease sales in the EPA.
- exclude blocks subject to Flower Garden Banks National Marine Sanctuary expansion;
- additional buffer zones around potential areas of concern (e.g., the blocks subject to Congressional moratorium pursuant to the Gulf of Mexico Energy Security Act of 2006 and the Gulf Islands National Seashore);
- proposed lease sale offering only available unleased blocks in the EPA;
- proposed lease sale with additional mitigating measures for sperm whale high-use areas;
- regionwide OCS proposed lease sale excluding blocks within the De Soto Canyon area;
- regionwide OCS proposed lease sale excluding blocks within loggerhead sea turtle critical habitat; and
- delay leasing until the state of the Gulf of Mexico's environmental baseline since the *Deepwater Horizon* explosion, oil spill, and response is better understood.

The justifications for not engaging in detailed analysis of these alternatives and deferrals is provided in the 2017-2022 GOM Multisale EIS, and BOEM has identified no new information that changes these conclusions.

Two additional alternatives were identified during scoping for this Supplemental EIS. They are listed below:

- stop issuing leases for oil and gas in the Gulf of Mexico; and
- use renewable energy in place of oil and gas.

Both of those issues were addressed in the Five-Year Program EIS, and because this Supplemental EIS tiers from the Five-Year Program EIS, the analyses are incorporated by reference into this Supplemental EIS. As a result, the full analyses of these alternatives will not be addressed in this Supplemental EIS. A brief summary of the alternative analyses is presented below.

BOEM has addressed the alternative to stop issuing leases in the Gulf of Mexico in Chapters 2.4, "Reduced Proposed Action (Alternative C)," and 2.5, "No Action (Alternative D)" of the Five-Year Program EIS. These alternatives evaluated the environmental effects of having reduced areas of leasing or no new lease sales during the 2017-2022 Five-Year Program. The impacts of these alternatives are discussed in Chapters 4.4.3.4 "C(4): Exclusion of the Gulf of Mexico Program Area" and 4.4.4 "Alternative D – The No Action Alternative" of the Five-Year Program EIS. However, it should be noted that oil -and gas-related activities stemming from previous programs would continue, and only activity resulting from proposed lease sales in the new Five-Year Program would be halted.

BOEM has addressed the potential for alternative energy on the OCS in Chapters 1.4.6.1 ("Renewable Energy") and 2.7.4 ("Develop Alternative or Renewable Energy Sources as a Complete or Partial Substitute for Oil and Gas Leasing on the OCS") of the Five-Year Program EIS. However, BOEM determined that an analysis of the potential for alternative energy is outside the scope of this Supplemental EIS for a proposed action. The purpose and need identified for this Supplemental EIS is to provide an analysis of the environmental impacts of oil and gas leasing. BOEM's Office of Renewable Energy is responsible for developing an offshore renewable energy program in the Gulf of Mexico. Information on BOEM's Renewable Energy Program, OCS leases, and renewable energy projects is available on BOEM's website at http://www.boem.gov/Renewable-Energy/.

2.2.3 What Types of Mitigating Measures Does BOEM Apply?

Agencies are required to identify and include in an EIS those appropriate mitigating measures not already included in the proposed action or alternatives. The CEQ regulations (40 CFR § 1508.20) define mitigation as follows:

- Avoidance—Avoiding an impact altogether by not taking a certain action or part of an action.
- Minimization—Minimizing impacts by limiting the intensity or magnitude of the action and its implementation.

Mitigating measures considered in this NEPA document rely primarily on avoiding an impact altogether by not allowing certain actions or parts of an action.

- Restoration—Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Maintenance—Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensation—Compensating for the impact by replacing or providing substitute resources or environments.

BOEM considers the use of mitigation at all phases of energy development and planning, from the overarching Five-Year Program EIS, through each of the NEPA documents for the lease sales, and followed by more site-specific reviews for exploration, development and production, and decommissioning plans (**Figure 1-3**). Mitigations can be applied at the prelease stage, typically through applying lease stipulations or at the postlease stage by applying site-specific mitigating measures to plans, permits, and/or authorizations (refer to Appendix A of the 2017-2022 GOM Multisale EIS). Through this approach, BOEM is able to analyze impacts and mitigations that are appropriate for consideration at the appropriate time.

2.2.3.1 Proposed Lease Mitigating Measures (Stipulations)

The potential lease stipulations and mitigating measures included for analysis in this Supplemental EIS were developed as a result of numerous scoping efforts for the continuing OCS Program in the Gulf of Mexico. The 10 lease stipulations being considered are as follows:

- Topographic Features Stipulation;
- Live Bottom (Pinnacle Trend) Stipulation;
- Military Areas Stipulation;
- Evacuation Stipulation;
- Coordination Stipulation;
- Blocks South of Baldwin County, Alabama, Stipulation;
- Protected Species Stipulation;
- United Nations Convention on the Law of the Sea Royalty Payment Stipulation;
- Below Seabed Operations Stipulation; and
- Stipulation on the Agreement Between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation).

These mitigating measures would be considered for adoption by the decisionmaker, as applicable, under authority delegated by the Secretary of the Interior. The Topographic Features and Live Bottom (Pinnacle Trend) Stipulations have been applied as programmatic mitigation in the

Five-Year Program EIS (USDOI, BOEM, 2016b) and, therefore, would apply to all leases issued under the Five-Year Program in the designated lease blocks. The analysis of the other eight stipulations for any particular alternative does not ensure application of the stipulations to leases that may result from any proposed lease sale nor does it preclude minor modifications in wording during subsequent steps in the prelease process if comments indicate changes are necessary or if conditions change.

Any stipulations or mitigation requirements to be included in a lease sale will be described in the Record of Decision for that lease sale. Mitigating measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease. In addition, each exploration and development plan, as well as any pipeline applications related to leases issued as a result of a lease sale, will undergo a NEPA review, and additional project-specific mitigations applied as conditions of plan approval at the postlease stage. The BSEE has the authority to monitor and enforce these conditions under 30 CFR part 250 subpart N and may seek remedies and penalties from any operator that fails to comply with those conditions, stipulations, and mitigating measures.

2.2.3.2 Prelease Mitigating Measures (Stipulations) by Alternative

Table 2-1 indicates what stipulations could be applied for each alternative. Alternative D would consider the same stipulations as Alternative A, B, or C, as applicable, with the exception of removing the Topographic Features and Live Bottoms (Pinnacle Trend) Stipulations since all blocks subject to these stipulations would not be made available. Since Alternative E is the cancellation of a proposed lease sale, no stipulations would apply.

Table 2-1. Applicable Stipulations by Alternative.

Stipulation	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E[1]
Topographic Features	X[2]	X	X	–[3]	–
Live Bottoms	X	X	–	–	–
Military Areas	X	X	X	X	–
Evacuation	X	X	–	See A, B, or C	–
Coordination	X	X	–	See A, B, or C	–
Blocks South of Baldwin County, Alabama	X	X	–	See A, B, or C	–
Protected Species	X	X	X	X	–
United Nations Convention on the Law of the Sea Royalty Payment	X	X	X	X	–
Below Seabed Operations	X	X	–	See A, B, or C	–
Transboundary	X	X	X	X	–

Stipulation	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E[1]

[1] Alternative E would cancel a proposed lease sale and no leasing activities would occur; therefore, no stipulations would apply.
[2] Stipulations that would apply to specific lease blocks under any given alternative are marked with an X.
[3] Stipulations that would not apply are marked "–".

2.2.3.3 Postlease Mitigating Measures

Mitigating measures are a standard part of BOEM's program to ensure that operations are always conducted in an environmentally sound manner.

Postlease mitigating measures have been implemented for over 40 years in the Gulf of Mexico region, as they relate to OCS plans and pipeline applications. Following a lease sale, an applicant seeks approvals to develop their lease by preparing and submitting OCS plans. The OCS plans are reviewed by BOEM and, depending on what is proposed to take place in a specific place, plans may be denied, approved, or approved with conditions of approval (COA). The COAs become part of the approved postlease authorization and include environmental protections, requirements that maintain conformance with law, the requirements of other agencies having jurisdiction, or safety precautions. Mitigating measures are an integral part of BOEM's program to ensure that operations are conducted in an environmentally sound manner (with an emphasis on avoiding or minimizing any adverse impact of routine operations on the environment). For example, certain measures ensure site clearance, and survey procedures are carried out to determine potential snags to commercial fishing and avoidance of archaeological sites and biologically sensitive areas such as pinnacles, topographic features, and chemosynthetic communities.

BOEM analyzes impacts on a finer geographic scale than that analyzed in the 2017-2022 GOM Multisale EIS and this Supplemental EIS through site-specific environmental reviews, and applies mitigations as conditions of approval to permits, as appropriate. Appendix A of the 2017-2022 GOM Multisale EIS discusses BOEM's rigorous postlease processes and Appendix B of the 2017-2022 GOM Multisale EIS describes over 120 standard mitigations that may be required by BOEM or BSEE as a result of plan and permit review processes for the Gulf of Mexico OCS Region.

Mitigating measures have been proposed, identified, evaluated, or developed through previous BOEM lease sale and site-specific NEPA reviews and analyses. For example, certain measures ensure site clearance, and survey procedures are carried out to determine potential snags to commercial fishing and avoidance of archaeological sites and biologically sensitive areas such as pinnacles, topographic features, and deepwater benthic communities. Many of these mitigating measures have been adopted and incorporated into regulations and/or as guidelines governing OCS exploration, development, and production activities. All plans for OCS oil- and gas-related activities (e.g., exploration and development plans, pipeline applications, and structure-removal applications) go through rigorous BOEM review and approval to ensure compliance with established laws and regulations. Existing mitigating measures must be incorporated and documented in plans submitted to BOEM. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

Some BOEM-identified mitigating measures are incorporated into OCS oil- and gas-related operations through cooperative agreements or efforts with industry and State and Federal agencies. These mitigating measures include the National Marine Fisheries Service's (NMFS) Observer Program to protect marine mammals and sea turtles during explosive removals, labeling operational supplies to track possible sources of debris or equipment loss, development of methods of pipeline landfall to eliminate impacts to beaches or wetlands, and beach cleanup events.

Site-specific mitigating measures are also applied by BOEM during plan and permit reviews. BOEM realized that many of these site-specific mitigations were recurring and developed a list of commonly applied "standard" mitigations. There are currently over 120 standard mitigations that could be applied by BOEM during plan and permit reviews. The wording of a standard mitigation is developed by BOEM in advance and may be applied whenever conditions warrant. Standard mitigation text is revised as often as is necessary (e.g., to reflect changes in regulatory citations, agency/personnel contact numbers, and internal policy). Categories of site-specific mitigations include the following: air quality; archaeological resources; artificial reef material; deepwater benthic communities; Flower Garden Banks; topographic features; hard bottoms/pinnacles/potentially sensitive biological features; military warning areas and Eglin Water Test Areas; hydrogen sulfide; drilling hazards; remotely operated vehicle surveys; geophysical survey reviews; and general safety concerns. Site-specific mitigation "types" include the following: advisories; conditions of approval; hazard survey reviews; inspection requirements; notifications; post-approval submittals; and safety precautions. In addition to standard mitigations, BOEM may also apply nonrecurring mitigating measures that are developed on a case-by-case basis. Refer to Appendix B of the 2017-2022 GOM Multisale EIS ("Commonly Applied Mitigating Measures") for more information on the mitigations that BOEM and BSEE typically apply to plans and/or permits.

BOEM is continually revising applicable mitigations to allow the Gulf of Mexico OCS Region to more easily and routinely track mitigation compliance and effectiveness. A primary focus of this effort is requiring post-approval submittal of information within a specified timeframe or after a triggering event (e.g., end of operations reports for plans, construction reports for pipelines, and removal reports for structure removals).

2.2.4 What are the Primary Topics and Resources Being Evaluated?

Issues are defined by CEQ to represent those principal "effects" that an EIS should evaluate in-depth. Scoping identifies specific environmental resources and/or activities rather than "causes" as significant issues (Council on Environmental Quality, 1981). The analysis in the EIS can then show the degree of change from the present conditions for each issue to the actions arising from the proposed action.

Selection of environmental and socioeconomic issues to be analyzed was based on the following criteria:

- issue is identified in CEQ regulations as subject to evaluation;
- the relevant resource/activity was identified through agency expertise, through the scoping process, or from comments on past EISs;
- the resource/activity may be vulnerable to one or more of the impact-producing factors associated with the OCS Program;
- a reasonable probability of an interaction between the resource/activity and impact-producing factor should exist; or
- information that indicates a need to evaluate the potential impacts to a resource/activity has become available.

2.2.4.1 Issues to be Analyzed

Chapter 2.2.5.1 of the 2017-2022 GOM Multisale EIS addresses the issues related to potential impact-producing factors and the environmental and socioeconomic resources and activities that could be affected by OCS oil- and gas-related activities, including accidental events, drilling fluids and cuttings, visual and aesthetic interference, air emissions, water quality degradation, other wastes, structure and pipeline emplacement, platform removals, OCS oil- and gas-related support services, activities, and infrastructure, sociocultural and socioeconomic, geological and geophysical activities, and other issues. **Chapter 4** of this Supplemental EIS and Chapter 4 of the 2017-2022 GOM Multisale EIS describe the resources and activities that could be affected by the impact-producing factors listed above and include the following resource topics:

- Air Quality
- Water Quality (Coastal and Offshore)
- Coastal Habitats (Estuarine Systems and Coastal Barrier Beaches and Associated Dunes)
- Deepwater Benthic Communities (Chemosynthetic and Deepwater Coral)
- *Sargassum* and Associated Communities
- Live Bottom Habitats (Topographic Features, Pinnacles, and Low-Relief Features)
- Fishes and Invertebrate Resources
- Birds
- Protected Species (ESA-Listed Marine Mammals, Sea Turtles, Beach Mice, Protected Birds, and Protected Corals)
- Commercial Fisheries
- Recreational Fishing
- Recreational Resources
- Archaeological Resources (Historic and Prehistoric)
- Human Resources and Land Use (Land Use and Coastal Infrastructure, Economic Factors, and Social Factors, Including Environmental Justice)

2.2.4.2 Issues Considered but Not Analyzed

As previously noted, the CEQ regulations for implementing NEPA instruct agencies to adopt an early process (termed "scoping") for determining the scope of issues to be addressed and for identifying significant issues related to a proposed action. As part of this scoping process, agencies shall identify and eliminate from detailed study the issues that are not significant to the proposed action or have been covered by prior environmental review.

Comments received during scoping are summarized in **Chapter 5.6.2.2**. Many of those issues were analyzed in detail in the 2017-2022 GOM Multisale EIS and summarized and/or updated as needed in this Supplemental EIS. These issues include the following:

- cumulative impacts to coastal resources, including wetlands;
- compensatory mitigation;
- updates and safety improvements implemented by regulators and industry;
- downstream and lifecycle greenhouse gas emissions from lease sales;
- well-stimulation activities and associated environmental impacts;
- climate change on GOM environmental resources, including warmer oceans, increased storms and flood events, and land loss;
- economic impacts as a result of canceling or holding a proposed lease sale;
- substitution effects of renewable energy sources in place;
- oil and chemical spills, including continued effects from past spills and leaking wells and pipelines; and
- environmental justice concerns related to those living near petrochemical facilities.

2.3 COMPARISON OF IMPACTS BY ALTERNATIVE

The full analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts are described in the individual resource discussions in Chapter 4 of the 2017-2022 GOM Multisale EIS and summarized in **Chapter 4** of this Supplemental EIS. **Table 2-2** provides a comparison of expected impact levels by alternative and is derived from the analysis of each resource in **Chapter 4**. The findings for Alternatives A-E represent the *incremental contribution* of a proposed lease sale to the cumulative impacts from past, present, and future activities in the GOM. These activities include both OCS oil- and gas-related and non-OCS oil- and gas-related activities that would be expected regardless of whether or not a lease sale were to occur. The impact-level ratings have been specifically tailored and defined for each resource within the **Chapter 4** impact analysis. Cumulative impacts of current, past, and reasonably foreseeable future activities would continue to occur under Alternative E.

Table 2-2. Alternative Comparison Matrix.

Impact Level Key[1]				
Beneficial[2]	Negligible	Minor	Moderate	Major

	Alternative				
Resource	A	B	C	D	E
Air Quality	Minor	Minor	Minor	Minor	None
Water Quality	Negligible	Negligible	Negligible	Negligible	None
Coastal Habitats					
Estuarine Systems	Moderate	Moderate	Minor	Moderate	Negligible
Coastal Barrier Beaches and Associated Dunes	Minor	Minor	Negligible to Minor	Negligible to Minor	Negligible
Deepwater Benthic Communities	Negligible	Negligible	Negligible	Negligible	None
Sargassum and Associated Communities	Negligible	Negligible	Negligible	Negligible	None
Live Bottoms					
Topographic Features	Negligible	Negligible	Negligible	Negligible	None
Pinnacles and Low-Relief Features	Negligible to Minor	Negligible to Minor	Negligible	Negligible	None
Fishes and Invertebrate Resources	Minor	Minor	Minor	Minor	None
Birds	Moderate	Moderate	Moderate	Moderate	None
Protected Species					
Marine Mammals	Negligible	Negligible	Negligible	Negligible	None
Sea Turtles	Negligible	Negligible	Negligible	Negligible	None
Beach Mice	Negligible	Negligible	Negligible	Negligible	None
Protected Birds	Negligible	Negligible	Negligible	Negligible	None
Protected Corals	Negligible	Negligible	Negligible	Negligible	None
Commercial Fisheries	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Recreational Fishing	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Recreational Resources	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Archaeological Resources	Negligible[3]	Negligible[3]	Negligible[3]	Negligible[3]	None
Human Resources and Land Use					
Land Use and Coastal Infrastructure	Minor	Minor	Minor	Minor	None
Economic Factors	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible to Minor
Social Factors (including Environmental Justice)	Minor	Minor	Minor	Minor	None

Impact Level Key[1]					
Beneficial[2]	Negligible	Minor	Moderate		Major
	Alternative				
Resource	A	B	C	D	E

Note: Some resources have a range for the impact levels to account for certain variables such as the uncertainty of non-OCS oil- or gas-related activities, the level and magnitude of potential accidental events, and the minimization of the OCS oil- or gas-related impacts through lease stipulations, mitigations, and/or regulations. The impact level ratings have been specifically tailored and defined for each resource within the **Chapter 4** impact analysis.

[1] The findings for Alternatives A-D are the incremental contribution of a proposed action added to what would be expected to occur under the No Action Alternative (i.e., no lease sale). Therefore, each impact determination under Alternatives A-D assumes that the conditions and impacts (i.e., past, present, and future activities as a result of past lease sales) under the No Action Alternative would still be present.

[2] The level of beneficial impacts is specified in the analysis, which could range from low, medium, or high.

[3] The level of impacts for archaeological resources ranges between negligible to major and is dependent upon whether a survey is performed, mitigation is imposed, mitigation is followed, or a site is identified prior to the activity.

2.4 SUMMARY OF IMPACTS

A search by BOEM's subject-matter experts was conducted for each resource to consider new information made available since publication of the 2017-2022 GOM Multisale EIS and to consider new information on the *Deepwater Horizon* explosion, oil spill, and response. It must also be emphasized that, in arriving at the overall conclusions for certain environmental resources (e.g., coastal and marine birds, fisheries, and wetlands), the conclusions are not based on impacts to individuals, small groups of animals, or small areas of habitat, but on impacts to the resources/populations as a whole.

BOEM's subject-matter experts determined through literature searches and communications with other agencies and academia that there was no new information made available since publication of the 2017-2022 GOM Multisale EIS that is relevant to potential impacts from a proposed lease sale. Therefore, the analyses and potential impacts for the resources remain the same as those that were presented in the 2017-2022 GOM Multisale EIS. These impact conclusions are presented in **Chapter 4** of this Supplemental EIS. The analyses and potential impacts detailed in that NEPA document remains valid and, as such, apply for the remaining proposed regionwide GOM lease sales scheduled in the Five-Year Program.

In accordance with CEQ guidelines to provide decisionmakers with a robust environmental analysis, the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b) provides an analysis of the potential impacts of a low-probability catastrophic oil spill, which is not part of a proposed action and not likely expected to occur, to the environmental and cultural resources and the socioeconomic conditions analyzed in **Chapter 4**. In addition, a low-probability catastrophic oil spill is analyzed in the Five-Year Program EIS, from which this Supplemental EIS tiers.

CHAPTER 3

IMPACT-PRODUCING FACTORS AND SCENARIO

What's in This Chapter?

BOEM develops scenarios that describe projected OCS oil- and gas-related routine activities and accidental events from a single proposed lease sale, the projected OCS oil and gas cumulative activities of multiple lease sales, and the non-OCS oil- and gas-related activities and/or events.

- Routine activities for a single proposed lease sale include the following:
  - exploration and delineation (geological and geophysical surveys, and drilling exploration and delineation wells);
  - offshore development and production (drilling production wells, infrastructure emplacement, and work-overs and abandonment of wells); and
  - decommissioning and removal operations (the removal and/or abandonment of platforms and pipelines).
- Accidental events for a single proposed lease sale could include the following:
  - releases into the environment (e.g., oil spills, loss of well control, accidental air emissions, pipeline failures, and chemical and drilling fluid spills);
  - collisions (e.g., helicopter, service vessels, and platforms); and
  - spill-response activities.
- Cumulative activities include the following:
  - Cumulative OCS Oil and Gas Program (all activities, i.e., the routine activities and the accidental events that could occur, from past, proposed, and future lease sales); and
  - non-OCS oil- and gas-related activities (impact-producing factors from the broad range of other activities taking place within the proposed lease sale area).

3 IMPACT-PRODUCING FACTORS AND SCENARIO

3.0 INTRODUCTION

Chapters 3.1 and 3.2 of the 2017-2022 GOM Multisale EIS describe in detail the routine and accidental impact-producing factors and activity scenarios associated with Alternatives A, B, C, and D that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. Chapter 3.3 of the 2017-2022 GOM Multisale EIS describes in detail the cumulative impact-producing factors and activity scenarios resulting from past and future lease sales that are relevant to Alternatives A, B, C, and D. The following information is a summary of the impact-producing factors and scenario incorporated from the 2017-2022 GOM Multisale EIS.

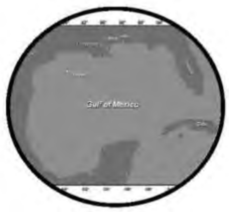
What is an Impact-Producing Factor?

An impact producing factor is an activity or process, as a result of a proposed lease sale, that could cause impacts on the environmental or socioeconomic setting. The impact analyses determine the context and intensity of effects caused by any source on environmental resources (**Chapter 4**) including OCS oil- and gas-related activity and other ecological, economic, or social effects. Each phase of oil- and gas-related operation has a set of impact-producing factors that may affect physical or environmental conditions and/or may affect one or more natural, cultural, or socioeconomic resources.

How are the Impact-Producing Factors Categorized?

Routine Activities. These activities generally occur on a regular basis during the lifetime of a lease. The operations are broken down by phase and include exploration, development, oil or gas production and transport, and decommissioning. Routine operations are evaluated over the 50-year analysis period. Routine operations are discussed in **Chapter 3.1**.

Accidental Events. As a consequence of routine activities, the potential for accidental releases exists. Types of accidental events include releases into the environment (e.g., oil spills, loss of well control, accidental air emissions, pipeline failures, and chemical and drilling fluid spills), collisions (e.g., helicopter, service vessels, and platforms) and spill-response activities. Reasonably foreseeable accidental events are discussed in **Chapter 3.2**.



Cumulative Impacts. The impact-producing factors considered in this chapter are defined as other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as the aforementioned projected routine activities and potential accidental events, including the Cumulative OCS Oil and Gas Program (2017-2086). Cumulative activities are discussed in **Chapter 3.3**.

3.1 Routine Activities

3.1.1 What Activities Routinely Occur as a Result of a Single Lease Sale?

The OCS oil and gas operations on a lease generally occur in four phases: (1) exploration to locate viable oil or natural gas deposits; (2) development well drilling, platform construction, and pipeline infrastructure; (3) operation (oil or gas production and transport); and (4) decommissioning of facilities once a reservoir is no longer productive or profitable. These phases are illustrated in **Figure 3-1**, which also illustrates that geological and geophysical (G&G) activities can occur during all four phases. Under a proposed action, activities would occur on OCS leases only after a lease sale is held. Although unusual cases exist where activity on a lease may continue beyond 50 years, our forecasts indicate that the significant activities associated with exploration, development, production, and abandonment of leases in the GOM occur well within the 50-year analysis period of a single lease sale. For each lease sale analyzed within the 50-year analysis period, all activities would be concluded by the 44th year.

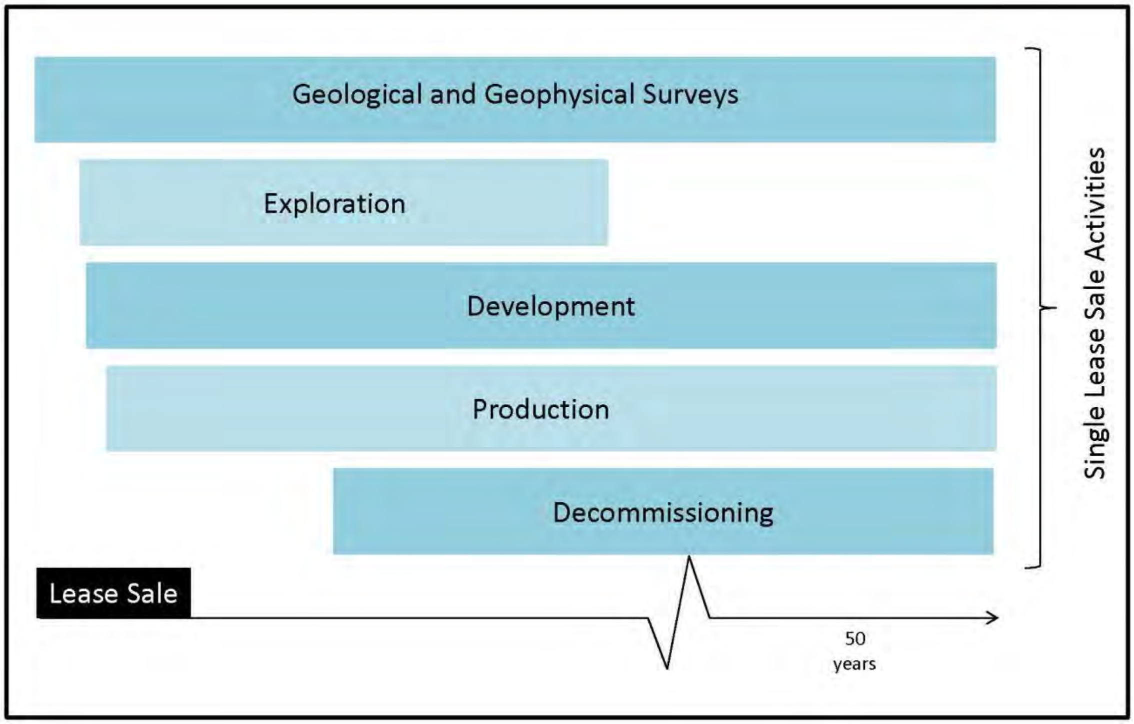


Figure 3-1. Phases of OCS Activity Resulting from a Single Proposed Lease Sale over 50 Years.

3.1.1.1 Exploration and Delineation

Geological and Geophysical

> ***What is a shallow hazard?*** *Buried channels up to 4,000 ft (1,219 m) below the seafloor filled with permeable sediment present hazards to drilling operations. Drilling through these channels may result in water flowing up and around the well casing and may deposit sand or silt on the seafloor within a few hundred feet of the wellhead and could result in hydrate formation if gas is present. Unanticipated shallow hazards can lead to downhole pressure kicks that range from minor and controllable to significant and uncontrollable, and up to and including a serious blowout condition.*

The G&G surveys conducted as a result of a lease sale typically collect data on surficial or near-surface geology used to identify on-lease potential shallow hazards for engineering and site planning for bottom-founded structures. Geological and geophysical processes and regulations are discussed in greater detail in Appendix A.1 and Chapter 3.1.2.1 of the 2017-2022 GOM Multisale EIS. The G&G activities for oil and gas exploration are authorized on the basis of whether or not the proposed activities are (1) before leasing takes place (prelease) and authorized by permits or (2) on an existing lease (postlease or ancillary) and authorized by OCS plan approvals, plan revisions, or by a requirement for notification of BOEM before certain on-lease activities are undertaken. BOEM's resource evaluation program oversees G&G data acquisition and permitting activities pursuant to regulations at 30 CFR parts 550 and 551. There are a variety of G&G activities that are conducted for oil and gas exploration and development as on-lease activities:

- various types of deep-penetration seismic airguns used almost exclusively for oil and gas exploration;
- electromagnetic surveys, deep stratigraphic and shallow test drilling, and various remote-sensing methods in support of oil and gas exploration;
- high-resolution geophysical (HRG) surveys (airgun and non-airgun) used to detect and monitor geohazards, archaeological resources, and certain types of benthic communities; and
- geological and geotechnical bottom sampling used to assess the suitability of seafloor sediments for supporting structures (e.g., platforms, pipelines, and cables), as well as to identify environmental resources such as chemosynthetic communities, gas hydrates, buried channels and faults, and archaeological resources.

Exploration and Delineation Plans and Drilling

The term exploration well generally refers to the first well drilled on a prospective geologic structure to confirm that a resource exists and to validate how much resource can be expected to be extracted.

Oil and gas operators use drilling terms that represent stages in the discovery and development of hydrocarbon resources. If a resource is discovered during the drilling of an exploration well in quantities appearing to be economically viable, one or more follow-up delineation wells are drilled. Refer to **Figure 3-1** above for a relative exploration timeline on an oil or gas lease. Delineation wells are drilled to specific subsurface targets in order to obtain information about the reservoir that can be used by the operator to identify the lateral and vertical extent of a hydrocarbon accumulation. Following a discovery, an operator often temporarily plugs and abandons the well to allow time for a development plan to be generated and for equipment to be built or procured. In the GOM, exploration and delineation wells are typically drilled with mobile offshore drilling units (MODUs) (i.e., jack-up rigs, semisubmersible rigs, submersible rigs, platform rigs, or drill ships). Non-MODUs, such as inland barges, are also used. Refer to Chapter 3.1.2.2 of the 2017-2022 GOM Multisale EIS for more information on exploration and delineation plans and drilling.

3.1.1.2 Development

Offshore Development

A development well is drilled to extract resources from a known hydrocarbon reservoir.

Delineation and production wells are sometimes collectively termed development wells. After a development well is drilled, the operator must decide whether or not to complete the well without delay, to delay completion with the rig on station so that additional tests may be conducted, or to temporarily abandon the well site and move the rig off station to a new location and drill another well. Sometimes an operator may decide to drill a series of development wells, move off location, and

The process that includes the suite of activities that are carried out to prepare a development well for production is referred to as the completion process.

then return with a rig to complete all the wells at one time. If an exploration well is clearly a dry hole and contains no oil or gas, the operator would typically permanently abandon the well without delay but could also convert the well into an injection well to store CO_2, dispose of waste water, enhance oil production and mining, or prevent saltwater intrusion. Development well drilling is discussed in greater detail in Chapter 3.1.3.1 of the 2017-2022 GOM Multisale EIS.

Offshore production systems may be placed over development wells to facilitate production from a prospective hydrocarbon reservoir. These structures provide the means to access and control wells. They serve as a staging area to process and treat produced hydrocarbons from wells, initiate export of produced hydrocarbons, conduct additional drilling or reservoir stimulation, conduct workover activities, and carry out eventual abandonment procedures. There is a range of offshore infrastructure installed for hydrocarbon production. Among these are pipelines, fixed and floating platforms, caissons, well protectors, casing, wellheads, and conductors. Offshore production systems are discussed in greater detail in Chapter 3.1.3.2 of the 2017-2022 GOM Multisale EIS.

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the GOM and are installed during the development phase. A mature pipeline network exists in the GOM to transport oil and gas production from the OCS to shore. BOEM projects that the majority of new pipelines constructed as a result of a proposed action would connect to the existing pipeline infrastructure.

Coastal Infrastructure

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore infrastructure industry that includes large and small companies providing an array of services from construction facilities, service bases, and waste disposal facilities to crew, supply, and product transportation, as well as processing facilities. It is an extensive and mature system that provides support for both offshore and onshore oil and gas activities in the GOM region. Coastal Infrastructure is discussed in greater detail in Chapter 3.1.7 of the 2017-2022 GOM Multisale EIS and **Chapter 4.14.1** of this Supplemental EIS.

3.1.1.3 Production

The production well is completed for the purpose of extracting hydrocarbons from the subsurface.

Depending on the information obtained from delineation or exploration well drilling, these wells can be completed and prepared to serve as production wells. Production wells are wells that are drilled following the delineation stage of the development program and are positioned within the reservoir to maximize the volume of production. Wells initially drilled as delineation wells that are later converted to production wells and wells drilled as production wells are sometimes collectively referred to as development wells.

Following the drilling of development wells, the operator of a field may decide to remain on location and immediately begin the next stage of the field development program, i.e., preparing the development wells for production. However, there are a number of reasons that the operator may decide to move off location and delay the work required to prepare the wells for production; for example, additional well tests may be required or the drilling rig may be committed to another location. When a decision to delay the work is chosen, each development well would be temporarily abandoned before the drilling rig can be moved to another location. It is also common for an operator to drill the required number of development wells in stages, leaving sometime between the stages to evaluate the information obtained from the wells and, if necessary, use this information to modify the development program.

A deepwater operations plan is required for all deepwater development projects in water depths ≥1,000 ft (305 m) and for all projects proposing subsea production technology. A deepwater operations plan is required initially and is usually followed by a development operations coordination document (DOCD). The DOCD is the chief planning document that lays out an operator's specific intentions for development. Production is discussed in greater detail in Chapters 3.1.1 and 3.1.3.2 of the 2017-2022 GOM Multisale EIS. Refer to Appendix A.2 of the 2017-2022 GOM Multisale EIS for a detailed discussion on regulations, processes, and environmental information requirements for lessees and operators related to exploration plans (EPs), deepwater operations plans, and DOCDs.

3.1.1.4 Decommissioning and Removal Operations

During exploration, development, and production operations, the seafloor around activity sites within a proposed lease sale area becomes the repository of temporary and permanent equipment and structures. Regulations and processes related to structure and site clearance are discussed in Appendix A.13 of the 2017-2022 GOM Multisale EIS. The structures are generally grouped into two main categories depending upon their relationship to the platform/facilities (i.e., piles, jackets, caissons, templates, mooring devises, etc.) or the well (i.e., wellheads, casings, casing stubs, etc.).

A varied assortment of severing devices and methodologies has been designed to cut structural targets during the course of decommissioning activities. These devices are generally grouped and classified as either nonexplosive or explosive, and they can be deployed and operated by divers using remotely operated vehicles, or from the surface. Which severing tool the operators and contractors use takes into consideration the target size and type, water depth, economics, environmental concerns, tool availability, and weather conditions.

Nonexplosive severing tools are used on the OCS for a wide array of structure and well decommissioning targets in all water depths. Based on 10 years of historical data (1994-2003), nonexplosive severing is employed exclusively on about 58 (~37%) removals per year (USDOI, MMS, 2005). Since many decommissionings use both explosive and nonexplosive technologies (prearranged or as a backup method), the number of instances may be much greater. Common nonexplosive severing tools consist of abrasive cutters (e.g., sand cutters and abrasive water jets), mechanical (carbide) cutters, diver cutting (e.g., underwater arc cutters and the oxyacetylene/ oxy-hydrogen torches), and diamond wire cutters. Explosive severance tools can be deployed on almost all structural and well targets in all water depths. Historically, explosive charges are used in about 98 (~63%) decommissioning operations annually (USDOI, MMS, 2005), often as a back-up cutter when other methodologies prove unsuccessful. Explosives work to sever their targets by using (1) mechanical distortion (ripping), (2) high-velocity jet cutting, and (3) fracturing or "spalling."

While production structures are removed, it is anticipated that multiple appurtenances or types of equipment (e.g., subsea systems, pipelines, umbilical lines, etc.) would not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft), as allowed under certain conditions in 30 CFR part 250. For more information on decommissioning, refer to Chapter 3.1.6 of the 2017-2022 GOM Multisale EIS.

Workovers and Abandonments

Completed and producing wells may require periodic reentry that is designed to maintain or restore a desired flow rate. These procedures are referred to as a well "workover."

Workover operations are also carried out to evaluate or reevaluate a geologic formation or reservoir (including recompletion to another stratum) or to permanently abandon a part or all of a well. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from 1 day to several months to complete depending on the complexity of the operations, with a median of 7 days. Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. On the basis of historical data, BOEM projects a producing well may have seven workovers or other well activities during its lifetime.

There are two types of well abandonment operations—temporary and permanent. An operator may temporarily abandon a well to (1) allow detailed analyses or additional delineation wells while deciding if a discovery is economically viable, (2) save the wellbore for a future sidetrack to a new geologic bottom-hole location, or (3) wait on design or construction of special production equipment or facilities. The operator must meet specific requirements to temporarily abandon a well. Permanent abandonment operations are undertaken when a wellbore is of no further use to the operator (i.e., the well is a dry hole or the well's producible hydrocarbon resources have been depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well that contain hydrocarbons are plugged with cement. A cement surface plug is also required for the abandoned wells. This serves as the final isolation component between the wellbore and the environment.

3.1.2 How Much and Where is Activity Expected to Occur as a Result of a Proposed Action?

A scenario describes the offshore activities that could occur for a single proposed lease sale under each alternative. BOEM's Gulf of Mexico OCS Region developed these scenarios to support the detailed analyses of a proposed lease sale's potential impacts whether regionwide or for individual planning areas, as defined in the alternatives in **Chapter 2.2.2**. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production for offshore and onshore activities and facilities. The scenario for each alternative is defined as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors.

> ***What is a scenario?*** *Scenario development is the process of analyzing and projecting future activities that could occur as a result of each action alternative (i.e., Alternative A, B, C, or D).*

The scenarios do not predict future oil and gas activities with absolute certainty even though they were formulated using historical information and current trends in the oil and gas industry. These scenarios are only approximate since future factors such as the economic climate, the future availability of support facilities, and future pipeline capacities are all unknown. The scenarios used in the 2017-2022 GOM Multisale EIS represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses (refer to Chapter 3 of the 2017-2022 GOM Multisale EIS). The development scenarios do not represent a BOEM recommendation, preference, or endorsement of any level of leasing or offshore operations or of the types, numbers, and/or locations of any onshore operations or facilities.

How are the Scenarios Developed?

BOEM uses a series of spreadsheet-based data analyses tools to develop the forecasts of oil and gas exploration, discovery, development, and production activity scenario for each action alternative presented in the 2017-2022 GOM Multisale EIS and this Supplemental EIS. The activity level associated with a proposed lease sale could vary based on a number of factors, including the price of oil, hydrocarbon resource potential, cost of development, and resource availability (e.g., drill rig availability), among other things. The scenario information presented takes into account historical oil and gas prices, price trends, oil and gas supply and demand, and related factors that influence oil and gas product-price and price volatility. The analyses are compared with actual historical activity and infrastructure data to ensure that historical precedent, as well as recent trends, is reflected in each activity forecast. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed to develop the scenario, and the results are reported as a range of values corresponding to probabilities of occurrence.

> ***How are ranges determined?*** *The low and high production scenarios, and the factors that influence them, are used to create the range in scenario oil and gas activity.*

> ***What does a range of activity mean?*** *A meaningful range provides a reasonable expectation of the lowest to highest oil and gas production and associated activity anticipated from a single proposed lease sale.*

BOEM used these analyses to develop a reasonable low activity scenario and a reasonable high activity scenario for each alternative. BOEM does not expect every lease sale to reach the highest high or lowest low of the forecasted scenario ranges, but every lease sale will fall within the ranges. The range of volumes described by these scenarios represents BOEM's best estimate of the range of possible production volumes and associated activity that can reasonably be expected from the acreage leased during a single proposed lease sale for Alternatives A, B, C, and D. Under Alternative D, the number of blocks that would become unavailable for lease represents a small percentage (<4%) of the total number of blocks to be offered under Alternative A, B, or C. Therefore, Alternative D could reduce offshore infrastructure and activities or may shift the location of offshore infrastructure and activities farther from sensitive topographic zones, but though this may affect the outcome of activity, the ranges provided for Alternatives A, B, and C are broad enough to encompass this change. The location and geologic formation of the oil and gas reserves, and the ability to access them, would determine if a reduction in offshore infrastructure and activities would occur or not. Since the ranges given for Alternatives A, B, and C are broad and represent the low and high levels of forecasted activity, any reduction of activity from choosing Alternative D would still fall within those ranges; therefore, the scenarios do not change when considering Alternative D. The potential impacts associated with selecting Alternative D are discussed in **Chapter 4** under each resource. Refer to **Chapter 2.2.2.4** for more information on Alternative D.

These scenarios are developed to provide the environmental impact analyses in **Chapter 4** the flexibility to develop impact metrics for the full range of potential impacts that could be possible from a single proposed lease sale. BOEM is confident that the analysis methodology, with adjustments and refinements based on recent activity levels and industry information, adequately project Gulf of Mexico OCS oil- and gas-related activities in both the short term and the long term in the analyses for the 2017-2022 GOM Multisale EIS and this Supplemental EIS.

To analyze impact-producing factors for a proposed action and each alternative, the geographic ranges of each alternative were divided into offshore subareas based upon ranges in water depth. **Figure 3-2** depicts the location of the offshore subareas. The water-depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water-depth range.

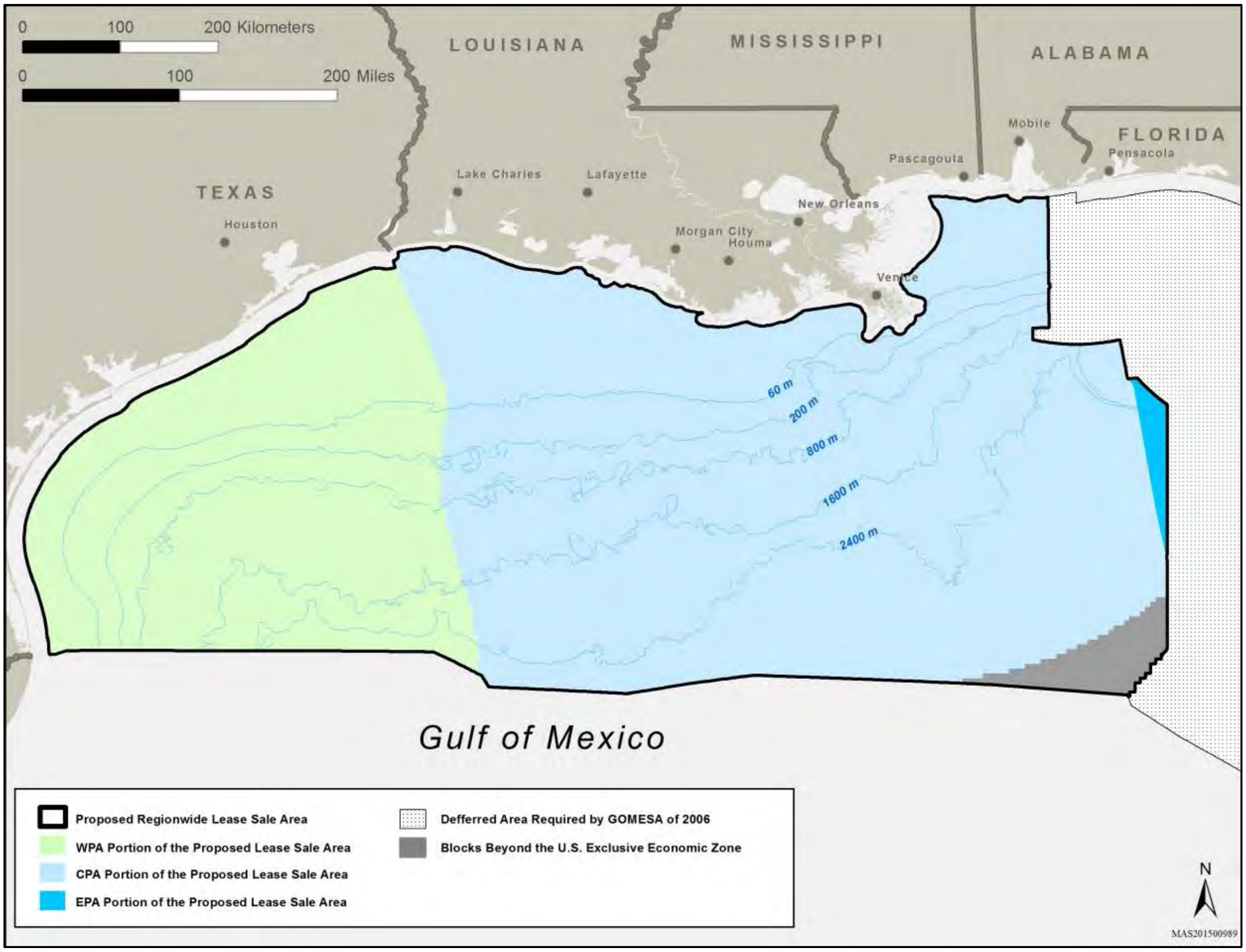


Figure 3-2. Offshore Subareas in the Gulf of Mexico.

The major impact-producing factors of a single proposed lease sale (including the number of exploration and delineation wells, production platforms, and development wells) projected to develop and produce the estimated oil and gas resources for Alternatives A, B, and C are given in **Table 3-1**. This table shows the distribution of these factors by offshore subareas for each alternative. **Table 3-1** also includes estimates of the major impact-producing factors related to the projected levels of exploration, development, and production activity. Estimates of resources and facilities are distributed into each of the subareas. The activities found in **Table 3-1** will occur within the 50-year analysis period of 2017-2066. When analyzing hydrocarbon resources by planning area across the GOM, the majority of oil and gas resources are located within the boundaries of the CPA; therefore, the majority of activity is expected to occur in the CPA.

Table 3-1. Offshore Scenario Activities Related to a Single Proposed Lease Sale for Alternative A, B, or C from 2017 through 2066.

Activity	Alternative[1]	Offshore Subareas (m)[2]						Totals[3]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Exploration and Delineation Wells	A	24-634	8-300	5-11	6-15	5-8	5-16	53-984
	B	20-570	5-293	2-8	2-10	2-2	2-10	33-893
	C	4-64	2-7	2-3	3-5	3-6	3-6	17-91
Development and Production Wells[4]	A Total	14-326	7-220	7-95	13-51	10-37	10-38	61-767
	B Total	10-282	4-211	4-78	10-35	9-31	9-34	46-671
	C Total	4-44	4-9	4-17	4-16	3-6	3-4	22-96
	A Oil	1-35	0-23	3-46	6-22	5-19	4-19	19-164
	B Oil	1-32	0-23	2-38	5-18	4-16	4-17	16-144
	C Oil	0-5	0-1	2-9	1-5	1-4	1-3	5-27
	A Gas	1-35	0-23	3-46	6-22	5-19	4-19	19-164
	B Gas	5-169	2-120	0-17	1-7	1-6	1-7	10-326
	C Gas	2-27	2-6	0-4	1-7	0-1	0-1	5-46
Installed Production Structures	A	8-183	4-85	1-4	1-3	1-2	1-3	16-280
	B	7-158	3-81	1-3	1-2	1	1-2	14-247
	C	3-25	2-4	1	1	1	1	9-33
Production Structures Removed Using Explosives	A	6-130	3-63	0	0	0	0	9-193
	B	5-112	2-60	0	0	0	0	7-172
	C	2-18	2-3	0	0	0	0	4-21
Total Production Structures Removed	A	8-183	4-85	1-4	1-3	1-2	1-3	16-280
	B	7-158	3-81	1-3	1-2	1	1-2	14-247
	C	3-25	2-4	1	1	1	1	9-33
Length of Installed Pipelines (km)[5]	A	59-527	53-417	53-327	78-358	59-275	53-240	355-2,144
	B	40-395	34-336	33-240	55-233	50-227	42-210	254-1,641
	C	20-132	20-81	20-88	24-125	10-48	11-31	105-505
Service-Vessel Trips (1,000's round trips)	A	9-265	4-126	6-51	7-38	7-26	7-36	43-541
	B	8-229	3-120	6-39	6-26	6-15	6-25	38-452
	C	3-36	2-6	6-13	6-13	6-12	6-11	30-89
Helicopter Operations (1,000's round trips)	A	52-2,131	34-1,409	8-71	8-53	8-36	8-53	122-3,750
	B	43-1,848	26-1,426	8-53	8-36	8-18	8-36	105-3,415
	C	17-299	17-71	8-18	8-18	8-18	8-18	70-440

[1] Alternative D could reduce activity values of the combined Alternative A, B, or C. Refer to **Chapter 2.2.2.4** for more information. Alternative A would be a regionwide lease sale, Alternative B would be the CPA/EPA portions of the proposed lease sale area, and Alternative C would be the WPA portion of the proposed lease sale area.

[2] Refer to **Figure 3-2**.

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

[4] Development and Production Wells includes some exploration wells that were re-entered and completed. These wells were removed from the Exploration and Delineation well count.

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

While the activities associated with exploration, development, production, and abandonment of leases in the GOM are expected to occur during the 50-year analysis period of 2017-2066, the Cumulative OCS Oil and Gas Program scenario has an analysis period of 70 years or 2017-2086. The Cumulative OCS Oil and Gas Program scenario includes the 50-year analysis period for a single proposed lease sale (e.g., Lease Sale 250). It is important to note that a single proposed lease sale, no matter which alternative is selected, would represent only a small proportion of activity and a small contribution to the overall Cumulative OCS Oil and Gas Program activity forecasted to occur between 2017 and 2086 (refer to **Table 3-2**). The information in **Table 3-2** represents the incremental contribution of each alternative of a single proposed lease sale (e.g., Lease Sale 250) to the Cumulative OCS Oil and Gas Program scenario (2017-2086). Further information about the Cumulative OCS Oil and Gas Program scenario can be found in **Chapter 3.3.2.1** below. Specific projections for activities associated with a single proposed lease sale under each alternative are discussed in the following scenario sections.

Table 3-2. Percent of Production of Each Alternative of a Single Proposed Lease Sale (2017-2066) in Relation to Each Cumulative Production Scenario.

Single Proposed Lease Sale (2017-2066)	Percent of Production of a Single Proposed Lease Sale in Relation to		
	Cumulative Production Regionwide (2017-2086)	Cumulative Production in the CPA/EPA (2017-2086)	Cumulative Production in the WPA (2017-2086)
Alternative A	1.2-4.2%	–	–
Alternative B	1.0-3.6%	1.2-4.4%	–
Alternative C	0.2-0.6%	–	1.2-3.5%

Note: Alternative D could reduce production values of the combined Alternative A, B, or C. Refer to **Chapter 2.2.2.4** for more information.

3.1.2.1 Exploration Scenario

Geophysical surveys generally would be the first activities to occur within the Gulf of Mexico. For each alternative, G&G surveys are projected to follow the same trend as exploration drilling activities, which would peak in the first 20-25 years and then begin declining, with regards to a particular lease sale. The HRG surveys generally occur before exploratory drilling, but they can also occur before development drilling, platform and pipeline installation, and decommissioning activities. It is important to note that the cycling of G&G data acquisition is not driven by the 50-year life cycle of a single productive lease but instead would tend to respond to new production or potential new production driven by new technology. Consequently, some areas would be resurveyed in 2-year cycles, while other areas, considered nonproductive, may not be surveyed for 20 years or more. **Table 3-3** reflects a reasonable level of G&G surveying activities during 2017-2066 that could be expected to occur leading up to and following a scheduled lease sale in the Gulf of Mexico. The estimates below far exceed the number of blocks available for leasing in the entire Gulf of Mexico OCS. Data collection may be repeated on any one block as technology advances, or multiple surveys may be conducted over the same OCS blocks for different purposes (e.g., prelease exploratory surveys and shallow hazard surveys). Ancillary permits are postlease operational permits obtained by lease owners in furtherance of developing oil and gas resources. Ancillary activities are defined in 30 CFR § 550.105 and regulated in 30 CFR §§ 550.207-550.210.

Table 3-3. Exploration and Seismic Survey Activity Leading Up To and Following a Proposed Lease Sale in the Gulf of Mexico

Survey Area	2D Surveys (km)	2D Permits	3D Lease Blocks	3D Permits	Ancillary Permits	HRG Surveys	VSP Surveys
Regionwide	77,248-1,046,073	31-310	13,400-185,000	25-128	19-214	87-709	17-263
CPA/EPA	75,639-970,434	27-283	18,900-171,300	20-108	16-198	64-576	11-234
WPA	1,448-6,598	4-9	5,500-25,100	6-21	3-26	30-134	5-29

2D = two-dimensional; 3D = three-dimensional; HRG = high-resolution geophysical; VSP = vertical seismic profiling.

Following a lease sale, exploratory drilling activity could begin within the 1st year and would likely continue to occur over the course of each lease. The majority of the exploratory drilling for all blocks leased would likely occur early and would generally be complete by the 25th year for Alternative A, B, C, or D. **Figure 3-3(A)** shows the timeline of drilling exploration and delineation wells for a proposed action under Alternative A. **Figure 3-3(B, C)** depicts the high and low production scenario by planning area and water depth. When analyzing both the low and high production scenarios for all of the alternatives, most exploration drilling activity is expected to occur on the continental shelf (0- to 200-m [0- to 656-ft] water depth). Note that exploratory drilling activity spans less than 40 years and exploration wells are not all drilled during the same time period. The most exploration wells drilled in a given year from a proposed action is 64. The most exploration wells drilled in any given 5-year span is 298 (averaging about 32 wells drilled per year during the exploration phase), demonstrating that all forecasted exploration wells are drilled over time and not consolidated into a narrow timeframe, i.e., a single year. **Figure 3-3(B, C)** gives the reader an idea of which water-depth category the majority of activity within the GOM would occur; however, in reality, the activity would not be equally distributed across water-depth categories as depicted and would have geographic specificity based on geology.

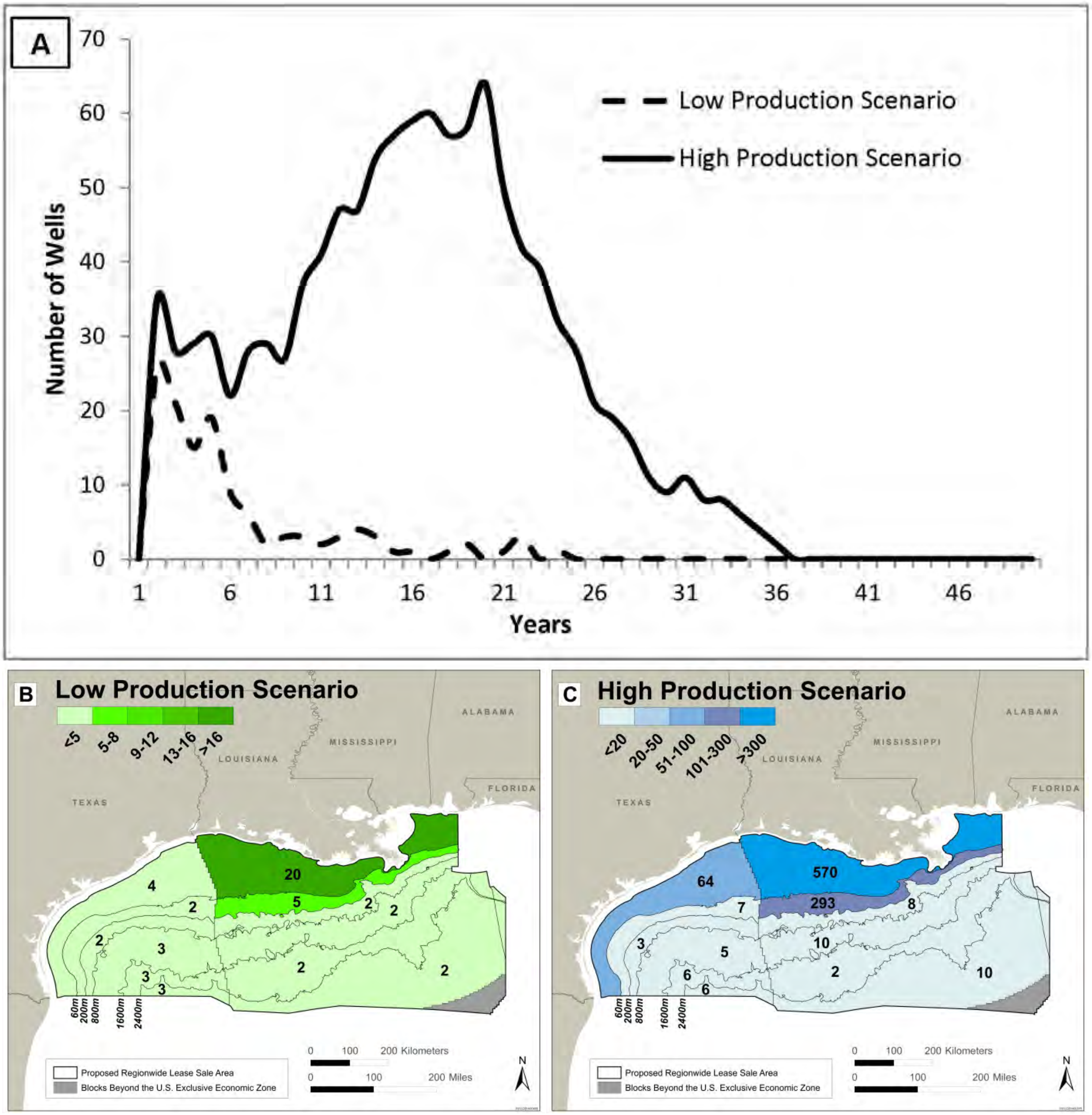


Figure 3-3. (A) Number of Exploration and Delineation Wells Drilled over the Course of a Proposed Action under Alternative A for 50 Years. (B, C) Location of Exploration Wells Drilled during the Entire 50-Year Period.

3.1.2.2 Development Scenario

Offshore Development Scenario

The peak in platform installation would lag behind the peak in exploration drilling. Following a lease sale, support infrastructure installation would likely occur over the course of each lease but could begin within 1 year. The majority of platforms installed in early years would be caissons and small fixed platforms in shallow water. Floating structures installed in deeper water would take many years to construct and install. The highest number of platforms operating as a result of a lease sale would peak before year 10 in the low production scenario and around year 25 for the high production scenario. **Figure 3-4(A)** depicts the estimated number of operating production structures in the GOM, with the exception of subsea systems for a single proposed lease sale. Various single well to multi-well structures would be installed and commissioned depending on the water depth. There would be a slight temporal lag between peak development drilling and platform installation. Platforms that are operated after peak development maximize production from the remaining production wells. **Table 3-1 and Figure 3-4(B, C)** show the estimated range installed production structures by water-depth range. Note that the production activity spans 40 years and that production structures are not all operational concurrently. **Figure 3-4(B, C)** gives the reader an idea of which water-depth category the majority of activity within the GOM would occur; however, in reality, the activity would not be equally distributed across water-depth categories as depicted and would have geographic specificity based on geology. Of the possible 280 total high forecasted production structures (refer to **Table 3-1**), the most structures operating in a given year from a proposed action would be 108 structures. Laying pipeline is part of the development process and must begin before the production phase can begin for most leases. The total estimated length of pipeline laid for each alternative can be found in **Table 3-1**. Regardless of the production scenario or alternative, most support structure installation is expected to be on the continental shelf (0- to 200-m [0- to 656-ft] water depth).

Coastal Infrastructure Scenario

The extensive presence of coastal infrastructure is not subject to rapid fluctuations and results from long-term industry trends. Existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. Should there be some expansion at current facilities, the land in the analysis area is sufficient to handle such development. The number and location of existing coastal infrastructure can be seen in **Table 3-4**. There are currently 144 pipeline landfalls (i.e., pipelines that have at one time or another carried hydrocarbon product) in the Louisiana Coastal Area (LCA) (Smith, official communication, 2015). The BSEE and DOT share responsibility for pipeline regulation on the OCS in the transition between Federal and State waters. For more information on the regulation and permitting of pipelines, refer to Appendix A.3 of the 2017-2022 GOM Multisale EIS.

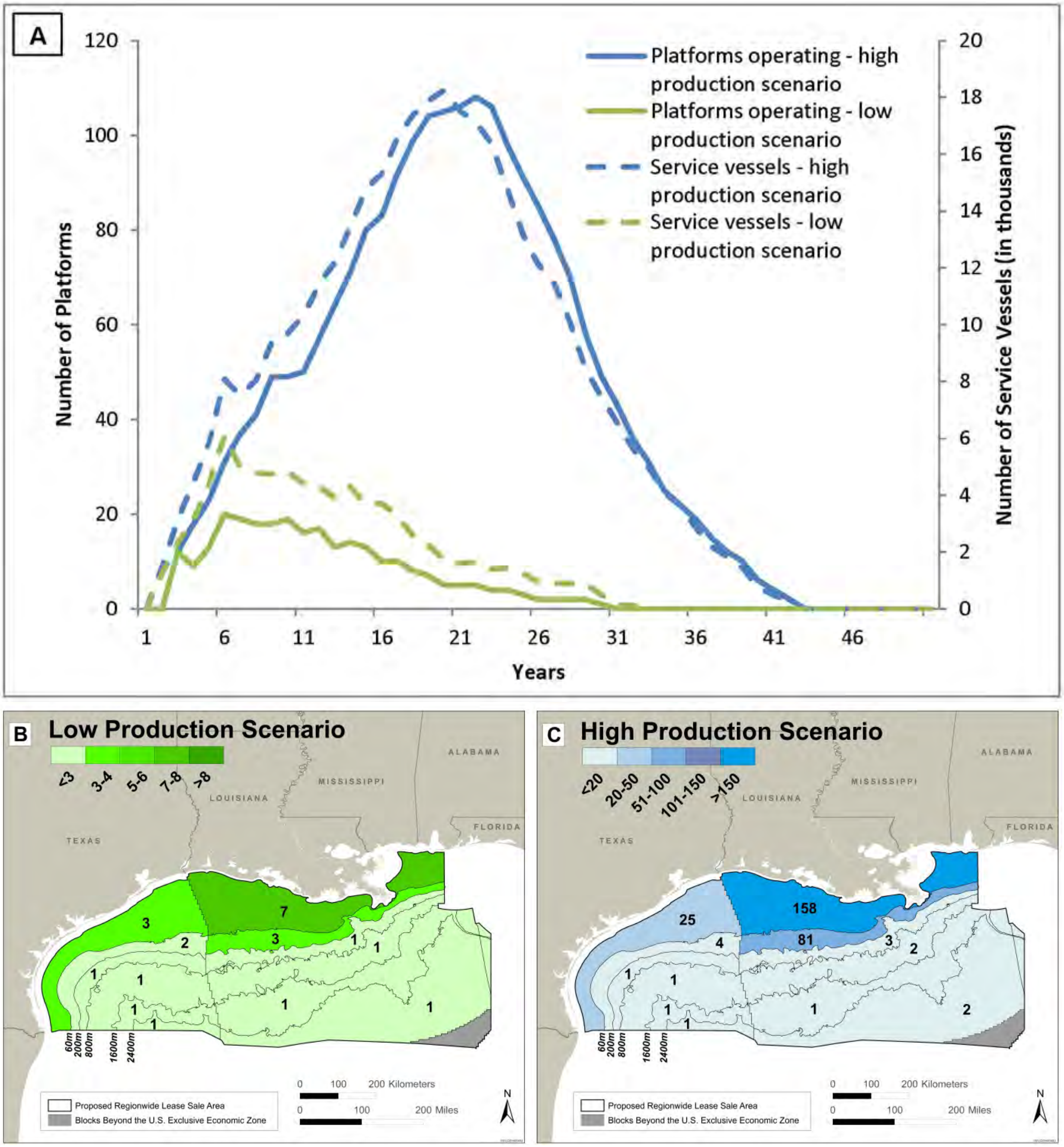


Figure 3-4. *(A) Number of Production Structures and Service Vessels Operating over the Course of a Proposed Action under Alternative A for 50 Years. (B, C) Total Number of Platforms Installed in the Low and High Production Scenario by Water Depth.*

Table 3-4. Existing Coastal Infrastructure Related to OCS Oil- and Gas-Related Activities in the Gulf of Mexico.

Infrastructure	Texas	Louisiana	Mississippi	Alabama	Florida	Total
Pipeline Landfalls[1]	14	122	3	5	0	144
Platform Fabrication Yards[2]	12	37	4	1	0	54
Shipyards[2]	32	64	9	18	14	137
Pipe Coating 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[3]	20	16	3	3	0	42
Petrochemical Plants[2]	126	66	2	9	13	216

[1] Source: Smith, 2015.
[2] Source: Dismukes, 2011a.
[3] Source: USDOE, Energy Information Administration, 2015.

3.1.2.3 Production Scenario

Development and Production Drilling

Figure 3-5 below depicts the number of development and production wells that may result from a low and high scenario case by planning area and water depth. BOEM estimates that approximately 63-70 percent of wells drilled as development wells will become producing wells. Because there is some overlap, the two types of wells are grouped to prevent double counting. The distribution of development and production wells by water depth that could possibly occur as result of Alternative A, B, or C can be found in **Table 3-1**.

Development and production activity during a proposed action usually takes place over a 49-year period, beginning with the installation of a production platform on the first lease and ending with the drilling of the last development wells. The majority of development well drilling would likely occur in the first 25 years of each lease. Production of oil and gas could begin by the 3rd year after the lease sale and generally would conclude by the 50th year; refer to **Figure 3-5(A)** below. In the low production scenario, development and production activity is expected to occur fairly evenly spread between the continental shelf (0- to 200-m [0- to 656-ft] water depth) and deeper water depths (200-1,600 m; 656-5,249 ft) with a majority of activity in the CPA; however, for the high production scenario, most development and production drilling activity is expected to occur on the continental shelf (0- to 200-m [0- to 656-ft] water depth). **Figure 3-5(B, C)** gives the reader an idea of which water-depth category the majority of activity within the GOM would occur; however, in reality, the activity would not be equally distributed across water-depth categories as depicted and would have geographic specificity based on geology. Note that production drilling activity spans 40 years and that production wells would not all be drilled during the same time period. The most wells drilled in a given year would be 34, and the most wells drilled in any given 5-year span would be 150 (averaging 30 wells drilled per year), demonstrating that all the forecasted wells are drilled over time and not consolidated into a narrow timeframe, i.e., a single year.

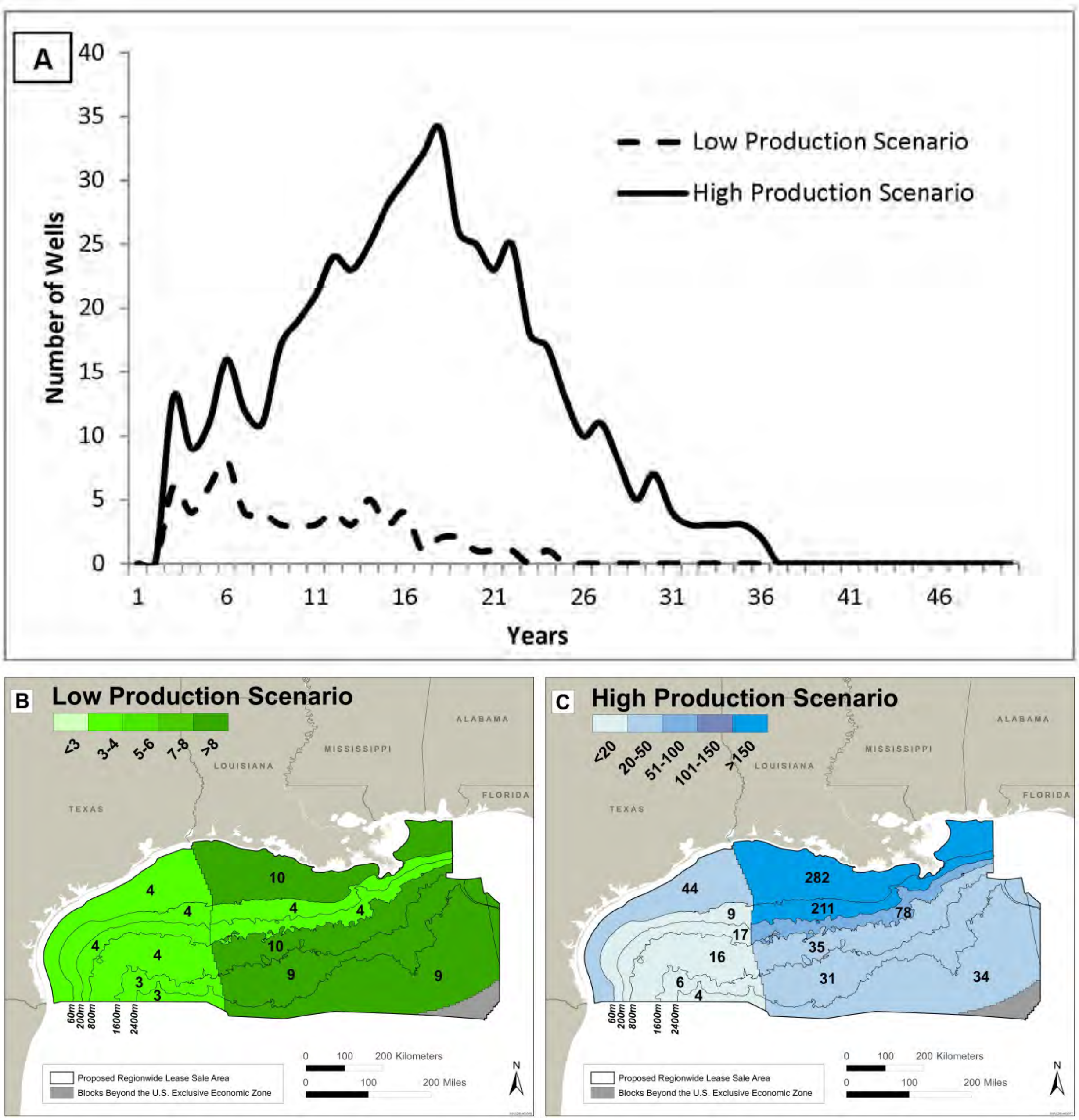


Figure 3-5. (A) Number of Production Wells Drilled over the Course of a Proposed Action under Alternative A for 50 Years. (B, C) Total Number of Development and Production Wells Drilled in the Low and High Production Scenario by Water Depth for Alternative A.

Oil and Gas Production

Table 3-5 presents the projected oil and gas production for a single proposed lease sale under each alternative (2017-2066) and for the Cumulative OCS Oil and Gas Program (2017-2086). Alternative D could reduce offshore production when chosen in conjunction with Alternative A, B, or C. However, it is also possible that Alternative D would only shift the location of offshore infrastructure and activities farther from sensitive topographic zones and not lead to a reduction in production. Refer to **Chapter 2.2.2.4** for more information on Alternative D. Refer to **Table 3-1** above for the offshore scenario activities related to a single proposed lease sale for Alternative A, B, or C from 2017 through 2066, which are associated with these projected oil and gas volumes in the Gulf of Mexico OCS.

Table 3-5. Projected Oil and Gas in the Gulf of Mexico OCS.

Reserve/Resource Production	Lease Sale (2017-2066)	OCS Cumulative (2017-2086)
Alternative A: Regionwide OCS Lease Sale		
Oil (BBO)	0.211-1.118	15.482-25.806
Gas (Tcf)	0.547-4.424	57.875-108.513
Alternative B: Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area (or the CPA/EPA Portion of the Proposed Lease Sale Area)		
Oil (BBO)	0.185-0.970	13.707-22.152
Gas (Tcf)	0.441-3.672	46.328-84.009
Alternative C: Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area (or the WPA Portion of the Proposed Lease Sale Area)		
Oil (BBO)	0.026-0.148	1.775-3.654
Gas (Tcf)	0.106-0.752	11.547-24.504

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

Regardless of the alternative, the majority of oil and gas resources are located within the boundaries of the CPA. Therefore, for a proposed action under Alternative A, which would encompass all acreage available for lease within the WPA, CPA, and EPA, the majority of the activity would still be located in the CPA. An analysis of the scenario forecast for Alternative A suggests that a maximum of 88 percent of the oil production and associated activity and 83 percent of the gas production and associated activity is forecasted to occur within the CPA/EPA. A maximum of 13 percent of the oil production and associated activity and 19 percent of the gas production and associated activity from Alternative A is forecasted to occur within the WPA. For Alternatives A, B, C, and D, the majority of production is expected to occur along the slope in both the low and high production scenarios (**Figure 3-6**). Note that production activity spans to just over

40 years. **Figure 3-6(B, C)** gives the reader an idea of which water-depth category the majority of activity within the GOM would occur; however, in reality, the activity would not be equally distributed across water-depth categories as depicted and would have geographic specificity based on geology. The highest production in a given year would be 0.112 billion barrels of oil equivalent (BOE), and the highest production in any given 5-year span would be 0.553 BOE (averaging 0.047 BOE per year when producing), demonstrating that the forecasted production occurs throughout the 40 years and is not consolidated into a narrow timeframe, i.e., a single year.

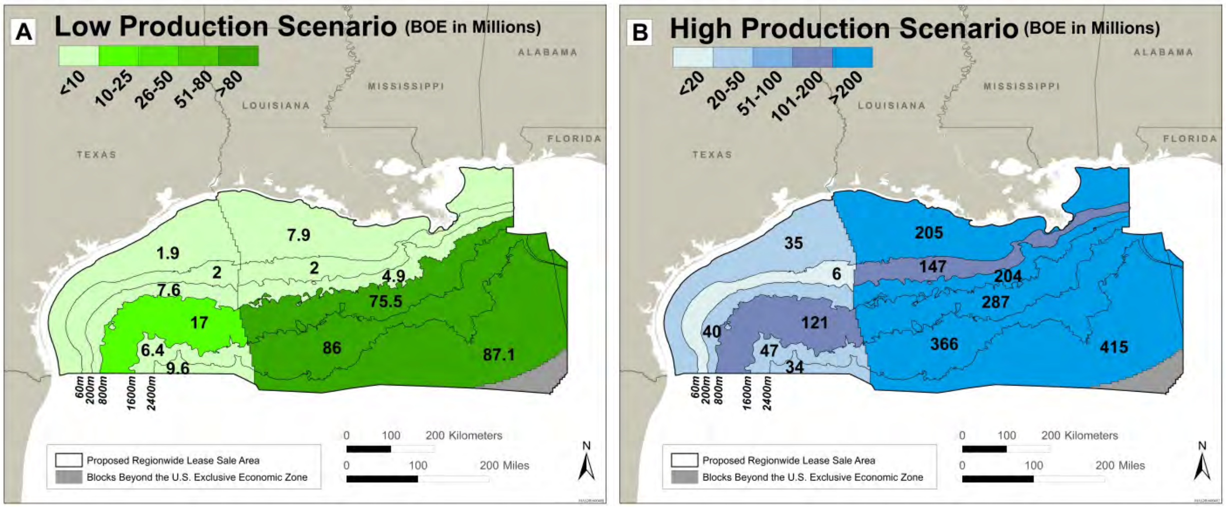


Figure 3-6. Total Oil and Gas Production (BOE) in the Gulf of Mexico in the Low and High Production Scenario by Water Depth.

Relatively more exploration and development drilling and structure installation would occur on the shelf (in depths <200 m [660 ft]) than in deep water, regardless of the production case scenario (**Table 3-6**).

Table 3-6. Depth Distributions within the Proposed Regionwide Lease Sale Area.

Geographic Province	Percent Wells		Percent Platforms		Percent Gas		Percent Oil Production	
	Low	High	Low	High	Low	High	Low	High
Shelf	46.5	85	75	95	13	73	1	6
Slope	53.5	15	25	5	87	27	99	94

3.1.2.4 Decommissioning Scenario

Table 3-1 shows platform removals by water-depth subarea as a result of Alternatives A, B, and C. Approximately 70 percent of production structures installed landward of the 800-m (2,625-ft) isobath could be removed using explosives. About 30 percent of production structures landward of the 800-m (2,625-ft) isobath and all structures in water deeper than the 800-m (2,625-ft) isobath would be removed using nonexplosive methods. While the production structure is removed, it is anticipated that multiple types of support equipment (e.g., subsea systems, pipelines, umbilical lines, etc.) would not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft) as allowed under certain conditions in 30 CFR part 250. An estimate of the well stubs and other various subsea structures that may be removed using explosives is not possible at this time.

3.1.2.5 Transportation Scenario

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the GOM (**Table 3-7**). A mature pipeline network exists in the GOM to transport oil and gas production from the OCS to shore. Historically, barging in the GOM has remained less than 1 percent. In 2005, barging activity temporarily rose to 1.29 percent while pipelines damaged from hurricanes were repaired. The average amount of oil barged between 2010 and 2014 was 0.12 percent annually. The number of active barging systems has been reduced over time from approximately eight systems in 2005 to four systems in 2010 and has remained constant since then. It is assumed that barging would continue to account for <1 percent of the oil transported for the entire OCS Program and for any single alternative. **Table 3-7** provides the percentages of oil barged to shore by subarea for each alternative. The floating, production, storage, and offloading (FPSO) systems are suitable for the light and intermediate oils of the GOM. The use of FPSOs is only projected in water depths >1,600 m (5,250 ft). Shuttle tankers are used to transport crude oil from FPSO production systems to Gulf Coast refinery ports or to offshore deepwater ports such as the Louisiana Offshore Oil Port (LOOP); the percentage of oil tankered is provided in **Table 3-7**.

Table 3-7. Oil Transportation Scenario under Alternative A, B, or C.

Activity	Alternative[1]	Offshore Subareas (m)[2]						Totals[3]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Percent Oil Piped[4]	A	72-94%	100%	100%	100%	100%	100-66%	99.8-90.0%
	B	70-94%	100%	100%	100%	100%	100-50%	98.8-84.6%
	C	100%	100%	100%	100%	100%	100%	100%
Percent Oil Barged	A	28-6%	0%	0%	0%	0%	0%	0.2%
	B	30-6%	0%	0%	0%	0%	0%	0.2%
	C	0%	0%	0%	0%	0%	0%	0%
Percent Tankered[5]	A	0%	0%	0%	0%	0%	0-34%	0-9.8%
	B	0%	0%	0%	0%	0%	0-50%	0-15.2%
	C	0%	0%	0%	0%	0%	0%	0%

[1] Alternative D could reduce activity values of the combined Alternative A, B, or C. Refer to **Chapter 2.2.2.4** for more information. Percentage values indicated here would not change.
[2] Refer to **Figure 3-1**. Ranges are reported from the low production case scenario to the high production case scenario.
[3] Subareas totals may not add up to the planning area total because of rounding.
[4] 100% of gas is assumed to be piped.
[5] Tankering is forecasted to occur only in water depths >1,600 m (5,250 ft).

According to the Helicopter Safety Advisory Conference (2015), from 1996 to 2014, helicopter operations (take offs and landings) in support of regionwide OCS operations have averaged, annually, about 1.2 million operations, 2.7 million passengers, and 386,000 flight hours. There has been a decline in helicopter operations from 1,668,401 in 1996 to 741,201 in 2014

(Helicopter Safety Advisory Conference, 2015). Future projections are based on a high equal to the average number of flights over the last 15 years and a low equal to a continuing forecast of the current decline. **Table 3-1** shows helicopter trips by water-depth subareas as a result of Alternatives A, B, and C.

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. Service-vessel operations are most closely tied to actual production activities. Visual representation of this can be seen in **Figure 3-4(A)**. **Table 3-1** shows service-vessel trips by water-depth subareas as a result of Alternatives A, B, and C.

3.1.3 Summary of Routine Impact Producing Factors

Table 3-8 below outlines the impact-producing factors and operations assumed to routinely occur throughout the lifetime of lease. The impact-producing factors and operations are grouped by operational phases that consist of exploration, development, oil or gas production, and decommissioning. Refer to **Table 3-9**, which provides descriptions of the routine impact-producing factors and operations that occur during the lifetime of a lease.

Table 3-8. Summary of the Timing of Impact-Producing Factors Associated with Routine Oil and Gas Activities.

Impact-Producing Factors and Activities	Exploration		Development	Production	Decommissioning
	Geological and Geophysical Survey	Exploration and Delineation Drilling			
Operations					
Geological and Geophysical	X	X	X	X	X
Drilling	X	X	X	X	-
Bottom Disturbance	X	X	X	X	X
Infrastructure Emplacement	-	X	X	X	-
Workovers and Abandonment	-	X	X	X	-
Decommissioning and Removal	-	-	-	-	X
Artificial Reefs	-	-	-	-	X
Transport					
Pipelines	-	X	X	X	X
Barges	-	X	X	X	X
Oil Tankers	-	-	X	X	-
Service Vessels	X	X	X	X	X
Helicopters	X	X	X	X	X
Navigation Channels	X	X	X	X	X
Discharges and Wastes					
Operational Wastes and Discharges Generated by OCS Oil- and Gas-Related Facilities	-	X	X	X	X
Operational Wastes and Discharges Generated by Service Vessels	X	X	X	X	X
Onshore Disposal of Waste and Discharge Generated Offshore or Onshore	X	X	X	X	X
Coastal Infrastructure					
Construction Facilities	X	X	X	X	-
Support Facilities and Transportation	X	X	X	X	X
Processing Facilities	-	-	X	X	-
Other Types of Impact-Producing Factors					
Air Emissions	X	X	X	X	X
Noise	X	X	X	X	X

Table 3-9. General Description of Routine Impact-Producing Factors.

Impact-Producing Factors and Specific Sources	Multisale EIS Chapter Reference	General Description
		Exploration and Delineation
Geological and Geophysical	3.1.2.1	The Exploration & Development (E&D) scenario considers two types of geophysical surveys: (1) marine seismic surveys, which generally cover a large area of leased and/or unleased acreage; and (2) geohazard surveys, which will include side-scan sonar and shallow-penetrating, reflection-seismic profiling conducted to detect archaeological resources or seafloor features that might be problematic for operations, such as drilling a well or installing a platform or pipeline on a more specific site. Geohazard surveys are often accompanied by geotechnical surveys, which involve sampling or measuring mechanical properties or stability of near-seafloor sediments. Sound source levels are dependent on equipment type and size. Airgun arrays may have source levels of 216 to 259 dB re 1 µPa-m, with frequencies <120 Hz. Other techniques (e.g., sparkers and boomers) are in the range of 212 to 221 dB re 1 µPa-m, with frequencies in the 800- to 1,200-Hz range (Richardson et al., 1995; USDOC, NOAA and Marine Conservation Biology Institution, 2000). Further detailed information for G&G surveys can be found in BOEM's *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement* (Atlantic G&G Activities Programmatic EIS; USDOI, BOEM, 2014).
Exploration and Delineation Plans and Drilling	3.1.2.2	Following a lease sale, exploratory drilling activity would likely occur over the course of each lease but could begin within 1 year. The majority of the exploratory drilling for all blocks leased would likely occur early and would generally be complete by the 25th year. If a resource is discovered during the drilling of an exploration well in quantities appearing to be economically viable, one or more follow-up delineation wells are drilled. Delineation wells are drilled to specific subsurface targets in order to obtain information about the reservoir that can be used by the operator to identify the lateral and vertical extent of a hydrocarbon accumulation.
		Offshore Development and Production
Development and Production Drilling	3.1.3.1	Delineation and production wells are sometimes collectively termed development wells. BOEM estimates that approximately 63-70% of wells drilled as development wells become producing wells. There is a wide variety of well completion techniques performed in the Gulf of Mexico, and the type of well completion used to prepare a drill well for production is based on the rock properties of the reservoir, as well as the properties of the reservoir fluid. However, for the vast majority of well completions, the typical process includes installing or "running" the production casing; cementing the casing; perforating the casing and surrounding cement; injecting water, brine, or gelled brine as carrier fluid for a "frac pack"/sand proppant pack and gravel pack; treating/acidizing the reservoir formation near the wellbore; installing production screens; running production tubing; and installing a production tree.
Infrastructure Emplacement/ Structure Installation	3.1.3.3	**Structures** may be placed over development wells to facilitate production from a prospect. These structures provide the means to access and control wells. They serve as a staging area to process and treat produced hydrocarbons from wells, initiate export of produced hydrocarbons, conduct additional drilling or reservoir stimulation, conduct workover activities, and carry out eventual abandonment procedures. There is a range of offshore infrastructure installed for hydrocarbon production. Among these are pipelines, fixed and floating platforms, caissons, well protectors, casing, wellheads, and conductors. **Subsea wells** may also be completed to produce hydrocarbons from on the shelf and in the deepwater portions of the GOM. The subsea completions would require a host structure to control their flow and to process their well

Table 3-9. General Description of Routine Impact-Producing Factors. (continued).

Impact-Producing Factors and Specific Sources	Multisale EIS Chapter Reference	General Description
		stream. Control of the subsea well is accomplished via an umbilical from the host. **Pipelines** are the primary means of transporting produced hydrocarbons from offshore oil and gas fields to distribution centers or onshore processing points. Pipelines range from small-diameter (generally 4-12 in; 10-30 cm) gathering lines, sometimes called flowlines, that link individual wells and production facilities to large-diameter (as large as 36 in; 91 cm) lines, sometimes called trunk lines, for transport to shore. Pipelines would typically be installed by lay barges that are either anchored or dynamically positioned while the pipeline is laid. **Production activities** can disturb small areas of the sea bottom beneath or adjacent to an emplaced structure. If mooring lines of steel, chain, or synthetic polymer are anchored to the sea bottom, or if wells are drilled, areas around the activity could also be directly affected by their emplacement. This disturbance includes physical compaction or crushing beneath the structure or mooring lines and the resuspension and settlement of sediment caused by the activities.
Offshore Infrastructure Presence	3.1.3.4	**Anchoring:** 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. Leasing on the OCS results in operations that temporarily occupy sea bottom and water surface area for dedicated uses. The OCS oil- and gas-related operations include the deployment of seismic vessels, bottom surveys, and installation of surface or subsurface bottom-founded production structures with anchor cables and safety zones. While in use, these areas would become unavailable to commercial fishermen, sand borrowing, or any other competing use. **Light pollution** in the GOM comes from OCS oil- and gas-related structures and service vessels and may increase visibility during night hours. The OCS oil- and gas-related structures in the GOM are illuminated from incandescent lights and from the glow of burning or flaring natural gas that cannot be stored or transported to shore.
Workovers and Abandonment	3.1.3.5	**Workovers:** Completed and producing wells may require periodic reentry that is designed to maintain or restore a desired flow rate. These procedures are referred to as a well "workover." Workover operations are also carried out to evaluate or reevaluate a geologic formation or reservoir (including recompletion to another strata) or to permanently abandon a part or all of a well. Workovers can take from 1 day to several months to complete depending on the complexity of the operations, with a median of 7 days. Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. On the basis of historical data, BOEM projects a producing well may expect to have seven workovers or other well activities during its lifetime. **Abandonment Operations:** There are two types of well abandonment operations—temporary and permanent. Temporary abandonment is described in **Chapter 3.1.1.3** above. Permanent abandonment operations are undertaken when a wellbore is of no further use to the operator (i.e., the well is a dry hole or the well's producible hydrocarbon resources have been depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well that contain hydrocarbons are plugged with cement. A cement surface plug is also required for the abandoned wells. This serves as the final isolation component between the wellbore and the environment.

Table 3-9. General Description of Routine Impact-Producing Factors. (continued).

Impact-Producing Factors and Specific Sources	Multisale EIS Chapter Reference	General Description
Transport		
Barges	3.1.4.1	The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil may remain offshore for as long as 1 week while collecting oil, although the average round trip is assumed to be only 5 days. Historically, barging in the GOM has remained less than 1%. In 2005, barging activity temporarily rose to 1.29% while pipelines damaged from hurricanes were repaired. In 2014, 0.08% of the total volume was transported by barge as compared with 0.13% in 2010. The average amount of oil barged between 2010 and 2014 was 0.12% annually.
Oil Tankers	3.1.4.2	The use of FPSOs and shuttle tankering are only projected in water depths >800 m (2,625 ft). Shuttle tankers are used to transport crude oil from FPSO production systems to Gulf Coast refinery ports or to offshore deepwater ports such as the LOOP. Shuttle tanker design and systems are in compliance with USCG regulations, the Jones Act, and OPA requirements. As such, shuttle tankers are required to be double hulled. In the Gulf of Mexico, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft (10- to 14-m) water depths. Because of these depth limitations, shuttle tankers are likely to be 500,000-550,000 bbl in cargo capacity.
Service Vessels	3.1.4.3	Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore.
Helicopters	3.1.4.4	Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. An operation is considered a roundtrip and includes takeoff and landing.
Discharges and Wastes		
Operational Wastes and Discharges Generated by OCS Oil- and Gas-Related Facilities	3.1.5.1	The primary operational wastes and discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, various waters (e.g., bilge, ballast, fire, and cooling), deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced water, produced sand, and well-treatment, workover, and completion fluids. Minor additional discharges occur from numerous sources. These discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, several fluids used in subsea production, and uncontaminated freshwater and saltwater. The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The USEPA Region 4 has jurisdiction over the eastern portion of the Gulf of Mexico OCS, including all of the EPA and a portion of the CPA off the coasts of Alabama and Mississippi. The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA. Each USEPA Region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines and 2001 effluent guidelines for synthetic-based, fluids-wetted cuttings as a minimum. Permits issued under Section 402 of the Clean Water Act for offshore activities must comply with any applicable water quality standards and/or Federal water quality criteria, as well as Section 403 of the Clean Water Act. Water quality standards consist of the waterbody's designated uses, water quality criteria to protect those uses and to

Table 3-9. General Description of Routine Impact-Producing Factors. (continued).

Impact-Producing Factors and Specific Sources	Multisale EIS Chapter Reference	General Description
		determine if they are being attained, and antidegradation policies to help protect high-quality waterbodies. Discharges from offshore activities near State water boundaries must comply with all applicable State water quality standards.
Operational Wastes and Discharges Generated by Service Vessels	3.1.5.2	Discharges from supply/service vessels equal to or greater than 79 ft (24 m) in length are regulated by the U.S. Environmental Protection Agency's NPDES under the Vessel General Permit (VGP). The Final 2013 VGP was issued on March 28, 2013, became effective on December 19, 2013, and expires on December 19, 2018 (USEPA, 2013a). The Final 2013 VGP regulates 26 specific discharge categories, including numeric ballast-water discharge limits for most vessels, and ensures that ballast-water treatment systems are functioning correctly.
Onshore Disposal of Waste and Discharge Generated Offshore or Onshore	3.1.5.3	Wastes that are typically transported to shore include produced sand, aqueous fluids such as wash water from drilling and production operations, naturally occurring radioactive materials such as tank bottoms and pipe scale, industrial wastes, municipal wastes, and other exploration and production wastes (Dismukes, 2010). Operators are prohibited in the GOM from discharging any produced sands offshore. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. Total produced sand from a typical platform is estimated to be 0-35 bbl/day (USEPA, 1993). The primary onshore facilities that support offshore oil- and gas-related activities include service bases, helicopter hubs at local ports/service bases, construction facilities (i.e., platform fabrication yards, pipeyards, and shipyards), processing facilities (i.e., refineries, gas processing plants, and petrochemical plants), and terminals (i.e., pipeline shore facilities, barge terminals, and tanker port areas). Water discharges from these facilities are from either point sources, such as a pipe outfall, or nonpoint sources, such as rainfall run-off from paved surfaces.
Decommissioning and Removal Operations		
Decommissioning and Removal	3.1.6	During exploration, development, and production operations, the seafloor around activity sites within a proposed lease sale area becomes the repository of temporary and permanent equipment and structures. Regulations and processes related to structure and site clearance are discussed in Appendix A.13 of the 2017-2022 GOM Multisale EIS. The structures are generally grouped into two main categories depending upon their relationship to the platform/facilities (i.e., piles, jackets, caissons, templates, mooring devises, etc.) or the well (i.e., wellheads, casings, casing stubs, etc.). A varied assortment of severing devices and methodologies has been designed to cut structural targets during the course of decommissioning activities. These devices are generally grouped and classified as either nonexplosive or explosive, and they can be deployed and operated by divers, remotely operated vehicles, or from the surface. Which severing tool the operators and contractors use takes into consideration the target size and type, water depth, economics, environmental concerns, tool availability, and weather conditions.
Artificial Reefs	3.1.6.2	Although BSEE supports and encourages the reuse of obsolete oil and gas structures as artificial reefs and is a cooperating agency in implementing the National Artificial Reef Plan, specific requirements must be met for a departure to be granted. More information on these regulations and processes can be found in Appendix A.15 of the 2017-2022 GOM Multisale EIS. Structure-removal permit applications requesting a departure under the Rigs-to-Reefs Policy undergo technical and environmental reviews. The policy document details the minimum engineering and environmental standards that operators/lessees must meet to be granted approval to deploy a structure as an artificial reef. Conditions of approval are applied as necessary to minimize the potential for adverse

Table 3-9. General Description of Routine Impact-Producing Factors. (continued).

Impact-Producing Factors and Specific Sources	Multisale EIS Chapter Reference	General Description
		effects to sensitive habitat and communities in the vicinity of the structure and proposed artificial reef site. Additionally, structures deployed as artificial reefs must not threaten nearby structures or prevent access to oil and gas, marine mineral, or renewable energy resources.
Coastal Infrastructure		
Onshore Facilities	3.1.7	Typical infrastructure (new or currently existing that may be expanded or retrofitted) that would support OCS activity and potentially may affect biological, physical, and socioeconomic resources include the following: • ports and support facilities (repair and maintenance yards, crew service, and; support sectors); • construction facilities (platform fabrication yards, shipyards and shipbuilding yards, and pipecoating facilities and yards); • transportation (offshore support vessels, tankers, pipelines, railroads, tank trucks, and navigation channels); and • processing facilities (natural gas processing, natural gas storage, LNG, refineries, petrochemical plants, and waste management).
Other Routine Activities		
Air Emissions	3.1.8	Activities affecting air quality include vessel operations during geophysical surveys, drilling activities, platform construction and emplacement, pipeline laying and burial operations, platform operations, flaring, fugitive emissions, support vessel and helicopter operations, and evaporation of volatile organic compounds (VOCs) during transfers and spills. Activities affecting air quality onshore include emissions from new infrastructure constructed onshore and offshore activities that occur within 40 km (25 mi) of the State's boundary.
Noise	3.1.9	Acoustic sources can be described by their sound characteristics. For the regulatory process, they are generally divided into two categories: pulsed and continuous noise. Pulsed noises (e.g., explosives, airguns, and impact pile drivers) are generally considered powerful sounds with relatively short durations, broadband frequency content, and rapid rise times to peak levels. Continuous noises generally include all other noise (e.g., rotary machinery, propeller cavitation, and vibratory pile drivers), including vessel noise.
New and Unusual Technology	3.1.10	Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. The operator must identify new or unusual technology, as defined in 30 CFR § 550.200, in exploration and development plans. Some of the technologies proposed for use by the operators are actually extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by BOEM for alternative compliance or departures that may trigger additional environmental review.

3.2 ACCIDENTAL EVENTS

3.2.1 What Events Might Accidentally Occur as a Result of Operations Following a Lease Sale?

As a consequence of routine activities or operations assumed to routinely occur throughout the lifetime of lease, the potential for accidents exist. Types of reasonably foreseeable accidental events include releases into the environment (e.g., oil spills, loss of well control, accidental air emissions, pipeline failures, and chemical and drilling fluid spills), collisions (e.g., helicopter, service vessels, and platforms) and spill-response activities. Substantial preventative measures and Federal regulatory requirements from prevention to spill response, which are summarized below and described in greater detail in Chapter 3.2 of the 2017-2022 GOM Multisale EIS, are in place to mitigate these events.

3.2.1.1 Releases into the Environment

Oil Spills: Accidental releases into the environment can be caused by many factors. Oil-spill occurrence cannot be predicted, but an estimate of its likelihood can be quantified. BOEM has estimated the source and number of accidental oil spills that may occur based on the estimated volume of oil production for each program area and the assumed mode of transportation (Anderson et al., 2012). Oil-spill data indicate that the vast majority of spills reported in the Gulf of Mexico are ≤1 bbl. The most common cause of oil spills from both platforms and pipelines are hurricane related, since multiple accidental releases into the environment can occur during one hurricane event (ABS Consulting, Inc., 2016). Platform and pipeline spills include both crude oil and condensate, but platform spills may also include refined products such as diesel fuel. Crude oils are a natural mixture of hundreds of different compounds, and the chemical composition can vary significantly from different producing areas. Once spilled, oil is subject to a number of physical, chemical, and biological processes that alter its composition and that can influence spill-response activities and determine environmental impacts. Spills from pipelines are assumed to occur within their respective routes from production platform to destination. A loss of well control can occur when improperly balanced well pressure results in sudden, uncontrolled releases of fluids from a wellhead or wellbore (PCCI Marine and Environmental Engineering, 1999; Neal Adams Firefighters, Inc., 1991).

Pipeline Breaks: Substantial sources of damages to OCS pipeline infrastructure can be caused by corrosion, physical pipeline stress due to location, mass sediment movements, and mudslides that can exhume or push the pipelines into another location and by accidents due to weather or impacts from anchor drops or boat collisions.

Other Spills: Chemicals and synthetic-based drilling fluids are used in offshore oil and gas drilling and production activities, and may be spilled to the environment due to equipment failure, weather (i.e., wind, waves, and lightning), accidental collision, and human error.

Air Emissions: Accidental events associated with offshore oil- and gas-related activities can result in the emission of air pollutants. These OCS oil- and gas-related accidental events could include the release of oil, condensate, or natural gas; chemicals used offshore; pollutants from the burning of these products; fire; or H_2S release.

Trash and Debris: The policy regarding marine debris prevention is outlined in NTL 2015-BSEE-G03; however, equipment may be accidentally dropped to the seafloor or debris may be released accidentally from a platform or service vessel.

3.2.1.2 Collisions

Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. The leading causes, not all inclusive, of recent helicopter accidents were engine related, loss of control or improper procedures, helideck obstacle strikes, controlled flight into terrain, and other technical failures (Helicopter Safety Advisory Conference, 2015).

3.2.1.3 Spill Response

In some cases, response efforts can also be an impact-producing factor. Offshore removal and spill-containment efforts to respond to an ongoing spill would likely require multiple technologies, including source containment, mechanical spill containment and cleanup, *in-situ* burning of the slick, and the use of chemical dispersants. Treatment methods for spills that extend onshore to sand beaches and marshes can include manual and mechanical removal, an on-site treatment plant, and sediment relocation. In the event of a spill, there is no single method of containment and removal that would be 100-percent effective. Refer to **Chapter 3.2.3** below for more information.

3.2.2 How Many Oil Spills Could Occur as a Result of a Proposed Lease Sale?

Analysis of Offshore Spills ≥1,000 bbl

BOEM conducts an oil-spill risk analysis prior to conducting lease sales in OCS areas (refer to **Figure 3-7**). The analysis is conducted in three parts:

(1) the trajectories of oil spills from hypothetical spill locations, which are simulated using the Oil Spill Risk Analysis (OSRA) model (Smith et al., 1982);

(2) the probability of oil-spill occurrence, which is based on spill rates derived from historical data (Anderson et al., 2012) and on estimated volumes of oil produced and transported; and

(3) the combination of results of the first two to estimate the overall oil-spill risk if there is oil development.

The OSRA model simulates the trajectory of thousands of spills throughout the Gulf of Mexico OCS and calculates the probability of these spills being transported and contacting specified geographic areas and features. Using the OSRA model, BOEM estimates the likely trajectories of hypothetical offshore spills ≥1,000 bbl. Only spills ≥1,000 bbl are addressed because smaller spills may not persist long enough to be simulated by trajectory modeling. For this analysis, the OSRA model was run for Alternatives A, B, and C, and the Cumulative OCS Oil and Gas Program (2017-2086). In the GOM, the Cumulative OCS Oil and Gas Program scenario comprises all future operations that would occur over a 70-year time period (2017-2086) from existing leases from previous lease sales, currently proposed lease sales within the Five-Year Program, and future proposed regionwide lease sales.

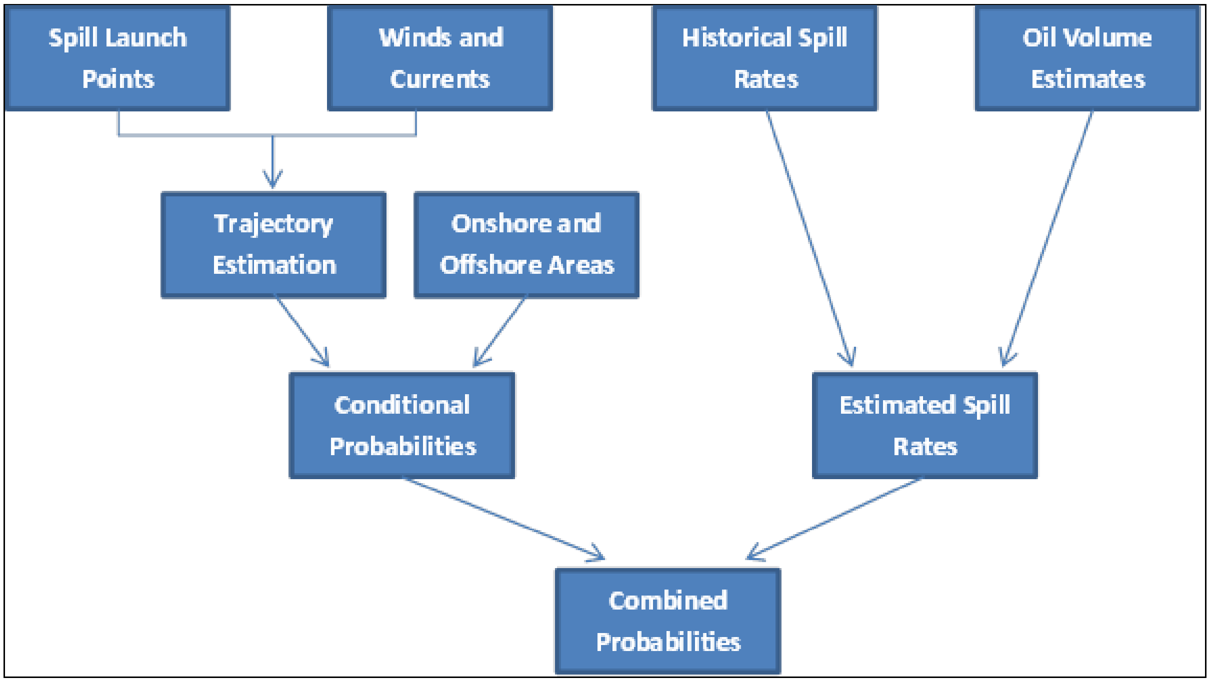


Figure 3-7. The Oil Spill Risk Analysis Model Process.

The mean number of spills estimated to occur as a result of each alternative is provided in **Table 3-10**. The range of the mean number of spills reflects the range of oil production volume estimated as a result of each alternative. The mean number of future spills ≥1,000 bbl is calculated by multiplying the spill rate by the volume of oil estimated to be produced as a result of each alternative. Spill rates were calculated based on the assumption that spills occur in direct proportion to the volume of oil handled and are expressed as number of spills per billion barrels of oil handled (spills/BBO).

Table 3-10. Mean Number and Sizes of Spills Estimated to Occur in OCS Offshore Waters from an Accident Related to Rig/Platform and Pipeline Activities Supporting Each Alternative Over a 50-Year Time Period.

Spill Size Group	Spill Rate (spills/BBO)[1]	Number of Spills Estimated			Estimated Median Spill Size (bbl)[1]
		Alternative A	Alternative B	Alternative C	
0-1.0 bbl	2,020	424-2,258	374-1,959	51-290	<1
1.1-9.9 bbl	57.4	12-64	11-56	2-9	3
10.0-49.9 bbl	17.4	4-20	3-17	1-3	
50.0-499.9 bbl	11.3	2-13	2-11	<1-2	126
500.0-999.9 bbl	1.63	<1-2	<1-2	<1	
Platforms					
≥1,000-9,999 bbl	0.25	<1	<1	<1	5,066
≥10,000 bbl	0.13	<1	<1	<1	–[2]
Pipelines					
≥1,000-9,999 bbl	0.88	<1-1	<1	<1	1,720
≥10,000 bbl	0.18	<1	<1	<1	–[2]

Notes: The number of spills estimated is derived by application of the historical rate of spills (1996-2010) per volume of crude oil handled based on the projected production for each alternative (**Table 3-3**). The actual number of spills that may occur in the future could vary from the estimated number.

[1]The spill rates presented are a sum of rates for United States OCS platforms/rigs and pipelines. The average (vs. the median) spill sizes for a larger number of spill size categories can also be found in the original source (Anderson et al., 2012).

[2]During the last 15 years, the only platform- or pipeline-related spill ≥10,000-bbl was the *Deepwater Horizon*. However, this spill is considered to be a low-probability catastrophic event, which is not reasonably foreseeable and is therefore not included.

The probabilities for oil-spill occurrence resulting from each alternative (2017-2066) and the Cumulative OCS Oil and Gas Program (2017-2086) for offshore spills ≥1,000 bbl can be found in **Table 3-11** and for spills ≥10,000 bbl in **Table 3-12**. The OSRA model estimates the chance of oil spills occurring during the production and transportation of a specific volume of oil over the lifetime of the scenario being analyzed. The estimation process uses a spill rate constant, based on historical accidental spills ≥1,000 bbl and ≥10,000 bbl, expressed as a mean number of spills per billion barrels of oil handled. For this analysis, the low estimate and high estimate of projected oil production for a single proposed lease sale for each alternative and for the Cumulative OCS Oil and Gas Program (2017-2086) are used. For more information on OCS spill-rate methodologies and trends, refer to Anderson et al. (2012). A discussion of how the range of resource estimates was developed is provided in **Chapter 3.1.2 and Table 3-6**.

Table 3-11. Oil-Spill Occurrence Probability Estimates for Offshore Spills ≥1,000 Barrels Resulting from Each Alternative (2017-2066) and the Cumulative OCS Oil and Gas Program (2017-2086).

	Forecasted Oil Production (Bbbl)[1]	Mean Number of Spills Estimated to Occur				Estimates of Probability (% chance) of One or More Spills			
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Single Proposed Lease Sale Alternatives									
Alternative A[2]	0.210	0.05	0.19	0	0.24	5	17	<0.5	21
	1.118	0.28	0.98	0.01	1.27	24	63	<0.5	72
Alternative B[3]	0.185	0.05	0.16	0	0.21	5	15	<0.5	19
	0.970	0.24	0.85	0	1.10	22	57	<0.5	67
Alternative C[4]	0.026	0.01	0.02	0	0.03	1	2	<0.5	3
	0.148	0.04	0.13	0	0.17	4	12	<0.5	15
Cumulative OCS Oil and Gas Program									
Regionwide	15.482	3.87	13.62	0.08	17.57	98	>99.5	7	>99.5
	25.806	6.45	22.71	0.13	29.29	>99.5	>99.5	12	>99.5
CPA/EPA	13.590	3.40	11.96	0.07	15.42	97	>99.5	7	>99.5
	22.381	5.60	19.70	0.11	25.40	>99.5	>99.5	11	>99.5
WPA	1.892	0.47	1.66	0	2.14	38	81	<0.5	88
	3.425	0.86	3.01	0	3.87	58	95	<0.5	98

Notes: Bbbl = billion barrels.
"Platforms" refers to facilities used in exploration, development, or production.

[1]Values represent the low and high resource estimates. Refer to **Table 3-1** for more information on resource estimates.
[2]Regionwide proposed lease sale.
[3]Regionwide proposed lease sale excluding blocks in the WPA.
[4]Regionwide proposed lease sale excluding blocks in the CPA/EPA.

Source: Ji, official communication, 2015.

Table 3-12. Oil-Spill Occurrence Probability Estimates for Offshore Spills ≥10,000 Barrels Resulting from Each Alternative (2017-2066) and the Cumulative OCS Oil and Gas Program (2017-2086).

	Forecasted Oil Production (Bbbl)[1]	Mean Number of Spills Estimated to Occur				Estimates of Probability (% chance) of One or More Spills			
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Single Sale Alternatives									
Alternative A[2]	0.210	0.03	0.04	0	0.07	3	4	<0.5	6
	1.118	0.15	0.20	0	0.35	14	18	<0.5	29
Alternative B[3]	0.185	0.02	0.03	0	0.06	2	3	<0.5	6
	0.970	0.13	0.17	0	0.30	12	13	<0.5	26
Alternative C[4]	0.026	0	0	0	0.01	<0.5	<0.5	<0.5	1
	0.148	0.02	0.03	0	0.05	2	3	<0.5	4
Cumulative OCS Oil and Gas Program									
Regionwide	15.482	2.01	2.79	0.02	4.82	87	94	2	99
	25.806	3.35	4.65	0.04	8.04	97	99	4	>99.5
CPA/EPA	13.590	1.77	2.45	0.02	4.23	83	91	2	99
	22.381	2.91	4.03	0.04	6.97	95	98	4	>99.5
WPA	1.892	0.25	0.34	0	0.59	22	29	<0.5	44
	3.425	0.45	0.62	0	1.06	36	46	<0.5	65

	Forecasted Oil Production (Bbbl)[1]	Mean Number of Spills Estimated to Occur				Estimates of Probability (% chance) of One or More Spills			
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total

Notes: Bbbl = billion barrels.
"Platforms" refers to facilities used in exploration, development, or production.
[1]Values represent the low and high resource estimates. Refer to **Table 3-1** for more information on resource estimates.
[2]Regionwide proposed lease sale.
[3]Regionwide proposed lease sale excluding blocks in the WPA.
[4]Regionwide proposed lease sale excluding blocks in the CPA/EPA.

Source: Ji, official communication, 2015.

Analysis of Offshore Spills <1,000 bbl

The number of spills <1,000 bbl estimated to occur over the next 50 years as a result of each alternative is provided in **Table 3-10**. The number of spills is estimated by multiplying the oil-spill rate for each of the different spill size groups by the projected oil production as a result of each alternative (**Tables 3-1 and 3-7**). As spill size increases, the occurrence rate decreases and so the number of spills estimated to occur decreases.

Analysis of Coastal Spills

Spills that occur in State offshore waters and/or navigation channels, rivers, and bays (coastal waters) from barges and pipelines carrying OCS-produced oil are referred to as coastal spills. These spills occur at shoreline storage, processing, and transport facilities supporting the OCS oil and gas industry. BOEM projects that most (>90%) oil produced as a result of a proposed action under Alternative A would be brought ashore via pipelines to oil pipeline shore bases, stored at these facilities, and eventually transferred via pipeline or barge to GOM coastal refineries. Because oil is commingled at shore bases and cannot be directly attributed to a particular lease sale, this analysis of coastal spills addresses spills that could occur prior to the oil arriving at the initial shoreline facility. It is also possible that non-OCS oil may be commingled with OCS oil at these facilities or during subsequent secondary transport.

According to USCG's database for the most recent 13 years (i.e., January 2002-July 2015) (USDHS, CG, 2016) (**Table 3-13**) in the waters 0-9 nmi (0-10.36 mi; 16.67 km) off the Texas coast, there were a total of 91 spills reported from 2002 to 2015 or about 7 spills <1,000 bbl/yr. In the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Louisiana coast, there were a total of more than 2,143 spills reported from 2002 to 2015, or about 165 spills <1,000 bbl/yr. In the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Mississippi coast, there were a total of 42 spills reported from all sources, or about 3.2 spills <1,000 bbl/yr. In the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Alabama coast, there were a total 2 spills reported from all sources from 2002 to 2015, or about 0.2 spills <1,000 bbl/yr. In the waters 0-9 nmi (0-10.36 mi; 16.67 km) off the Florida coast, there were a total 0 spills reported from all sources from 2002 to 2015. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODUs, and support vessels, the number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related commercial and recreational activities remain the same. The coastal waters of Louisiana, Texas, Mississippi, Alabama, and

Florida have had a total of 165, 7, 3.2, 0.2, and 0, spills <1,000 bbl/yr, respectively. Assuming future trends would reflect past historical records, it is also predicted that Louisiana will be the state most likely to have a spill ≥1,000 bbl occur in water 0-3 mi (0-5 km) offshore. Between 2002 and 2015, only two spills ≥1,000 bbl occurred in coastal waters (refer to **Table 3-13** below), and those occurred in the coastal waters of Louisiana.

Table 3-13. Historic Spill Source, Location, and Characteristics of a Maximum Spill for Coastal Waters[1] (data extracted from USDHS CG records, 2002-July 2015).

Source	Number of Spills			Maximum Volume of a Single Incident	
	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume (bbl) of Maximum Spill from the Source	Maximum Spill Amount Product/Year
Western Planning Area (WPA)[2]					
Fixed Platform	147	147	0	7.62	Crude/2005
Pipeline	0	0	0	N/A	N/A
MODU	2	2	0	4	Crude/2002
OSV	1	1	0	0.05	Crude/2014
Tank Ship or Barge	5	5	0	23.8	Crude/2009
Total	155	155	0	–	–
Central Planning Area (CPA)[2]					
Fixed Platform	2,398	2,398	0	300	Crude/2004
Pipeline	4	4	0	5	Crude/2002
MODU	28	27	1	4,928,100	Crude/2010
OSV	7	7	0	0.07	Crude 2014
Tank Ship or Barge	6	6	0	2	Crude/2013
Total	2,443	2,442	1	–	–
Eastern Planning Area (EPA)[2]					
Fixed Platform	0	0	0	N/A	N/A
Pipeline	0	0	0	N/A	N/A
MODU	0	0	0	N/A	N/A
OSV	0	0	0	N/A	N/A
Tank Ship or Barge	0	0	0	N/A	N/A
Total	0	0	0	–	–

Source	Number of Spills			Maximum Volume of a Single Incident	
	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume (bbl) of Maximum Spill from the Source	Maximum Spill Amount Product/Year
Coastal Waters: Texas					
Fixed Platform	67	67	0	20	Crude/2002
Pipeline	14	14	0	10	Crude/2005
MODU	5	5	0	0.48	Crude/2002
OSV	2	2	0	0.05	Crude/2003
Tank Ship or Barge	3	3	0	0.36	Crude/2009
Total	91	91	0	–	–
Coastal Waters: Louisiana					
Fixed Platform	2,022	2,021	1	1,200	Crude/2008
Pipeline	98	97	1	7,000	Crude/2008
MODU	4	4	0	0.24	Crude/ 2013
OSV	17	17	0	3	Crude/2013
Tank Ship or Barge	2	2	0	50	Crude/2002
Total	2,143	2,141	2	–	–
Coastal Waters: Mississippi					
Fixed Platform	1	1	0	0.001	Crude/2008
Pipeline	0	0	0	N/A	NA
MODU	0	0	0	N/A	N/A
OSV	0	0	0	N/A	N/A
Tank Ship or Barge	1	1	0	0.05	Crude/2002
Total	2	2	0	–	–
Coastal Waters: Alabama					
Fixed Platform	2	2	0	0.024	Crude/2007
Pipeline	0	0	0	N/A	N/A
MODU	0	0	0	N/A	N/A
OSV	0	0	0	N/A	N/A
Tank Ship or Barge	0	0	0	N/A	N/A
Total	2	2	0	–	–

Source	Number of Spills			Maximum Volume of a Single Incident	
	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume (bbl) of Maximum Spill from the Source	Maximum Spill Amount Product/Year
Coastal Waters: Florida					
Fixed Platform	0	0	0	N/A	N/A
Pipeline	0	0	0	N/A	N/A
MODU	0	0	0	N/A	N/A
OSV	0	0	0	N/A	N/A
Tank Ship or Barge	0	0	0	N/A	N/A
Total	0	0	0	–	–

bbl = barrel; MODU = mobile offshore drilling unit; N/A = not applicable; OSV = offshore support vessel.

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

[1]Coastal Waters – the portion of the Gulf of Mexico under State jurisdiction that begins at the coastline and ends at the Federal/State boundary 9 nmi (10.36 mi; 16.67 km) offshore Texas; 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama; and 9 nmi (10.36 mi; 16.67 km) offshore West Florida.

[2]The database included represents spill events from January 2002 until July 2015.

3.2.3 What is the Response to Accidental Events?

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. It is likely that larger spills under the right conditions would require the simultaneous use of all available cleanup methods (i.e., source containment, mechanical spill containment and cleanup, dispersant application, and *in-situ* burning). There are many situations and environmental conditions that necessitate different approaches. Spill cleanup is a complex and evolving technology. Each new tool then becomes part of the spill-response tool kit. Each spill-response technique/tool has its specific uses and benefits (Fingas, 1995). Offshore removal and spill-containment efforts to respond to an ongoing spill offshore would likely require multiple technologies, including source containment, mechanical spill containment and cleanup, *in-situ* burning of the slick, and the use of 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 can be contained and removed offshore.

The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods and, in many cases, the cleanup is more damaging than allowing natural recovery. Refer to Chapter 3.2.8 of the 2017-2022 GOM Multisale EIS for more information on specific spill-response techniques. For information on the effects of spill-response activity, refer to Chapter 4 of the 2017-2022 GOM Multisale EIS.

Within BSEE, the Oil Spill Preparedness Division addresses all aspects of oil-spill planning and preparedness. Additional information about the Oil Spill Preparedness Division can be found on BSEE's website at http://www.bsee.gov/About-BSEE/Divisions/OSPD/index/. BOEM receives and reviews the worst-case discharge information submitted for EPs, development and production plans (DPPs), and DOCDs on the OCS. BOEM also has regulatory requirements addressing site-specific, oil-spill response plans (OSRPs). As required by BOEM at 30 CFR §§ 550.219 and 550.250, operators are required to provide BOEM with an OSRP that is prepared in accordance with 30 CFR part 254 subpart B with their proposed exploration, development, or production plan for the facilities that they will use to conduct their activities or to alternatively reference their approved regional OSRP. Refer to Chapter 3.2.8 of the 2017-2022 GOM Multisale EIS for more information.

3.2.4 Summary of Accidental Impact-Producing Factors

Table 3-14 below outlines the impact-producing factors from initial exploration to decommissioning for accidental oil and gas events. **Table 3-15** provides a general description of all accidental events that could occur during the lifetime of a lease.

Table 3-14. Summary of the Timing of Impact-Producing Factors Associated with Accidental Oil and Gas Events.

Impact-Producing Factors and Activities	Exploration		Development	Production	Decommissioning
	Geological and Geophysical Survey	Exploration and Delineation Drilling			
Oil Spills	–	X	X	X	X
Offshore Spills ≥1,000 bbl	–	X	X	X	X
Offshore Spills <1,000 bbl	–	X	X	X	X
Coastal Spills	X	X	X	X	X
Loss of Well Control	-	X	X	X	X
Accidental Air Emissions	X	X	X	X	X
Pipeline Failures	-	X	X	X	X
Vessel or Helicopter Collisions	X	X	X	X	X
Chemical and Drilling Fluid Spills	X	X	X	X	X
Wastes and Debris	X	X	X	X	X
Spill Response*	X	X	X	X	X

*Spill response can occur as a result of chemical or fuel spills as well as oil spills.

Table 3-15. General Description of Accidental Event Impact-Producing Factors.

	Multisale EIS Chapter Reference	General Description
Oil Spills	3.2.1	As a consequence of activities related to the exploration, development, production, and transportation of oil and gas, the potential for accidental releases exists. Petroleum spills include crude oil, condensate, and refined products such as diesel, hydraulic oil, lube oil and mineral oil. Spills from facilities include drilling rigs, drillships, and storage, processing, or production operations, while spills from pipelines are those that occur on the OCS and are directly attributable to the transportation of OCS oil. BOEM uses the Oil Spill Risk Analysis (OSRA) model to simulate the trajectory of thousands of hypothetical spills ≥1,000 bbl throughout the Gulf of Mexico OCS and calculates the probability of these spills being transported and contacting specified geographic areas and features. Additionally, the OSRA model calculates combined probabilities by multiplying the probability of contact by the probability of a spill occurring as a result of a proposed action. A more thorough discussion of oil spills and the OSRA model can be found in the chapters above and in Chapter 3.2.1 of the 2012-2022 GOM Multisale EIS.
Loss of Well Control	3.2.2	Operators are required to document any loss of well control event, even if temporary, and the cause of the event by mail or email to the addressee indicated in NTL 2010-N05. The operator does not have to include kicks that were controlled but should include the release of fluids through a flow diverter (a conduit used to direct fluid flowing from a well away from the drilling rig). The current definition for loss of well control is as follows: • uncontrolled flow of formation or other fluids (the flow may be to an exposed formation [an underground blowout] or at the surface [a surface blowout]); • uncontrolled flow through a diverter; and/or • uncontrolled flow resulting from a failure of surface equipment or procedures. Not all loss of well control events would result in a blowout as defined above. A loss of well control is most commonly thought of as a release to the human environment. A loss of well control can occur during any phase of development, i.e., exploratory drilling, development drilling, well completion, production, or workover operations. A loss of well control can occur when improperly balanced well pressure results in sudden, uncontrolled releases of fluids from a wellhead or wellbore (PCCI Marine and Environmental Engineering, 1999; Neal Adams Firefighters, Inc., 1991). Of the 48 loss of well control events reported in the GOM from 2007 to August 2015, 25 (52%) resulted in loss of fluids at the surface or underground (USDOI, BSEE, 2016a).
Accidental Air Emissions	3.2.3	Accidental events associated with offshore oil- and gas-related activities can result in the emission of air pollutants. These OCS oil- and gas-related accidental events could include the release of oil, condensate, or natural gas; chemicals used offshore; pollutants from the burning of these products; fire; or H_2S release. The air pollutants could include National Air Ambient Quality Standards criteria pollutants, volatile and semi-volatile organic compounds, hydrogen sulfide, and methane. Emissions sources related to accidents from OCS operations can include well blowouts, oil spills, pipeline breaks, tanker accidents, and tanker explosions.
Pipeline Failures	3.2.4	Significant sources of damages to OCS pipeline infrastructure can be caused by corrosion (Chapters 3.1.3.3.1 and 3.1.6.1 of the 2012-2022 GOM Multisale EIS), physical pipeline stress due to location, mass sediment movements and mudslides that can exhume or push the pipelines into another location, and accidents due to weather or impacts from anchor drops or boat collisions.
Vessel or Helicopter Collisions	3.2.5	From 2007 to 2014, there were 137 OCS oil- and gas-related vessel collisions (USDOI, BSEE, 2015). Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10% of vessel collisions with platforms in the OCS caused diesel spills. Fires resulted from hydrocarbon releases in several of the collision incidents.

Table 3-15. General Description of Accidental Event Impact-Producing Factors. (continued).

	Multisale EIS Chapter Reference	General Description
		The average number of helicopter accidents per year in the GOM since 1984 has been 7.9 per year, with the last 10 years averaging 4.7 per year and with only 2 in 2014. The 2014 GOM oil industry helicopter accident rate per 100,000 flight hours was 0.68, with a total of 2 accidents compared with a 31-year annual average accident rate of 1.74. The fatal accident rate per 100,000 flight hours during 2014 was 0.34 compared with a 31-year average of 0.44 (Helicopter Safety Advisory Conference, 2015).
Chemical and Drilling Fluid Spills	3.2.6	Chemicals and synthetic-based drilling fluids are used in offshore oil and gas drilling and production activities, and may be spilled to the environment due to equipment failure, weather (i.e., wind, waves, and lightning), accidental collision, and human error.
Wastes and Debris	3.2.7	The BSEE policy regarding marine debris prevention is outlined in NTL 2015-BSEE-G03, "Marine Trash and Debris Awareness and Elimination." This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harms of discharging marine debris
Spill Response		
BSEE-Spill Response Requirements	3.2.8.1	As a result of the Oil Pollution Act of 1990 and the reorganization of the Bureau of Ocean Energy Management, Regulation and Enforcement into BOEM and BSEE, BSEE was tasked with a number of oil-spill response duties and planning requirements. Within BSEE, the Oil Spill Preparedness Division addresses all aspects of offshore oil-spill planning, preparedness, and response. Additional information about the Oil Spill Preparedness Division can be found on BSEE's website at http://www.bsee.gov/About-BSEE/Divisions/OSPD/index/. The BSEE implements the following regulations according to 30 CFR parts 250 and 254: • requires immediate notification for spills >1 bbl—all spills require notification to USCG, and BSEE receives notification from USCG of all spills ≥1 bbl; • conducts investigations to determine the cause of a spill; • assesses civil and criminal penalties, if needed; • oversees spill source control and abatement operations by industry; • sets requirements and reviews and approves OSRPs for offshore facilities (More information on oil-spill response plan regulations and processes can be found in Appendix A.5 of the 2017-2022 GOM Multisale EIS.); • conducts unannounced drills to ensure compliance with OSRPs; • requires operators to ensure that their spill-response operating and management teams receive appropriate spill-response training; • conducts inspections of oil-spill response equipment; • requires industry to show financial responsibility to respond to possible spills; and • provides research leadership to improve the capabilities for detecting and responding to an oil spill in the marine environment.
Offshore Response	3.2.8.2	It is likely that larger spills under the right conditions would require the simultaneous use of all available cleanup methods (i.e., source containment, mechanical spill containment and cleanup, dispersant application, and *in-situ* burning).
Onshore Response	3.2.8.3	Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline, it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate Area Contingency Plans for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods and, in many cases, the cleanup is more damaging than allowing natural recovery.

3.3 CUMULATIVE IMPACTS

3.3.1 What Activities, Not Considered a Part of a Proposed Action, has BOEM Considered?

A cumulative impact "results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR § 1508.7). The scope of a proposed action is important to consider in a broader context that accounts for the full range of actions and associated impacts taking place within the Gulf of Mexico, currently and into the foreseeable future. Repeated actions, even minor ones, may produce significant impacts over time.

The cumulative impacts assessment focuses on the resources, ecosystems, and human communities that may be affected by the incremental impacts associated with a proposed action (under any of the action alternatives), in combination with other past, present, and reasonably foreseeable future actions. Cumulative impacts on a given resource, ecosystem, or human community may result from single actions or a combination of multiple actions over time. They may be additive, less than additive (countervailing), or more than additive (synergistic).

Many of the past, present, and reasonably foreseeable future actions and trends that would contribute to cumulative impacts under a proposed action's alternatives also contribute to cumulative impacts under the No Action Alternative (Alternative E). Under Alternative E, a proposed action (i.e., a single proposed OCS oil and gas lease sale) would not occur and, as a result, energy could be obtained from other sources to replace the lost oil and gas production. The opportunity for development of the estimated oil and gas that could have resulted from a proposed action (i.e., a single proposed lease sale) or alternative to a proposed action, as described above, would be precluded or postponed to a future lease sale. As a result, a separate treatment of the cumulative effects under Alternative E is not considered here.

3.3.2 Summary of Cumulative Activities

3.3.2.1 Cumulative OCS Oil and Gas Program Scenario

The Cumulative OCS Oil and Gas Program scenario includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales. This includes projected activity from (1) past lease sales for which exploration or development has either not yet begun or is continuing; (2) lease sales that would be held in the 2017-2022 Five-Year Program; and (3) future lease sales that would be held as a result of future Five-Year Programs (4 additional programs are included in this cumulative analysis). This equates to a 70-year timeframe or 2017-2086 and includes a 50-year analysis period (2017-2066) for a single proposed lease sale (e.g., Lease Sale 250). Activities that take place as a result of Five-Year Programs beyond the next four programs are not included in this analysis.

It is reasonably foreseeable to assume that lease sales would continue to be proposed for many years to come in the Gulf of Mexico region based on resource availability, existing infrastructure, and projected time lapses required for any other major energy sources to come online. For the purposes of conducting cumulative impact analyses here, even though additional NEPA reviews would be required, four additional Five-Year Programs are assumed to occur (an additional 20 years of proposed lease sales), resulting in activities that could occur over the next 70 years. However, the level of activities (i.e., exploration wells, production wells, and pipelines) becomes more speculative as time is projected into the future. The causes for this are a number of things, including uncertainty in oil prices, resource potential, and cost of development and resource availability (e.g., drilling rig availability) versus the amount of acreage leased from a lease sale.

Therefore, these scenarios do not predict future OCS oil- and gas-related activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. These scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknowns. Notwithstanding these unpredictable factors, the scenarios used in this Supplemental EIS represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses. The development scenarios do not represent BOEM's recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities for future programs. Methodologies for the Cumulative OCS Oil and Gas Program scenario are similar to those for a regionwide or individual planning area typical lease sale scenario analysis and are described in detail in **Chapter 3.0** above. **Tables 3-16 and 3-17** present projections of the major activities and impact-producing factors related to future Cumulative OCS Oil and Gas Program activities.

Table 3-16 Future Activity Projections Associated with the Cumulative OCS Oil and Gas Program (2017-2086), Including All Future Activities that are Projected to Occur from Past, Proposed, and Future Lease Sales.

Activity	Planning Area		Offshore Subareas (m)[1]						Totals[2]
			0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Exploration and Delineation Wells	GOM		939-2,562	253-1,166	110-170	153-240	97-278	119-301	1,671-4,717
	CPA/EPA		775-1,999	202-1,007	83-142	88-184	70-142	99-211	1,317-3,685
	WPA		164-563	51-159	27-28	65-56	27-136	20-90	354-1,032
Development and Production Wells[3]	GOM	Total	4,050-9,225	1,570-4,324	912-2,034	617-1,127	446-723	633-985	8,238-18,418
		Oil	438-987	164-453	446-993	280-487	230-372	310-482	1,868-3,774
		Gas	2,440-5,566	894-2,457	186-415	149-288	79-126	126-194	3,874-9,046
	CPA/EPA	Total	3,170-6,634	1,139-3,558	676-1,557	490-779	405-623	595-899	6,475-14,050
		Oil	354-740	122-379	326-750	240-385	207-319	289-437	1,538-3,010
		Gas	1,898-3,972	645-2,015	142-327	95-152	72-110	119-179	2,971-6,755

Activity	Planning Area		Offshore Subareas (m)[1]						Totals[2]
			0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
	WPA	Total	880-2,591	431-766	236-477	137-348	41-100	38-86	1,763-4,368
		Oil	84-247	42-74	120-243	40-102	23-53	21-45	330-764
		Gas	542-1,594	249-442	44-88	54-136	7-16	7-15	903-2,291
Installed Production Structures	GOM		2,168-5,121	558-1,638	36-71	26-38	16-38	23-42	2,827-6,948
	CPA/EPA		1,760-3,682	432-1,347	23-54	17-26	14-21	20-30	2,266-5,160
	WPA		408-1,439	126-291	13-17	9-12	2-17	3-12	561-1,788
Production Structures Removed Using Explosives	GOM		2,435-4,388	568-1,310	0	0	0	0	3,003-5,698
	CPA/EPA		2,051-3,315	440-1,065	0-0	0-0	0-0	0-0	2,491-4,380
	WPA		384-1,073	128-245	0-0	0-0	0-0	0-0	512-1,318
Total Production Structures Removed	GOM		3,381-6,148	784-1,796	39-69	36-44	20-33	21-31	4,281-8,121
	CPA/EPA		2,847-4,639	608-1,459	26-54	25-31	17-22	18-24	3,541-6,229
	WPA		534-1,509	176-337	13-15	11-13	3-11	3-7	740-1,892
Length of Installed Pipelines (km)[4]	GOM		2,181-15,822	1,432-10,511	1,078-8,037	1,268-8,265	700-7,001	704-7,359	7,363-56,995
	CPA/EPA		586-11,799	388-8,355	328-6,390	385-6,381	364-6,168	405-6,750	2,456-45,843
	WPA		1,595-4,023	1,044-2,156	750-1,647	883-1,884	336-833	299-609	4,907-11,152
Service-Vessel Trips (1,000's round trips)	GOM		2,443-6,998	645-2,300	284-942	213-556	134-498	187-577	3,909-11,873
	CPA/EPA		1,978-5,037	496-1,892	186-722	140-389	115-306	163-440	3,079-8,788
	WPA		465-1,960	150-408	98-221	72-167	19-192	23-137	830-3,085
Helicopter Operations (1,000's round trips)	GOM		11,714-55,063	4,511-25,155	270-1,162	183-651	139-422	183-546	17,000-83,000
	CPA/EPA		9,614-40,734	3,544-21,159	191-898	148-440	121-352	165-475	13,786-64,059
	WPA		2,098-14,329	966-3,996	78-264	34-211	17-70	17-70	3,214-18,941

[1]Refer to **Figure 3-1**.
[2]Subareas totals may not add up to the planning area total because of rounding.
[3]Development and Production Wells include some exploration wells that were re-entered and completed. These wells were removed from the Exploration and Delineation well count.
[4]Projected length of pipelines does not include length in State waters.

Table 3-17. Future Oil Transportation Projections Associated with the Cumulative OCS Oil and Gas Program (2017-2086), Including All Future Transportation that is Projected to Occur from Past, Proposed, and Future Lease Sales.

Activity	Region	Offshore Subareas (m)[1]						Totals[2]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Percent Oil Piped[3]	GOM	94-95%	100%	100%	100%	89.6-87.4%	87.4-85.7%	91.6-90.6%
	CPA/EPA	94-95%	100%	100%	100%	97.8-96.3%	94.9-95.3%	90.8-91.0%
	WPA	100%	100%	100%	100%	100-89%	100-86.4%	100-95.1%
Percent Oil Barged	GOM	6-5%	0%	0%	0%	0%	0%	0.2%
	CPA/EPA	6-5%	0%	0%	0%	0%	0%	0.2%
	WPA	0%	0%	0%	0%	0%	0%	0%
Percent Tankered[4]	GOM	0%	0%	0%	0%	10.4-12.6%	12.6-14.3%	8-9%
	CPA/EPA	0%	0%	0%	0%	12.2-13.7%	5.1-4.7%	9-8.75%
	WPA	0%	0%	0%	0%	0-11%	0-13.6%	0-4.85%

[1]Refer to **Figure 3-1**. Ranges are reported from the low production case scenario to the high production case scenario.
[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 (5,249 ft).

3.3.2.2 Non-OCS Oil- and Gas-Related Impact-Producing Factors

The impact-producing factors considered in this chapter are defined as other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as the aforementioned projected routine activities and potential accidental events, but they are not related to the Cumulative OCS Oil and Gas Program. **Table 3-18** below summarizes other impact-producing factors that could potentially affect an environmental or socioeconomic resource in addition to OCS oil- and gas-related activity.

While the scenario developed for the Cumulative OCS Oil and Gas Program scenario forecasts 70 years of activities, the scenarios developed as part of this chapter vary in the length of time projected depending on what would be considered reasonably foreseeable by impact-producing factors based on the data available and the ability to predict future actions without being speculative.

Table 3-18. General Description of Cumulative Non-OCS Oil- and Gas-Related Impact-Producing Factors.

Impact-Producing Factor and Specific Sources	Multisale EIS Chapter Reference	General Description
State Oil and Gas Activity		
State Oil and Gas Activity	3.3.2.1	All of the five Gulf Coast States have had some historical oil and gas exploration activity and, with the exception of Florida and Mississippi, all currently produce oil and gas in State waters. The coastal infrastructure that supports the OCS Program also supports State oil and gas activities. State oil and gas infrastructure consists of the wells that extract hydrocarbon resources, facilities that produce and treat the raw product, pipelines that transport the product to refineries and gas plants for further processing, and additional pipelines that transport finished product to points of storage and final consumption. The type and size of infrastructure that supports production depends upon the size, type, and location of the producing field, the time of development, and the life cycle stage of operations.
Pipeline Infrastructure	3.3.2.1.1	The existing pipeline network in the Gulf Coast States is the most extensive in the world and has unused capacity (Cranswick, 2001). The network carries oil and gas onshore and inland to refineries and terminals, and a network of pipelines distributes finished products such as diesel fuel or gasoline to and between refineries and processing facilities onshore (Peele et al., 2002, Figure 4.1). Expansion of this network is projected to be primarily small-diameter pipelines to increase the interconnectivity of the existing network and a few major interstate pipeline expansions. However, there is spare capacity in the existing pipeline infrastructure to move oil and gas to market, and deepwater ports can serve onshore facilities, including intrastate as well as interstate pipelines.
Artificial Reefs	3.3.2.1.2	The OCSLA and implementing regulations establish decommissioning obligations for lessees, including the removal of platforms. The Rigs-to-Reefs Policy provides a means by which lessees may request a waiver to the removal requirement. For additional information, refer to Chapter 3.1.6.2 of the 2017-2022 Gulf of Mexico Multisale EIS. Since the first Rigs-to-Reefs conversion, approximately 11% of the platforms decommissioned from the Gulf of Mexico OCS have been redeployed within designated State artificial reefs. Scientific and public interest in the ecology of offshore structures and the potential benefits of contributing hard substrate to a predominantly soft bottom environment have led to increased emphasis on the development of artificial reefs. The current paradigm posits oil and gas structures act as both fish-attracting and production-enhancing devices, depending upon the species (Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009; Dance et al., 2011). However, determination of specific and cumulative impacts resulting from the construction of artificial reefs within permitted areas is very difficult. As recommended by the National Artificial Reef Plan (USDOC, NOAA, 2007), well-defined objectives, clear management strategies, and long-term monitoring are critical elements of an artificial reef program and are necessary if managers intend to use artificial reefs as a fisheries management tool.
Marine Vessel Activity		
Marine Transportation	3.3.2.2	Non-OCS oil- and gas-related vessels, other than above, utilize the GOM. These ships include research, recreational, and commercial vessels. Commercial and recreational fishing in the Gulf of Mexico are regulated by NMFS. For more information on recreational fishing vessels, refer to Chapter 4.11 of the 2017-2022 GOM Multisale EIS. For more information on commercial fishing vessels, refer to Chapter 4.10 of the 2017-2022 GOM Multisale EIS. Research activities, including surveys, genetic research, capture, relocation, or telemetric monitoring, may affect organisms or ecosystems in the GOM. The OCS oil- and gas-related vessels are required to survey for undiscovered archaeological and biological resources; however, these resources may be damaged by anchors of non-OCS oil- and gas-related vessels that do not perform surveys. Non-OCS oil- and gas-related tankering includes ships carrying crude or ships

Table 3-18. General Description of Cumulative Non-OCS Oil- and Gas-Related Impact-Producing Factors. (continued).

Impact-Producing Factor and Specific Sources	Multisale EIS Chapter Reference	General Description
		carrying product. Overall, tankering (including U.S. ships and foreign ships) in the U.S. increased by 28% between 2003 and 2011 (USDOT, MARAD, 2013). While U.S. tankering port of calls declined between 2003 and 2011, foreign ship tankering port of calls increased. Due to the double-hulled ships' ability to reduce or prevent oil spills and as part of the OPA requirements, double-hulled ships have replaced almost all single-hulled ships. In 2003, 60-70% of all tankers were double hulled, but by 2011, 97-100% of all tankers were double hulled.
Non-OCS Oil- and Gas-Related Wastes		
Shipwrecks	3.3.2.3.1	There are thousands of shipwrecks in U.S. waters. Some of the vessels involved in those wrecks are likely to contain oil, as fuel and possibly cargo, and may eventually result in pollution to the marine environment. Warships and cargo vessels sunk in wartime may also contain munitions, including explosives and chemical warfare agents, which may pose a continued threat because of their chemical composition.
Discharges Associated with Military Activities	3.3.2.3.2	Between the years of 1995 through 1999, Eglin Air Force Base in Florida conducted nearly 39,000 training sorties per year in the eastern Gulf. Potential impacts from these activities are discussed in the *Eglin Gulf Test and Training Range: Final Programmatic Environmental Assessment* (Air Force Air Armament Center, 2002). These military activities may result in marine impacts from chaff, fuel releases, flares, chemical materials, and debris.
Chemical Weapon Disposal	3.3.2.3.3	After World War I, chemical weapons were routinely disposed of in the world's oceans, including the GOM. In some instances, conventional explosives and radiological wastes were dumped along with chemical weapons. Army records document several instances of mustard and phosgene bombs being disposed of in the Gulf of Mexico, originating from New Orleans, Louisiana, and Mobile, Alabama. Chemical weapons disposed of in other locations, and potentially in the Gulf of Mexico, contained hydrogen cyanide, arsenic trichloride, cyanogen chloride, lewisite, tabun, sarin, and VX (Bearden, 2007).
Industrial Waste Dumping	3.3.2.3.4	Between 1940 and 1970, certain offshore locations of the United States were used for the disposal of various industrial wastes and low-level radioactive wastes, these activities being large, unrecorded, and unregulated (USDOC, NOAA, 2004).
Dredged Material Disposal	3.3.2.3.5	Dredged material is described in 33 CFR part 324 as any material excavated or dredged from navigable waters of the United States. Materials from maintenance dredging are primarily disposed of offshore on existing dredged-material disposal areas and in ocean dredged-material disposal sites (ODMDSs). Additional dredged-material disposal areas for maintenance or new project dredging are developed as needed and must be evaluated and permitted by the U.S. Army Corps of Engineers (COE) and relevant State agencies prior to construction. The ODMDSs are regulated by the USEPA under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act. BOEM anticipates that, over the next 70 years, the amount of dredged material disposed of at ODMDSs would fluctuate, generally within the trends established by COE's district offices.
Land-Based Discharges	3.3.2.3.6	As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating point sources on land that discharge pollutants into waters of the United States. Point sources are discrete conveyances (outfalls) such as pipes or manmade ditches that may contain process water flows and/or precipitation from impervious surfaces. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In most cases, the NPDES permit program is administered by authorized states (USEPA, 2015a).
Trash and Debris	3.3.2.3.7	Marine debris originates from both land-based and ocean-based sources. Forty-nine percent of marine debris originates from land-based sources, 18% originates from ocean-based sources, and 33% originates from general sources (sources that are a combination of land-based and sea-based activities) (USEPA, 2009a).

Table 3-18. General Description of Cumulative Non-OCS Oil- and Gas-Related Impact-Producing Factors. (continued).

Impact-Producing Factor and Specific Sources	Multisale EIS Chapter Reference	General Description
Other Non-OCS Oil- and Gas-Related Activities		
Non-OCS Oil- and Gas-Related Spills	3.3.2.4	The National Research Council (2003) computed petroleum hydrocarbon inputs into North American marine waters for several major categories. The results show that three activities – extraction, transportation, and consumption – are the main sources of anthropogenic petroleum hydrocarbon pollution in the sea.
Air Emissions	3.3.2.5	Air emissions are caused by non-OCS onshore oil and gas activities and offshore State oil and gas activities, including combustion sources from power and heat generation, and the use of compressors, pumps, and reciprocating engines (i.e., boilers, turbines, and other engines); emissions resulting from flaring and venting of gas; and fugitive emissions. Non-OCS oil- and gas-related activities can also include emissions from commercial and home heating, naturally occurring forest fires, motor vehicles, industrial activities in territorial seas and coastal waters, and industrial and transportation activities onshore.
Noise	3.3.2.7	Other noise sources in the GOM are from non-OCS oil- and gas-related activities: vessel propeller cavitation from commercial shipping vessels, research vessels, tourism vessels, and commercial and recreational fishing vessels; sources from other equipment used on vessels (e.g., pingers used in fisheries to prevent animals getting caught in nets); State drilling operations; aircraft; military operations; coastal infrastructure construction (e.g., pile driving); underwater explosions; and natural phenomena such as wind, large storms, or lightning strikes. It is not under BOEM's authority to regulate any of these non-OCS oil- and gas-related noise sources, although some do occur on the OCS.
Military Warning and Water Test Areas	3.3.2.6.1	The Gulf of Mexico (GOMEX) Range Complex contains four separate operating areas: Panama City and Pensacola, Florida; New Orleans, Louisiana, and Corpus Christi, Texas. The operating areas within the GOMEX Range Complex are not contiguous but are scattered throughout the GOM. The GOMEX Range Complex includes special-use airspace with associated warning areas and restricted airspace, and surface and subsurface sea space of the four operating areas. The air space over the GOM is used by the Department of Defense for conducting various military operations. Twelve military warning areas and six Eglin Water Test Areas are located within the GOM (**Figure 2-7**). These military warning areas and Eglin Water Test Areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years. Several military stipulations are planned for leases issued within identified military areas.
Offshore Deepwater Ports and LNG Terminals	3.3.2.6.2	Deepwater ports are designed to provide access for tankers and LNG carriers to offshore offloading facilities for hydrocarbon products, i.e., crude oil and natural gas. Crude oil passing through an offshore port may be temporarily stored and then transported to shore via pipeline. The term "deepwater port" includes all associated components and equipment, including pipelines, pumping stations, service platforms, mooring buoys, and similar features or equipment to the extent that they are located seaward of the high water mark (USDOT, MARAD, 2015). The LNG terminal means all natural gas facilities located onshore or nearshore (in State waters) that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is imported to the U.S. from a foreign country, exported to a foreign country from the U.S., or transported in interstate commerce by a waterborne vessel.
Gas Hydrates	3.3.2.6.3	Methane hydrates (or gas hydrates) are cage-like lattices of water molecules containing methane, the chief constituent of natural gas found under arctic permafrost, as well as beneath the ocean floor. These may represent one of the world's largest reservoirs of carbon-based fuel. BOEM anticipates that, over the next 40 years, the Joint Industry Project would complete the third leg of its characterization project for GOM gas hydrates in the cumulative impacts area. Within 40 years, it is likely that the first U.S. domestic production from hydrates may occur in Alaska, where gas obtained from onshore hydrates would either support local oil and gas field operations or be available for commercial sale if and when a gas pipeline is constructed to the lower 48 states. However, it is not possible to discount the

Table 3-18. General Description of Cumulative Non-OCS Oil- and Gas-Related Impact-Producing Factors. (continued).

Impact-Producing Factor and Specific Sources	Multisale EIS Chapter Reference	General Description
		possibility that first U.S. domestic production of gas hydrates could occur in the GOM.
Renewable Energy	3.3.2.6.4	The two primary categories of renewable energy that have the potential for development in the coastal and OCS waters of the U.S. are wind turbines and marine hydrokinetic systems. The first and most technologically mature renewable energy is wind energy, a popular source of clean and renewable energy that has been in use for centuries.
Aquaculture	3.3.2.6.5	Offshore aquaculture is the rearing of aquatic animals in controlled environments (e.g., cages or net pens) in Federal waters. The NOAA has published the rule to implement a Fishery Management Plan for regulating offshore aquaculture in the Gulf of Mexico (*Federal Register*, 2016a). The rule establishes a comprehensive regulatory program for managing the development of an aquaculture industry in Federal waters of the Gulf of Mexico.
OCS Sand Barrowing	3.3.2.6.6	If OCS sand is desired for coastal restoration or beach nourishment, BOEM uses the following two types of lease conveyances: a noncompetitive negotiated agreement that can only be used for obtaining sand and gravel for public works projects funded in part or whole by a Federal, State, or local government agency; and a competitive lease sale in which any qualified person may submit a bid. BOEM has issued 51 noncompetitive negotiated agreements but has never had a competitive lease sale for OCS sand and gravel resources. BOEM's Marine Minerals Program continues to focus on identifying sand resources for coastal restoration, investigating the environmental implications of using those resources, and processing noncompetitive use requests.
Coastal Environments		
Sea-Level Rise	3.3.2.8.1	As part of the Mississippi River's delta system, both the Delta Plain and the Chenier Plain of the Louisiana Coastal Area (LCA) are experiencing relatively high rates of subsidence. An absolute sea-level rise would be caused by the following two main contributors to the volume of ocean water on the Earth's surface: (1) change in the volume of ocean water based on temperature; and (2) change in the amount of ice locked in glaciers, mountain ice caps, and the polar ice sheets. For the period 1961-2003, thermal expansion of the oceans accounts for only 23 ± 9% of the observed rate of sea-level rise (Bindoff et al., 2007); the remainder is water added to the oceans by melting glaciers, ice caps, and the polar ice sheets. The lowest rate of rise is found in Panama City, Florida, with a rate of 1.6 mm/yr or 0.53 ft/century. Given this range, BOEM anticipates that, over the next 50 years, the northern GOM would likely experience a minimum relative sea-level rise of 80.7 mm (3.18 in) and a maximum relative sea-level rise of 482.6 mm (19.0 in). Sea-level rise and subsidence together have the potential to affect many important areas, including the OCS oil and gas industry, waterborne commerce, commercial fishery landings, and important habitat for biological resources (State of Louisiana, Coastal Protection and Restoration Authority, 2012a).
Erosion	3.3.2.8.2	BOEM conservatively estimates that there are approximately 4,850 km (3,013 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic regionwide (Table 3-7 of the 2017-2022 GOM Multisale EIS) and that the average canal is widening at a rate of 0.99 m/year (3.25 ft/year) (Thatcher et al., 2011). Regionwide, this results in a total annual land loss of approximately 480 ac/yr (1,186 ha/yr).
Coastal Restoration Programs	3.3.2.8.3	Coastal Louisiana wetlands make up the seventh largest delta on Earth and undergo about 90% of the total coastal wetland loss in the continental United States. In fact, from 1932 to 2010, coastal Louisiana has undergone a net change in land area of about 1.2 million ac (0.48 million ha). The first systematic program authorized for coastal restoration in the LCA was the 1990 Coastal Wetlands Planning, Protection and Restoration Act, otherwise known as the "Breaux Act." The projects included in the Louisiana Coastal Master Plan have the potential to build between 580 and 800 mi^2 (1,502 and 2,072 km^2) of land over the next 50 years, depending on future coastal conditions. The Coastal Impact Assistance Program provides Federal grant funds derived from Federal offshore lease revenues to oil-producing states for conservation, protection, or restoration of coastal areas. The Natural Resource Damage Assessment Trustee Council has a statutory responsibility to assess natural resource damages from the *Deepwater Horizon* oil spill, restore

Table 3-18. General Description of Cumulative Non-OCS Oil- and Gas-Related Impact-Producing Factors. (continued).

Impact-Producing Factor and Specific Sources	Multisale EIS Chapter Reference	General Description
		trust resources, and seek compensation for lost use of those trust resources.
Saltwater Intrusion	3.3.2.8.4	Saltwater intrusion is one of many factors that impact coastal environments, contributing to coastal land loss. Such impacts can be natural, as when storm surge brings GOM water inland, or anthropogenic, as when navigation or pipeline canals allow tides to introduce high salinity water to interior marshes.
Maintenance Dredging	3.3.2.8.5	Along the Texas Coast there are eight federally maintained navigation channels in addition to the Gulf Intracoastal Waterway. Most of the dredged materials from the Texas channels have high concentrations of silt and clay. Beneficial uses of dredged material include beach nourishment for the more sandy materials and storm reduction projects or ocean disposal for much of the finer-gained material. Current figures estimate that approximately 38% of that average is available for the beneficial use of the dredge materials program (U.S. Dept. of the Army, COE, 2013). The COE reported that, over the last 20 years, approximately 12,545 ha (31,000 ac) of wetlands have been created with dredged materials, most of which are located on the LCA delta plain (U.S. Dept. of the Army, COE, 2013). The remaining material is disposed of in areas described in the dredged material disposal chapter of the 2017-2022 GOM Multisale EIS (i.e., Chapter 3.3.2.3.5).
Natural Events and Processes		
Physical Oceanography	3.3.2.9.1	Physical oceanographic processes in the GOM include the Loop Current, Loop Current eddies, and whirlpool-like features that appear underneath the Loop Current and Loop Current eddies that interact with the bottom. Infrequently observed processes include a limited number of high-speed current events, at times approaching 100 cm/s (39 in/s). These events were observed at depths exceeding 1,500 m (4,921 ft) in the northern GOM (Hamilton and Lugo-Fernandez, 2001; Hamilton et al., 2003) and as very high-speed currents in the upper portions of the water column observed in deep water by several oil and gas operators.
Natural Seeps	3.3.2.9.2	"Natural seeps" is used here to mean the naturally occurring seepage of crude oil and tar into the GOM. These seeps are geographically common and have likely been active throughout history. Natural seeps account for approximately 47% of the crude oil entering the marine environment (Kvenvolden and Cooper, 2003).
Hurricanes	3.3.2.9.3	Twenty-one hurricanes made landfall in the WPA, CPA and EPA during the 1995-2016 hurricane seasons, disrupting OCS oil- and gas-related activity in the GOM (Table 3-31 of the 2017-2022 GOM Multisale EIS). Half of these hurricanes reached a maximum strength of Category 1 or 2 while in the CPA or WPA, while the other half were powerful hurricanes reaching maximum strengths of Category 4 or 5. The current era of heightened Atlantic hurricane activity began in 1995; therefore, the Gulf of Mexico could expect below average hurricanes in the GOM in the near term due to a strong El Nino. Increased hurricanes may occur if El Nino wanes during the first half of the 50-year analysis period and levels return to below-normal activity during the remaining half to three-quarters of the 50-year analysis period.
Climate Change	3.3.2.9.4	Issues related to climate change, including global warming, sea-level rise, and programmatic aspects of climate change relative to the environmental baseline for the GOM are discussed in Chapter 4.2.1 of the Five-Year Program EIS.
Mississippi River-Related Issues		
Mississippi River Hydromodification	3.3.2.10	The Mississippi River has been anchored in place by engineered structures built in the 20th century and has been hydrologically isolated from the delta it built. The natural processes that allowed the river to flood and distribute alluvial sediments across the delta platform and channels to meander have been shut down. Hydromodifying interventions include construction of (1) levees along the river and distributary channel systems, (2) upstream dams and flood control structures that impound sediment and meter the river flow rate, and (3) channelized channels with earthen or armored banks. Once the natural processes that act to add sediment to the delta platform to keep it emergent are shut down, subsidence begins to outpace deposition of sediment.

Table 3-18. General Description of Cumulative Non-OCS Oil- and Gas-Related Impact-Producing Factors. (continued).

Impact-Producing Factor and Specific Sources	Multisale EIS Chapter Reference	General Description
Mississippi River Eutrophication	3.3.2.11	The Mississippi River Basin drains 41 percent of the contiguous United States. The basin covers more than 1,245,000 mi^2 (3,224,535 km^2) and includes all or parts of 31 states and 2 Canadian provinces (U.S. Dept. of the Army, COE, 2015). Dissolved pollutants, including nutrients, enter surface water within the Mississippi River Basin via uncontained runoff and groundwater discharge (nonpoint sources).
Hypoxia	3.3.2.12	The Gulf of Mexico hypoxic zone is a band of oxygen-stratified water that stretches along the Texas-Louisiana shelf each summer where the dissolved oxygen concentrations are less than 2 milligrams/liter (USEPA, 2015b). Other small hypoxic areas infrequently form at the discharge of smaller rivers along the Gulf Coast; however, in the Gulf of Mexico, the hypoxic zone resulting from the Mississippi and Atchafalaya Rivers is by far the predominant feature. The hypoxic zone is the result of excess nutrients, primarily nitrogen, carried downstream by rivers to discharge to coastal waters.
Sedimentation	3.3.2.13	The lower Mississippi River, from Cairo, Illinois, to the Gulf of Mexico, transported an average of 150 million tons (with a range of 70-230 million tons) of sediment annually between 1963 and 2005. Historically, the quantity of sediment derived from catchment erosion has been affected by changes in land use and river management, increasing in the 19th and early 20th centuries before decreasing due to soil conservation and improved land management. Seasonal analysis shows that, in the spring, the median load is approximately four times the median total load in the fall. The median sediment size is mostly silt, but it coarsens during the winter and spring when 10% of the sediment load is coarser than fine sand (U.S. Dept. of the Army, European Research Office, 2008).

CHAPTER 4

DESCRIPTION OF THE ENVIRONMENT AND IMPACT ANALYSIS

What's in This Chapter?

- **Chapter 4** describes the affected environment and potential environmental consequences of a proposed regionwide lease sale.
- Resources analyzed are as follows:
  - Air Quality
  - Water Quality
  - Coastal Habitats (Estuarine Systems, and Coastal Barrier Beaches and Associated Dunes)
  - Deepwater Benthic Communities
  - *Sargassum* and Associated Communities
  - Live Bottom Habitats (Topographic Features, and Pinnacles and Low-Relief Features)
  - Fishes and Invertebrate Resources
  - Birds
  - Protected Species (Marine Mammals, Sea Turtles, Beach Mice, Protected Birds, and Protected Corals)
  - Commercial Fisheries
  - Recreational Fishing
  - Recreational Resources
  - Archaeological Resources
  - Socioeconomic Issues (Land Use and Coastal Infrastructure, Economic Factors, and Social Factors, Including Environmental Justice)
- Impact-producing factors and impact-level definitions are identified for each resource.
- The analyses of environmental consequences consider the potential impacts from routine activities, accidental events, and cumulative impacts; and incomplete or unavailable information.
- Other analyses in this chapter include the following:
  - Unavoidable Adverse Impacts of a Proposed Action
  - Irreversible and Irretrievable Commitment of Resources
  - Relationship Between the Short-Term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT AND IMPACT ANALYSIS

4.0 OVERVIEW

The impacts of the 10 regionwide lease sales proposed in the Five-Year Program were analyzed in the 2017-2022 GOM Multisale EIS. This Supplemental EIS has been prepared to inform decisions for the proposed 2018 GOM lease sales and analyzes a single proposed action (i.e., a proposed regionwide lease sale in the Gulf of Mexico) as scheduled in the Five-Year Program. This Supplemental EIS contains analyses of the potential environmental impacts that could result from a proposed regionwide lease sale in the Gulf of Mexico as scheduled in the Five-Year Program, but the analyses may be applied and supplemented as necessary to inform decisions for each of the remaining proposed lease sales scheduled in the Five-Year Program. This Supplemental EIS supplements, tiers from, updates, summarizes, and incorporates by reference all of the relevant analyses from the Five-Year Program EIS and 2017-2022 GOM Multisale EIS, which are referenced below:

- November 2016 – *Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022—Final Programmatic Environmental Impact Statement* (Five-Year Program EIS; USDOI, BOEM, 2016b); and

- March 2017 – *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS; (USDOI, BOEM, 2017a).

An analysis of the routine activities, accidental events, and cumulative impacts of a proposed action on the environmental, socioeconomic, and cultural resources of the Gulf of Mexico can be found in Chapter 4 of the 2017-2022 GOM Multisale EIS, which is hereby incorporated by reference.

The purpose of this Supplemental EIS is to determine if there are significant new circumstances or information bearing on a proposed action or its impacts, as previously discussed in the 2017-2022 GOM Multisale EIS, and if so, to disclose those changes and conclusions. This includes all relevant new information available since publication of the 2017-2022 GOM Multisale EIS. As will be demonstrated within each environmental, socioeconomic, and cultural resources chapter in this Supplemental EIS, no new circumstances or new information was identified since the publication of the 2017-2022 GOM Multisale EIS and the conclusions reached in the 2017-2022 GOM Multisale EIS remain the same for this Supplemental EIS.

As discussed in **Chapter 1.2**, BOEM makes individual decisions on whether and how to proceed with each proposed lease sale pursuant to the OCSLA's staged leasing process. The decision on whether and how to proceed with proposed Lease Sale 250, which is the first lease sale proposed for 2018, will be made following the completion of this NEPA analysis. A separate decision will be made on whether and how to proceed with the second lease sale proposed for 2018, which is Lease Sale 251. Decisions on the remaining proposed GOM lease sales in the Five-Year Program will be made based on additional NEPA review that may update this Supplemental EIS as necessary. This chapter describes the affected environment and the potential impacts of routine activities, reasonably foreseeable accidental events, and cumulative impacts caused by a proposed lease sale and the alternatives on these resources.

***Chapter 4** describes the affected environment and potential environmental consequences of a single proposed lease sale.*

This chapter is organized by groups of resources. The chapter is divided into the physical factors (i.e., air and water quality), biological factors (i.e., habitat resources followed by the fauna that are found in or utilize these habitats), and finally the social environment, including commercial fisheries, recreational resources, land use, and environmental justice.

- Air Quality (**Chapter 4.1**)
- Water Quality (**Chapter 4.2**)
- Habitat Resources
  - Coastal Habitats (**Chapter 4.3**)
  - Deepwater Benthic Communities (**Chapter 4.4**)

    - *Sargassum* and Associated Communities (**Chapter 4.5**)
    - Live Bottom Habitats (**Chapter 4.6**)
- Faunal Resources
    - Fish and Invertebrate Resources (**Chapter 4.7**)
    - Birds (**Chapter 4.8**)
    - Protected Species (**Chapter 4.9**)
- Social Environment
    - Commercial Fisheries (**Chapter 4.10**)
    - Recreational Fishing (**Chapter 4.11**)
    - Recreational Resources (**Chapter 4.12**)
    - Archaeological Resources (**Chapter 4.13**)
    - Human Resources and Land Use (**Chapter 4.14**)

The habitat resource chapters focus on the impact-producing factors that would affect their environment while the other chapters concentrate on the biological effects of impact-producing factors on fauna and human resources. To decrease repetition, the habitat information is generally not restated in the fauna chapters and vice versa.

As discussed above, this Supplemental EIS tiers from and uses information contained in both the Five-Year Program EIS (USDOI, BOEM, 2016b) and 2017-2022 GOM Multisale EIS (USDOI, BOEM, 2017a). BOEM concentrated on providing a focused analysis by incorporating information by reference from these documents. Programmatic aspects of the potential impacts of climate change relative to the environmental baseline for the Gulf of Mexico OCS Program are discussed within each resource and in Chapter 1 of the Five-Year Program EIS. In addition, the potential for alternative energy on the Federal OCS is addressed in the Five-Year Program EIS (Chapters 1.4.6.1 and 2.7.4), from which this Supplemental EIS tiers. Furthermore, supporting technical information in previous NEPA reviews have been developed as white papers and are summarized and incorporated by reference as appropriate. These white papers include the *OCS Regulatory Framework* (Cameron and Matthews, 2016), *Catastrophic Spill Event Analysis* (USDOI, BOEM, 2017b) and *Essential Fish Habitat Assessment* (USDOI, BOEM, 2016d). BOEM has also prepared a technical report on climate change as part of the Five-Year Program EIS, which is incorporated by reference into this Supplemental EIS (Wolvovsky and Anderson, 2016).

This Supplemental EIS was prepared with consideration of potential changes to or new information about the baseline conditions of the physical, biological, and socioeconomic resources. Current baselines (including past and present events) are described for all resources in full detail under their respective “Affected Environment” sections in the 2017-2022 GOM Multisale EIS, which is hereby incorporated reference, and are summarized in this Supplemental EIS. Past events such as Hurricanes Katrina and Rita and the *Deepwater Horizon* explosion, oil spill, and response have potentially affected multiple resources over a large area. Specific to the *Deepwater Horizon*, the *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* (PDARP/PEIS; Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), which has the purpose and need of assessing and creating restoration plans to relieve injuries from the *Deepwater Horizon* explosion, oil spill, and response to natural resources and services, has been completed. The injuries assessed within the PDARP/PEIS do not necessarily equate the baseline as defined in NEPA.

The level of adverse effect depends on many factors, including the sensitivity of the resource as well as the sensitivity of the environment in which the resource is located. All effects may not currently be known and some could take years to fully develop (refer to the "Incomplete or Unavailable Information" for each resource). The analyses of impacts from the *Deepwater Horizon* explosion, oil spill, and response on the physical, biological, and socioeconomic resources in this Supplemental EIS, are based on credible scientific information that was publicly available at the time this document was prepared. This credible scientific information was applied using accepted methodologies, including numerical modeling of data and scientific writing methods to convey the information of BOEM's subject-matter experts' technical knowledge and experience. However, BOEM and the Deepwater Horizon Natural Resource Damage Assessment Trustee Council continue to study, measure, and interpret impacts arising out of that spill. BOEM continues to analyze the *Deepwater Horizon* explosion, oil spill, and response as information becomes available, and it was evaluated as part of the baseline for resources in this Supplemental EIS. Thus, there are instances in which BOEM is faced with incomplete or unavailable information (refer to **Chapter 4.0.2.4**) that may be relevant to evaluating reasonably foreseeable significant adverse impacts on the human environment. Further, a low-probability catastrophic event and the resulting analysis of potential effects are presented in *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b).

4.0.1 What Encompasses the Affected Environment for a Gulf of Mexico Lease Sale?

Each resource chapter includes a unique description of the affected environment and an analysis of the potential environmental consequences of the alternatives for that particular resource. The Federal and State waters of the Gulf of Mexico and the adjacent coastal states are generally the affected environment described in each resource chapter. Current baselines are described for all resources under their respective "Affected Environment" sections. Specific to the PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), the altered baseline includes individual protected species directly affected by the *Deepwater Horizon* explosion, oil spill, and response, an unexpected unique catastrophic event. BOEM understands that each oil-spill event is unique and that its outcome depends on several factors, including time of year and location of the release relative to winds, currents, land, and sensitive resources, as well as specifics of the well and response effort. BOEM also understands that the severity of impacts from an oil spill cannot be predicated on volume alone. BOEM has analyzed a low-probability catastrophic event (USDOI, BOEM, 2017b) in conjunction with its analysis of potential effects, as requested by CEQ pursuant to its regulation at 40 CFR § 1502.22. A low-probability catastrophic spill is, by definition, not reasonably certain to occur. Other methods of analysis are neither significantly limited in their applicability and availability nor would they provide any meaningful or useful information to be used to assess the risk of catastrophic spill occurrence at this programmatic level of oil and gas activities in the GOM. The return period of a catastrophic oil spill in OCS areas is estimated to be 165 years, with a 95 percent confidence interval between 41 years and more than 500 years (Ji et al., 2014).

4.0.2 How are the Potential Environmental Consequences Determined?

The analyses of potential impacts to the wide variety of physical, environmental, and socioeconomic resources in the vast area of the GOM and adjacent coastal areas is very complex. For this Supplemental EIS, a set of assumptions and a scenario were developed, along with descriptions of impact-producing factors that could occur from routine OCS oil- and gas-related activities, including accidental events. Analysis of the various alternatives considers these impact-producing factors (described in detail in **Chapter 3**) within a distinct framework that includes frequency, duration, and geographic extent. Frequency (whether rare, intermittent, or continuous) refers to how often the factor occurs over the entire analysis period of 50 years for routine activities and accidental events. Duration refers to how long the factor lasts from less than a year to many years. Geographic extent covers what areas are affected, and depending on the factor, how large of an area is affected.

*An impact-producing factor is an activity or process, as a result of a proposed lease sale, that could cause impacts on the environmental or socioeconomic setting. **Chapter 3** provides a description of all possible impact-producing factors considered in this analysis.*

Using this information, the interdisciplinary team of subject-matter experts applied knowledge and experience to conduct analyses of the potential effects of a proposed lease sale on resources. Specialized education, experience, and technical knowledge are required of these subject-matter experts, as well as familiarity with the numerous impact-producing factors associated with OCS oil- and gas-related activities and other activities that can cause cumulative impacts in the area to conduct this analysis. Knowledge and practical working experience of major environmental laws and regulations such as NEPA, the Clean Water Act, Clean Air Act, Coastal Zone Management Act (CZMA), ESA, Marine Mammal Protection Act, Magnuson-Stevens Fishery Conservation and Management Act, and others are also required to conduct this analysis. In order to accomplish this task, BOEM has assembled an interdisciplinary team with many years of collective experience. The vast majority of this team has advanced degrees with a high level of knowledge related to the particular resources discussed in this chapter. This team prepares the input to BOEM’s lease sale EISs and a variety of subsequent postlease NEPA reviews, and is also involved with ESA, EFH Assessment, and CZMA consultations. In addition, this same staff is also directly involved with the development of studies conducted by BOEM’s Environmental Studies Program. The results of these studies feed directly into the Bureau of Ocean Energy Management’s NEPA analyses.

How Were Impact Levels Defined?

The environmental consequences in each resource chapter include an analysis of applicable impact-producing factors from the categories of routine activities, accidental events, and cumulative impacts that would occur under any of the action alternatives (i.e., Alternatives A, B, C, and D).

It must be emphasized that, in arriving at the overall conclusions for certain environmental resources (e.g., birds, fisheries, and wetlands) for each alternative, the conclusions are based on potential impacts to the resources or species population as a whole, not to individuals, small groups of animals, or small areas of habitat. BOEM analyzes impacts on a finer geographic scale and mitigations that are appropriate for consideration through site-specific environmental reviews (refer to Appendix A of the 2017-2022 GOM Multisale EIS). Each resource topic discussion includes a threshold effects determination and includes a resource-specific definition of impact level. Additionally, potential beneficial effects of a proposed action have also been considered and identified in individual resource chapters. For example, implementation of a proposed lease sale is anticipated to have beneficial impacts in the Area of Interest for economics due to the direct and indirect spending associated with the oil and gas industry. For this Supplemental EIS, effects thresholds are defined using four categories of significance.

- **Negligible** – Impacts may or may not cause observable changes to natural conditions; regardless, they do not reduce the integrity of a resource.
- **Minor** – Impacts cause observable and short-term changes to natural conditions but they do not reduce the integrity of a resource.
- **Moderate** – Impacts cause observable and short-term changes to natural conditions and/or they reduce the integrity of a resource.
- **Major** – Impacts cause observable and long-term changes to natural conditions and they reduce the integrity of a resource.

The potential magnitude of impact using these resource-specific definitions are provided in most resource chapters as a summary table to help the reader quickly identify the level of potential impacts for each impact-producing factor.

The conclusions developed by BOEM's subject-matter experts regarding the potential effects of a proposed lease sale for most resources are necessarily qualitative in nature; however, they are based on the science-based judgment of the highly trained subject-matter experts. Staff approach this effort utilizing credible scientific information and apply it to the subject resources using accepted methodologies. It is important to note that, barring another catastrophic oil spill, which is a low-probability accidental event not expected to occur and therefore not part of a proposed action, the adverse impacts associated with a proposed lease sale are expected to be small, and beneficial impacts are projected as well for certain activities and species. This is because of BOEM's potential use of lease sale stipulations and mitigations, site-specific mitigations that may become conditions of plan or permit approval at the postlease stage, and mitigations required by other State and Federal agencies that help to avoid or minimize many of the impacts. Over the years, a suite of lease stipulations and mitigating measures has been developed to eliminate or ameliorate potential environmental effects, where implemented (refer to Appendix B of the 2017-2022 GOM Multisale EIS, "Commonly Applied Mitigation Measures"). BOEM's primary mitigative method is the avoidance of impacts, which is primarily implemented during approval of postlease activities. In many instances, these were developed in coordination with other natural resource agencies such as NMFS and FWS. Informal and formal consultation with other Federal agencies and affected States, and commenting opportunities for the public are implemented to assist in the development of the information and analyses in this Supplemental EIS. Specifically, information requests soliciting input on the proposed lease sales were issued during scoping for this Supplemental EIS (refer to **Chapter 5**). The impact-level conclusions reached in each resource area consider the applicable impact-producing factors, the level of activity, and the geographic area of each alternative.

Lease sale stipulations considered for a proposed lease sale may include the Topographic Features Stipulation; Live Bottom (Pinnacle Trend) Stipulation; Military Areas Stipulation; Evacuation Stipulation; Coordination Stipulation; Blocks South of Baldwin County, Alabama, Stipulation; Protected Species Stipulation; United Nations Convention on the Law of the Sea Royalty Payment Stipulation; Below Seabed Operations Stipulation; and the Stipulation on the Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation). The Topographic Features and Live Bottom (Pinnacle Trend) Stipulations have been applied as programmatic mitigation in the Five-Year Program EIS (USDOI, BOEM, 2016b) and, therefore, would apply to all leases issued under the Five-Year Program in the designated lease blocks. Site-specific postlease mitigations may include buffer zones and avoidance criteria to protect sensitive resources such as areas of deepwater benthic communities, topographic features, and historic shipwrecks. Mitigations may also be required by other agencies (i.e., the U.S. Army Corps of Engineers and State Coastal Zone Management agencies) to avoid or reduce impacts from OCS oil- and gas-related activities, e.g., boring under beach shorelines and the rerouting of pipelines to reduce or eliminate impacts from OCS pipelines that make landfall. These mitigations and their potential effect on reducing or eliminating impacts from a proposed lease sale are analyzed in this chapter.

Under all four action alternatives, postlease activities would be reviewed on a case-by-case basis and the applicable commonly applied mitigating measures (refer to Appendix B of the 2017-2022 GOM Multisale EIS) would be identified during site-specific reviews of plans and permits. This avoids excessive replication of discussion of similar if not identical impacts throughout the entire document, allowing the reader to focus on the differences between the alternatives.

4.0.2.1 Routine Activities

The types of routine activities that could occur from all operations as a result of a single proposed lease sale are described in **Chapter 3.1**. The major types of routine activities include geological and geophysical surveys; exploration, development, and production drilling; infrastructure emplacement and presence, including pipelines; transportation, including barges, vessels, and helicopters; discharges and wastes; decommissioning and removal; coastal infrastructure; air emissions; noise; and safety issues. The time period for postlease activities related to a single proposed lease sale is 50 years.

4.0.2.2 Accidental Events

A summary of the information on accidental events that are reasonably foreseeable from all operations conducted under the OCS Program, as well as information on the number and sizes of spills from non-OCS oil- and gas-related sources is provided in **Chapter 3.2**. The types of accidental events that could reasonably be expected as a result of postlease activities include oil spills, losses of well control, accidental air emissions, pipeline failures, vessel and helicopter collisions, chemical and drilling-fluid spills, and spill response as a result of a proposed lease sale.

4.0.2.3 Cumulative Impacts

The cumulative analysis considers impacts to physical, biological, and socioeconomic resources that may result from the incremental impact of a proposed lease sale when added to all past, present, and reasonably foreseeable future human activities and natural processes. However, most resources consider the past and present cumulative impacts as part of the baseline environmental conditions, and they are covered where relevant in the affected resource description. It is reasonably foreseeable to assume that lease sales would continue to occur, as they have historically, for many years to come in the Gulf of Mexico region, based on resource availability, existing infrastructure, and projected time lapses required for any other major energy sources to come online. However, the level of activities (exploration wells, production wells, and pipelines) becomes more speculative as time is projected further into the future. The causes for this are uncertainty in long-term oil price forecasts, hydrocarbon resource potential, cost of exploration, development and production, and various resource constraints (e.g., drilling rig availability versus the amount of acreage leased from a lease sale). Furthermore, OCSLA provides for phased decisionmaking, each of which is a decision subject to NEPA. The OCSLA stages include the Five-Year Program stage to identify a schedule of leases over the period; the lease sale stage; the exploration stage; the development and production stage; and ultimately decisions on how a lessee may proceed with decommissioning. These reviews require consideration of cumulative impacts that would factor in changing environmental baselines, oil and gas price forecasts, and technology advancements, among others. Additionally, even though continued consumer demand is likely, new advances in technology (both on upstream development and production ends and downstream user ends) can potentially change the level of projected activities and how they are conducted. These could further minimize environmental risks. Technology advancements and organizational effectiveness could also further reduce projected air emissions, wastewater quantities, and other impact producing factors such as helicopter and vessel trips and accidental events.

Therefore, cumulative impact assessment for this Supplemental EIS considers existing environmental baseline conditions, past OCS oil- and gas-related and non-OCS oil- and gas-related activities in the GOM, projected future activities as a result of past lease sales, 50 years of incremental projected activities as a result of the proposed lease sales during the 2017-2022 Five-Year Program, and reasonably assumes projected activities for future lease sales based on current trends. Non-OCS oil- and gas-related activities include, but are not limited to, import tankering; marine transportation; State oil and gas activity; recreational, commercial, and military vessel traffic; offshore liquefied natural gas activity; recreational and commercial fishing; onshore development; and natural processes. The time period for reasonably foreseeable future actions are dependent upon the nature of each resource and are therefore defined in each resource chapter. The types of cumulative activities that could reasonably occur are described in **Chapter 3.3**.

4.0.2.4 Incomplete or Unavailable Information

Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it was essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether scientifically credible information using generally accepted scientific methodologies can be applied in its place (40 CFR § 1502.22).

The most notable incomplete or unavailable information relates to some aspects of the effects from the *Deepwater Horizon* explosion, oil spill, and response. Credible scientific data regarding the potential short-term and long-term impacts from the *Deepwater Horizon* explosion, oil spill, and response on some GOM resources have become available. However, information relating to long-term effects continue to be studied and remain incomplete at this time, and it could be many years before this information becomes available. The Trustees have released the PDARP/PEIS (Deepwater Horizon Natural Resource Damaage Assessment Trustees, 2016). However, the information collected during the Natural Resource Damage Assessment (NRDA) process that the assessment, plan, and EIS used as a basis for their determinations are not yet publicly available (e.g., NRDA technical working group reports). There remains information being developed through the NRDA process, but it is not yet available as a final report. Nonetheless, BOEM's subject-matter experts acquired and used newly available, scientifically credible information; determined that other additional information was not available absent exorbitant expenditures or could not be obtained regardless of cost in a timely manner; and where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. While incomplete or unavailable information could conceivably result in potential future shifts in baseline conditions of habitats that could affect BOEM's decisionmaking, BOEM has determined that it can make an informed decision at this time without this incomplete or unavailable information. BOEM's subject-matter experts have applied other scientifically credible information using accepted theoretical approaches and research methods, such as information on related or surrogate species. Moreover, BOEM will continue to monitor these resources for effects caused by the *Deepwater Horizon* explosion, oil spill, and response, and will ensure that future BOEM environmental reviews take into account any new information that may emerge.

Furthermore, BOEM has considered the reasonably foreseeable impacts of a low-probability catastrophic oil spill in a white paper. These types of events, such as the one that resulted from the *Deepwater Horizon* explosion, are not reasonably expected to occur and therefore are not part of a proposed action. BOEM has prepared the *Catastrophic Spill Event Analysis* white paper, which provides a summary of existing credible scientific evidence related to this issue and BOEM's evaluation of the potential impacts to the physical, biological, and socioeconomic resources and conditions based upon theoretical approaches or research methods generally accepted in the scientific community (USDOI, BOEM, 2017b). The white paper was included in previous lease sale EISs as an appendix. To avoid repetition and redundancies, the white paper is incorporated by reference and is publicly available on BOEM's website at http://www.boem.gov/nepaprocess/. BOEM updated the analysis in the white paper and will update it again should new information become available relevant to the reasonably foreseeable impacts of a catastrophic spill event.

4.0.2.5 Alternatives

Each resource chapter includes an analysis of the relevant impact-producing factors to that specific resource from the routine activities, accidental events, and cumulative impacts that are described in **Chapter 3**. After this general analysis, the scale and location of these activities, events, and impacts are considered for each alternative.

Alternative A

In general, Alternative A could potentially result in 1.2-4.2 percent of the forecasted cumulative OCS oil and gas activity in the Gulf of Mexico and would occur in the WPA, CPA, and EPA portions of the proposed lease sale area (refer to **Chapter 3.1.2**). Most of the activity (up to 83%) of a proposed lease sale under Alternative A is expected to occur in the CPA and EPA portions of the proposed lease sale area, while up to 19 percent of the activity could occur in the WPA portion of the proposed lease sale area. Approximately 75.7 million acres (82%) of the regionwide lease sale area would be available for lease under this alternative.

Alternative B

Alternative B could potentially result in 1.0-3.6 percent of the forecasted cumulative OCS oil and gas activity in the Gulf of Mexico, or a slightly smaller amount of activity than proposed for Alternative A, and would be located geographically in the CPA and EPA portions of the proposed lease sale area (refer to **Chapter 3.1.2**). Approximately 49.8 million acres (54%) of the regionwide lease sale area would be available for lease. While all of the leases issued under this alternative would occur in the CPA and EPA portions of the proposed lease sale area, activities such as vessel support and pipeline or coastal infrastructure could occur in the WPA portion of the proposed lease sale area.

Alternative C

Alternative C could potentially result in 0.2-0.6 percent of the forecasted cumulative OCS oil and gas activity in the Gulf of Mexico, which is much smaller than either Alternative A or B (refer to

Chapter 3.1.2). Approximately 25.9 million acres (28%) of the regionwide lease sale area would be available for lease. While all of the leases issued under this alternative would occur in the WPA portion of the proposed lease sale area, activities such as vessel support and pipeline or coastal infrastructure could occur in the CPA/EPA portion of the proposed lease sale area.

Alternative D

Under Alternative D, the number of blocks that would become unavailable for lease represents only a small percentage of the total number of blocks to be offered under Alternative A, B, or C (<4%), even if blocks subject to all three stipulations were excluded. However, it is also possible (and BOEM believes more reasonable to expect) that Alternative D would only shift the location of offshore infrastructure and activities farther from these sensitive zones and not lead to a reduction in offshore infrastructure and activities.

Alternative E

Alternative E is the cancellation of a single proposed lease sale. Under Alternative E, there would be no routine activities or accidental events as a result of a proposed lease sale. Therefore, there would be no associated impacts resulting from a proposed lease sale. Cancellation of a proposed lease sale, however, would not stop all OCS oil- and gas-related activities. Activities related to previously issued leases and permits (as well as those that may be issued in the future under separate decision) related to the OCS oil and gas program would continue and could have impacts similar to those described in each resource chapter. However, no new activities related to a proposed lease sale would proceed and, therefore, those additional impacts would be avoided.

4.0.2.6 Summary

This chapter has thoroughly examined the existing credible scientific evidence that is relevant to evaluating the reasonably foreseeable significant impacts of a proposed lease sale and the alternatives on the environment. All reasonably foreseeable impacts, including beneficial ones, were considered. Impacts that could have catastrophic consequences, even if their probability of occurrence is low, not reasonably expected, and not part of a proposed action are considered in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b). Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it was essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether credible scientific information applied using generally accepted scientific methodologies can be used in its place (40 CFR § 1502.22). BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts.

4.1 AIR QUALITY

Typical Supplemental EIS analyses summarize the analyses from which they tier and re-analyze the conclusions based on new information. However, since this air quality analysis was completed for the Final 2017-2022 GOM Multisale EIS and did not have the benefit of public review, the complete analysis is included in this Supplemental EIS for public review and comment. BOEM looks forward to receiving relevant comments on the methods used in air quality modeling and the resulting analyses.

The analyses of the potential impacts of routine activities and accidental events associated with a GOM proposed lease sale and its incremental contribution to the cumulative impacts to air quality are presented in this chapter. The approach of the analysis is to focus on the greatest reasonably foreseeable impact-producing factors from OCS oil- and gas-related routine activities (from exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact levels for each. The impact-producing factors considered and analyzed include (1) OCS oil- and gas-related emissions sources related to drilling and associated vessel support, production and the connected action of vessel support, flaring and venting, decommissioning, and oil spills; (2) other emissions not caused by OCS oil and gas development (i.e., non-OCS oil- and gas-related emissions such as State oil and gas programs, onshore industrial and transportation sources, and natural events); and (3) the incremental contribution of all postlease activities as a result of a single proposed lease sale. The impact-level definitions and the analyses supporting these conclusions are discussed in this chapter.

In order to assess the impacts from these oil- and gas-related activities, BOEM used an emissions inventory along with air dispersion and photochemical modeling. While an emissions inventory is an accounting of air emissions of criteria pollutants, precursors of criteria pollutants, and hazardous air pollutants from a variety of air emission sources, the comprehensive data from the inventory can be used to support air quality modeling. Typically, impacts are determined through modeling, and concentrations are reported. These impacts are then compared with reference measures, such as National Ambient Air Quality Standards (NAAQS), Significant Impact Levels (SILs), etc., to support impact conclusions. For the 2017-2022 GOM Multisale EIS and this Supplemental EIS analyses, BOEM used the following: (1) the results of the *Year 2011 Gulfwide Emissions Inventory* (GWEI) study, herein incorporated by reference (Wilson et al., 2014); (2) the changes in regulations as a result of the 2010 *Deepwater Horizon* explosion, oil spill, and response to determine the impact-producing factors (**Table 4-1**) that have the greatest impact potential in the GOM region; and (3) the results of the "Air Quality Modeling in the Gulf of Mexico Region" study to determine impacts. Pollutants included the emissions inventory support analysis of air quality impacts in terms of impacts on the attainment of the NAAQS and on air quality-related values (AQRVs), including acid deposition and visibility. The results of the emissions inventory study and air modeling study are discussed later in this chapter. The "Air Quality Modeling in the Gulf of Mexico Region" study includes technical support documents (**Appendices B-D**) that provide detailed descriptions of the emissions data, meteorological and photochemical grid, modeling parameters and methodology, and the results of the air quality impact analysis.

Table 4-1. Air Quality Impact-Producing Factors That Are Reasonably Foreseeable.

Air Quality	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Drilling	Minor	Minor	Minor	Minor	None
Production	Minor	Minor	Minor	Minor	None
Vessel Support during Drilling and Production	Minor	Minor	Minor	Minor	None
Routine Flaring and Venting	Minor	Minor	Minor	Minor	None
Decommissioning	Minor	Minor	Minor	Minor	None
Accidental Impacts					
Emergency Flaring and Venting	Minor	Minor	Minor	Minor	None
Oil Spills	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
Incremental Contribution[2]	Minor	Minor	Minor	Minor	None
OCS Oil and Gas[3]	Moderate				
Non-OCS Oil and Gas[4]	Moderate				

[1] The analysis supporting these conclusions is discussed in detail in the environmental consequences "Environmental Consequences" chapter below.

[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the Five-Year Program.

[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.

[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

Impact-Level Definitions

The following impact categories and definitions are used:

- **Negligible** – No measurable impact(s).
- **Minor** – Most impacts on the affected resource could be avoided with proper mitigation; if impacts occur, the affected resource would recover completely without mitigation once the impacting stressor is eliminated.
- **Moderate** – Impacts on the affected resource are unavoidable. The viability of the affected resource is not threatened although some impacts may be irreversible, or the affected resource would recover completely if proper mitigation is applied or proper remedial action is taken once the impacting stressor is eliminated.

- **Major** – Impacts on the affected resource are unavoidable. The viability of the affected resource may be threatened although some impacts may be irreversible, and the affected resource would not fully recover even if proper mitigation is applied or remedial action is implemented once the impacting stressor is eliminated.

BOEM's Gulf of Mexico OCS Region manages the responsible development of oil, gas, and mineral resources for the 430 million ac in the WPA, CPA, and a small portion of the EPA on the OCS comprising the GOM region. The Gulf of Mexico OCS area of possible influence includes the States of Texas, Louisiana, Mississippi, Alabama, and Florida, and is depicted on **Figure 4-1**. However, the Clean Air Act Amendments of 1990 designated air quality authorities in the GOM, giving BOEM air quality jurisdiction westward of 87°30' W. longitude and USEPA air quality jurisdiction eastward of 87°30' W. longitude. The USEPA air quality jurisdiction includes part of the CPA and all of the EPA, while BOEM's air quality jurisdiction includes most of the CPA and all of the WPA. In 2006, oil and gas leasing operations within 125 mi (201 km) of the Florida coastline were placed under moratorium until 2022 under the Gulf of Mexico Energy Security Act (GOMESA). The GOMESA moratoria area is depicted in **Figure 4-1**.

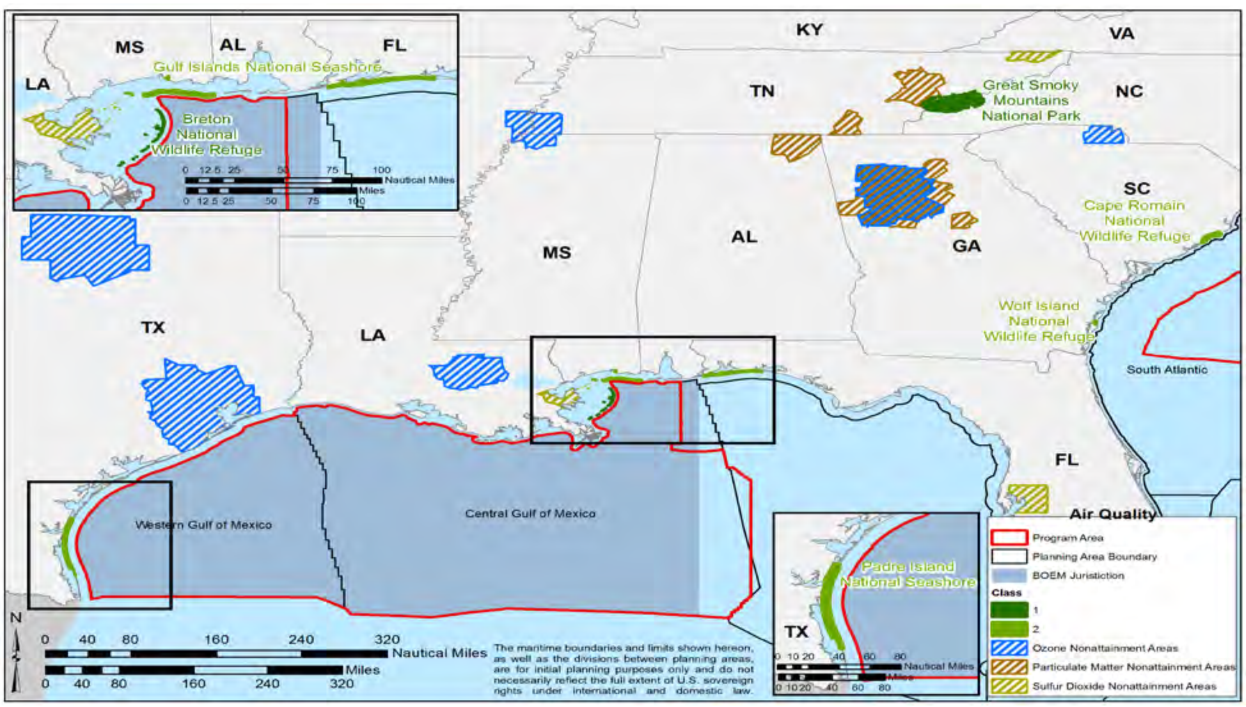


Figure 4-1. Gulf of Mexico Region with the Planning Areas, Nonattainment Areas, and Class I (dark green) and Sensitive Class II (light green) Areas. (Note: The South Atlantic Planning Area was removed from the Five-Year Program.)

BOEM is required under the OCSLA (43 U.S.C. § 1334(a)(8)) to develop regulations to ensure compliance with the NAAQS to the extent that OCS offshore oil and gas exploration, development, and production sources do not significantly affect the air quality of any state pursuant to the NAAQS. Since the primary NAAQS are designed to protect human health, BOEM focuses this Supplemental EIS analysis on the impact of these activities on the States, where there are permanent human populations. However, the potential impacts for the whole Gulf of Mexico region were modeled, including the impacts at the State/seaward boundary of Gulf Coast States (3-9 nmi [3.45-10.36 mi; 5.56-16.67-km] from shore, depending on the State). Detailed potential impacts from the "Air Quality Modeling in the Gulf of Mexico Region" study are included in **Appendix D**.

4.1.1 Description of the Affected Environment

For this Supplemental EIS analysis, the affected environment comprises the WPA, CPA, and EPA, including the States of Texas, Louisiana, Mississippi, Alabama, and Florida, and the respective State waters. This area also includes national parks and Federal wilderness areas where air quality and AQRVs (primarily visibility) are protected more stringently than under the NAAQS. These protected Class I areas in the GOM region include the following: the Breton Wilderness Area in Louisiana; and the Bradwell Bay Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area in Florida.

The Clean Air Act Amendments of 1977 designated 156 Class I areas, consisting of national parks and wilderness areas that are offered special protection for air quality and the AQRVs. The Class I areas, compared to the Class II areas, have lower Prevention of Significant Deterioration (PSD) air quality increments that new sources may not exceed and are protected against excessive increases in several AQRVs, including visibility impairment, acid (sulfur and nitrogen) deposition, and nitrogen eutrophication. The Regional Haze Rule (40 CFR § 51.308) has a goal of natural visibility conditions by 2064 at Class I areas, and States must submit Regional Haze Rule State Implementation Plans that demonstrate progress towards that goal. **Figure 4-1** displays the locations of the mandatory Class I areas in the GOM region.

While not included in the Clean Air Act Amendments of 1977 as an area of special protection, Federal management agencies have designated certain other areas as sensitive Class II areas for tracking PSD increment consumption and AQRV impacts. The sensitive Class II areas, designated as such in the GOM region, include the Padre Island National Seashore and Gulf Islands National Seashore. Since Class I and sensitive Class II areas are of concern, the areas located in or nearby the GOM region are discussed in this Supplemental EIS and are shown in **Figure 4-1**.

Clean Air Act and the Clean Air Act Amendments Overview

The Clean Air Act of 1970 established the NAAQS, which include the primary standards to protect public health and secondary standards to protect public welfare including visibility and vegetation. Under the Clean Air Act, the USEPA is periodically required to review and, as appropriate, modify the criteria based on the latest scientific knowledge. Several revisions to the NAAQS have occurred in the past few years as more is understood about the effects of the pollutants. The current NAAQS, shown in **Table 4-2**, address six pollutants: carbon monoxide (CO); nitrogen dioxide (NO_2); particulate matter ($PM_{2.5}$ and PM_{10}); sulfur dioxide (SO_2); lead (Pb); and ozone (O_3).

Table 4-2. National Ambient Air Quality Standards.

Pollutant (Final Rule Citation)		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO) (*Federal Register*, 2011)		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead (Pb) (*Federal Register*, 2008a)		Primary and Secondary	Rolling 3-month average	0.15 μg/m^3 [1]	Not to be exceeded
Nitrogen Dioxide (NO_2) (*Federal Register*, 2010a) (*Federal Register*, 1996)		Primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		Primary and Secondary	Annual	53 ppb [2]	Annual mean
Ozone (O_3) (*Federal Register*, 2015b)		Primary and Secondary	8-hour	0.070 ppm [3]	Annual 4th-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (*Federal Register*, 2013) (*Federal Register*, 2006a)	$PM_{2.5}$	Primary	Annual	12 μg/m^3	Annual mean, averaged over 3 years
		Secondary	Annual	15 μg/m^3	Annual mean, averaged over 3 years
		Primary and Secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2) (*Federal Register*, 2010b) (*Federal Register*, 1973)		Primary	1-hour	75 ppb [4]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

[1] The Final Rule was signed on October 15, 2008. The 1978 lead standard (1.5 μg/m^3 as a quarterly average) remains in effect until 1 year after an area is designated for the 2008 standard. Areas designated nonattainment under the 1978 standard remain in effect until implementation plans are approved to attain or maintain the 2008 standard.

[2] 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.

[3] The final rule was signed on October 1, 2015, and became effective on December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

[4] The Final Rule was signed on June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until 1 year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Notes: PM – particulate matter; ppb – parts per billion; ppm – parts per million.

Source: USEPA, 2017a.

The Clean Air Act establishes classification designations based on regional monitored levels of ambient air quality. These designations impose mandated timetables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. based on the seriousness of the regional air quality problem. These designations are nonattainment, attainment, and unclassifiable. Nonattainment is any area that does not meet the national primary or secondary ambient air quality standard for the pollutant. When measured concentrations of these regulated pollutants exceed the standards established by the NAAQS, the number of exceedances and the concentrations determine the nonattainment classification of an area. The Clean Air Act Amendments of 1990 established these designations as marginal, moderate, serious, severe, and extreme. Attainment is any area that meets the national primary or secondary ambient air quality standard for the pollutant. Unclassifiable is any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant. **Figure 4-1** depicts all of the current nonattainment areas in the GOM region.

The Federal OCS waters are unclassifiable. The OCS areas are not classified because there is no regulatory provision for any classification in the Clean Air Act for waters outside of the boundaries of State waters. Only areas within State boundaries can be classified as either attainment or nonattainment.

Gulf of Mexico OCS Region Attainment Status

After promulgation of a NAAQS, the USEPA designates areas that fail to achieve the NAAQS as nonattainment areas, and States are required to submit State Implementation Plans to the USEPA; these plans contain emission control plans and a demonstration that the nonattainment area would achieve the NAAQS by the required date. After an area comes into attainment of the NAAQS, the area can be redesignated as a maintenance area and must continue to demonstrate compliance with the NAAQS. **Figure 4-1** depicts all the current nonattainment areas in the GOM region while **Table 4-3** summarizes the nonattainment and maintenance areas in the GOM region. Sulfur dioxide (SO_2) and lead (Pb) nonattainment areas are focused around specific large industrial sources of SO_2 or Pb emissions, whereas ozone nonattainment areas are more regional in nature, reflecting the formation of ozone as a secondary pollutant from emissions of NO_x and VOC precursors from a wide range of sources. (*Note: As November 1, 2016, the USEPA proposed to redesignate the Baton Rouge, Louisiana, area as being in attainment of Federal health-based ozone standards. The State of Louisiana requested that the redesignation, based on 3 years of air quality data showing the metropolitan areas of Ascension, East Baton Rouge, Iberville, Livingston, and West Baton Rouge Parishes, meet the 2008 8-hour ozone standard of 0.075 parts per million [ppm]. The USEPA also proposes to approve the State's plan for maintaining the standard.*)

Table 4-3. Nonattainment and Maintenance Areas in the Gulf of Mexico Region.

State	Area	8-hr O_3 (1997)	8-hr O_3 (2008)	SO_2 (2010)	Lead (2008)
Alabama	Troy				NAA
Florida	Tampa				NAA
	Hillsborough County			NAA	
	Nassau County			NAA	
Louisiana	Baton Rouge	M	NAA		
	St. Bernard Parish			NAA	
Texas	Beaumont-Port Arthur	M			
	Houston-Galveston-Brazoria	NAA	NAA		
	Frisco				NAA

M = maintenance area; NAA = nonattainment area; O_3 = ozone; SO_2 = sulfur dioxide.
Blank cells indicate the area is in attainment of the National Ambient Air Quality Standards.

As previously mentioned, the USEPA periodically modifies the NAAQS criteria based on new scientific knowledge. On October 1, 2015, the USEPA strengthened the 8-hour NAAQS for ozone to 0.07 ppm (70 parts per billion [ppb]). Under this more stringent ozone NAAQS, there may be more areas in the southeastern U.S. designated as nonattainment. The USEPA plans to make attainment and nonattainment designations for the revised standards by October 2017, with the designations based on 2014-2016 air quality monitoring data.

In February 2010, the USEPA issued a new 1-hour NO_2 NAAQS with a threshold of 100 ppb (98^{th} percentile daily maximum average over 3 years), and a new 1-hour SO_2 NAAQS was promulgated in June 2010 with a threshold of 75 ppb (99^{th} percentile averaged over 3 years). The USEPA has not yet designated the nonattainment areas for the 1-hour NO_2 and 1-hour SO_2 NAAQS.

A lead NAAQS was issued in 2008; nonattainment areas for lead are associated with specific industrial sources. The USEPA has not yet designated the nonattainment areas for the lead NAAQS.

The carbon monoxide NAAQS has remained essentially unchanged since it was originally promulgated in 1971. As of September 27, 2010, all prior CO nonattainment areas throughout the country have been redesignated as maintenance areas.

Emissions Inventories

One of the most accurate methods for estimating air emissions is by developing a comprehensive emissions inventory. To develop a calendar year 2011 inventory of criteria pollutants, criteria precursors, and greenhouse gas emissions for all OCS oil and gas production-related sources in the GOM, BOEM collected activity data from platform operators during the year 2011. On September 15, 2010, NTL 2010-G06 was published to introduce the “2011 Gulfwide OCS Emissions Inventory (Western Gulf of Mexico)” and inform operators about the mandatory data collection. Affected operators are lessees and operators of Federal oil, gas, and sulfur leases in the Gulf of Mexico OCS region west of latitude 87.5°. The USEPA jurisdiction has air quality jurisdiction east of latitude 87.5°.

BOEM updated and distributed a Microsoft® Visual Basic® program for platform operators to use to collect activity data on a monthly basis and submit to BOEM on an annual basis. The program, known as GOADS-2011, was used by operators to submit activity data for a number of production platform emission sources. Operators used the GOADS software to collect activity data for amine units, boilers/heaters/burners, diesel engines, drilling equipment, fugitives, combustion flares, glycol dehydrators, losses from flashing, mud degassing, natural gas engines, natural gas/diesel/dual-fuel turbines, pneumatic pumps, pressure/level controllers, storage tanks, and cold vents. These activity data were used to calculate CO, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and VOC emissions estimates, as well as CO_2, CH_4, and N_2O. The Gulfwide Oracle® DBMS calculates and archives the activity data and the resulting emissions estimates. Database users can query by pollutant, month, equipment type, platform, etc. Emission estimates for non-platform sources on the Gulf of Mexico OCS include both oil and natural gas production-related sources, as well as non-oil and natural gas sources. Production sources consist of survey vessels, drilling rigs, pipe-laying operations, and support vessels and helicopters. Non-oil and natural gas sources include commercial marine vessels, the Louisiana Offshore Oil Platform (LOOP), and biogenic and geogenic sources. Ultimately, State agencies and Regional Planning Organizations will use these offshore oil and gas platform and non-platform inventories to perform modeling for ozone and regional haze for use in their State Implementation Plans, and BOEM will use the emission inventory for the cumulative impact analysis in NEPA documents.

2011 GWEI Pollutants

NAAQS: CO, NO_x, $PM_{2.5}$, PM_{10}, SO_2

Criteria Precursors: VOC

Greenhouse Gases: CO_2, CH_4, N_2O

Emissions estimates calculated in the study were used to support analysis of air quality modeling impacts. In this inventory, emissions estimates are provided for directly emitted pollutants. While there are national air quality standards for six common air quality pollutants, only four of these pollutants (i.e., CO, Pb, NO_2, and SO_2) are directly emitted. Indirect emissions and the formation of other pollutants, as well as pollutants not included in the inventory, are analyzed below.

- *Greenhouse Gases*. Fluorinated gases, hydrofluorocarbons, and sulfur hexafluoride are not covered in this inventory because they are used in trace amounts and at no time are deliberately emitted into the atmosphere.
- *Lead*. Lead (Pb), a NAAQS criteria pollutant, is not covered in this inventory because oil and gas sources have negligible lead emissions. Since unleaded fuels have been phased out, lead remains a trace contaminant in other fuels (USEPA, 2016a).
- *Nitrogen Dioxide*. Nitrogen dioxide (NO_2), a NAAQS criteria pollutant, is one of a group of highly reactive gases known as nitrogen oxides (NO_x). Nitrogen oxides

are stated as an equivalent mass of NO_2; consequently, NO_x is used instead of NO_2.

- *Particulate Matter*. Particulate matter (PM), a NAAQS criteria pollutant expressed as $PM_{2.5}$ and PM_{10}, can be emitted directly or it can be formed in the atmosphere when emissions of NO_x, sulfur oxides (SO_x), ammonia, organic compounds, and other gases react in the atmosphere. According to USEPA's "Particulate Matter Emissions Report," coarse PM (PM_{10}) is composed largely of primary particles, while a much greater portion of fine PM ($PM_{2.5}$) contains secondary particles. "Primary" particles are those released directly to the atmosphere whereas "secondary" particles are formed in the atmosphere from chemical reactions involving primary gaseous emissions. While both $PM_{2.5}$ and PM_{10} are included the inventory, the secondary formation is not included the inventory because secondary PM is not directly emitted. Since the USEPA has not developed separate $PM_{2.5}$ and PM_{10} emissions factors per source, particulate-matter emission estimates of $PM_{2.5}$ and PM_{10} are similar. Therefore, PM_{10} values have been used in this chapter to represent particulate matter emission estimates.

- *Ozone*. Ozone (O_3), an NAAQS pollutant, is not directly emitted into the air but is formed by photochemical reactions of NO_x and VOCs in the presence of sunlight. Since NO_x and VOCs are directly emitted pollutants, they are included in the emissions inventory, and their resulting emission estimates are used in the air quality model to analyze the air quality impacts of O_3.

Summary of Results of the Year 2011 Gulfwide Emissions Inventory

The Year 2011 GWEI results indicate that OCS oil and gas production platform and non-platform sources emit the majority of NAAQS criteria pollutants, VOCs, and greenhouse gases on the Gulf of Mexico OCS, with the exception of SO_2 (primarily emitted from commercial marine vessels), and N_2O (from biological sources) (Wilson et al., 2014). The total platform and non-platform emission estimates for criteria pollutants and the total platform and non-platform emission estimates for greenhouse gases are depicted in **Figures 4-2 and 4-3**, respectively. In both figures, total emission estimates are subdivided into three main categories: total non-OCS oil/gas source emissions; total OCS oil/gas non-platform source emissions; and total OCS oil/gas platform source emissions.

Total emissions estimates include

- *total non-OCS oil and gas source emissions,*
- *total OCS oil and gas non-platform source emissions, and*
- *total OCS oil and gas platform production source emissions.*

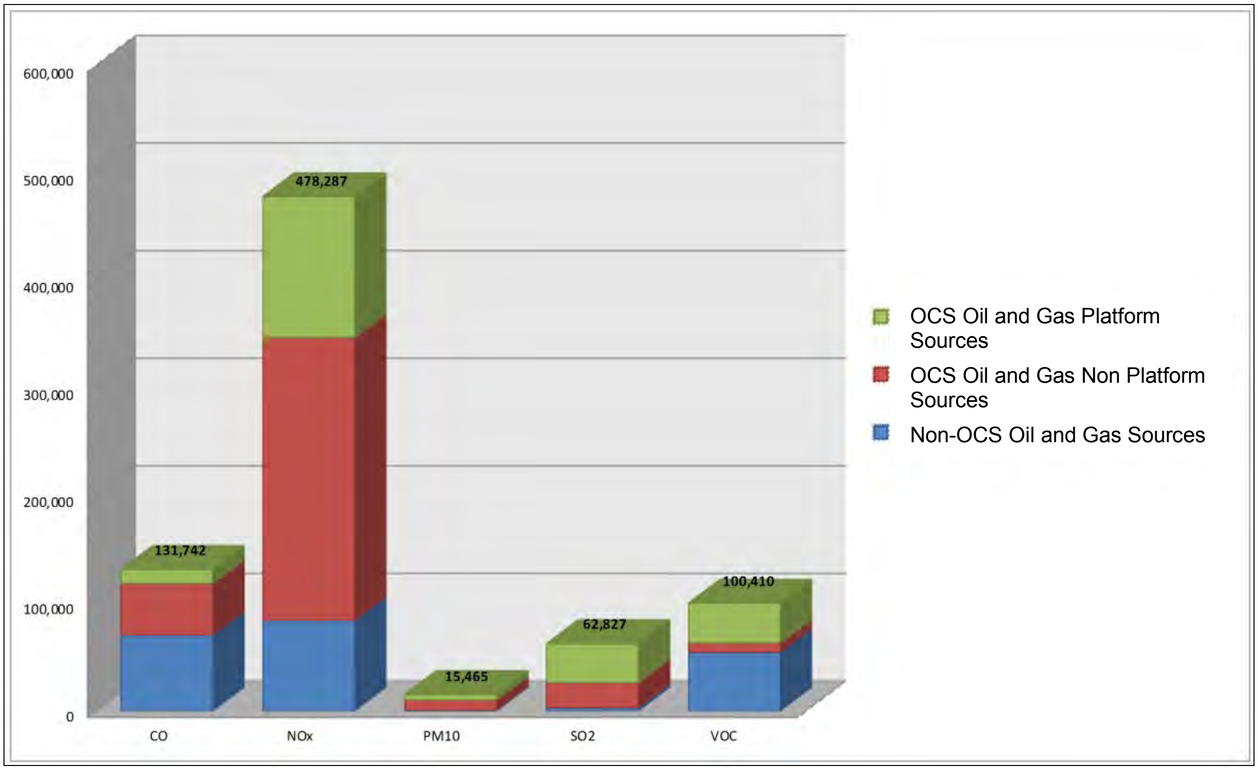


Figure 4-2. Year 2011 Gulfwide Emission Inventory Results for Total Platform and Non-Platform Criteria Pollutant Emissions (TPY).

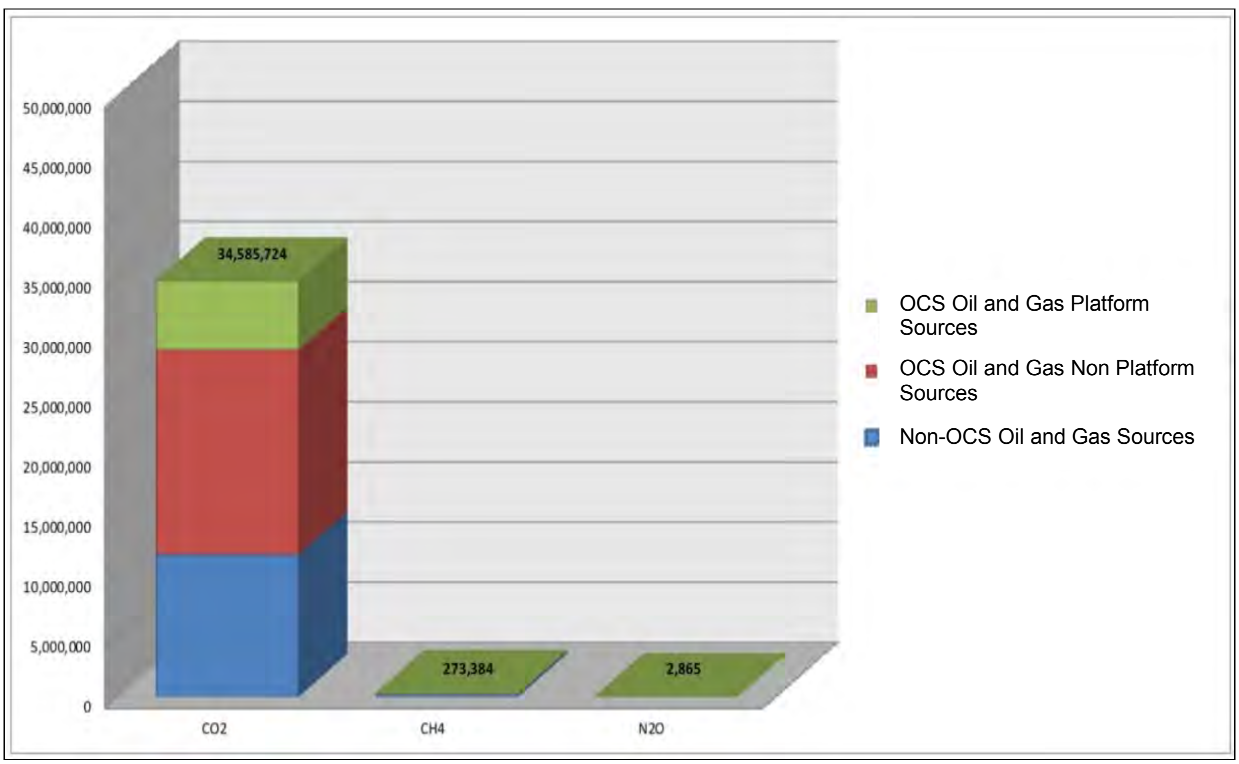


Figure 4-3. Year 2011 Gulfwide Emission Inventory Results for Total Platform and Non-Platform Greenhouse Gas Emissions (TPY).

Platform sources include

- *criteria pollutants,*
- *emissions in (TPY),*
- *greenhouse gases, and*
- *emissions in (TPY).*

Natural gas engines on platforms represented the largest CO emission source, and support vessels were the highest emitters of both NO_x and PM_{10}. Oil and natural gas production platform vents account for the highest percentage of the VOC emissions. Support vessels; production platform natural gas, diesel, and dual-fuel turbines; and commercial marine vessels emit the majority of the greenhouse gas emissions.

The Year 2011 GWEI results for criteria pollutant and greenhouse gas emissions (in tons/year) from platform sources are depicted in **Figures 4-4 and 4-5**, respectively. In both figures, each platform source emission type is represented per pollutant in tons/year.

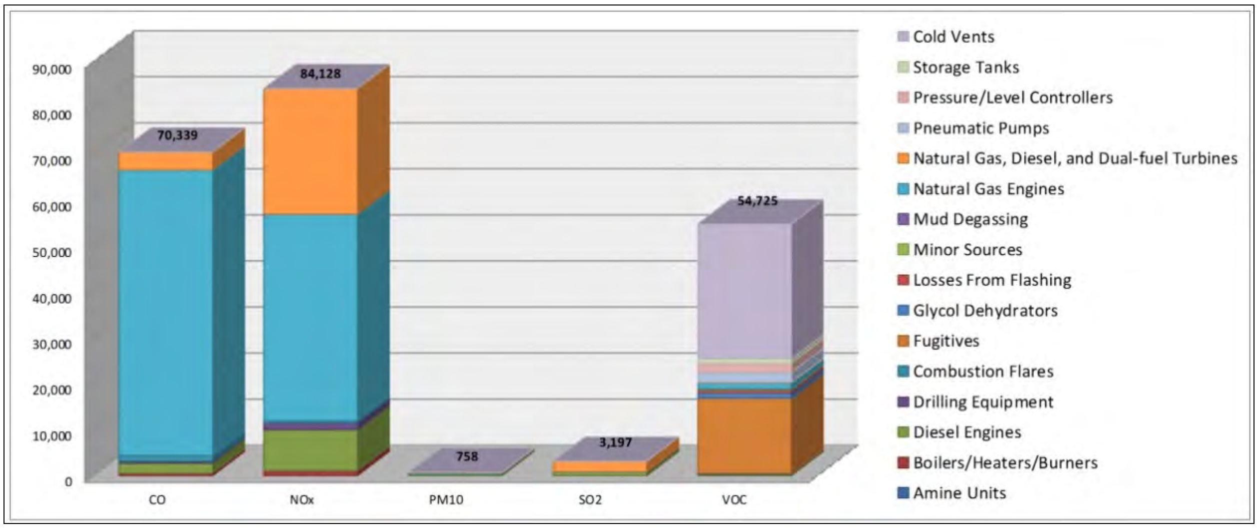


Figure 4-4. 2011 Criteria Pollutant Emissions (TPY) from Platform Sources.

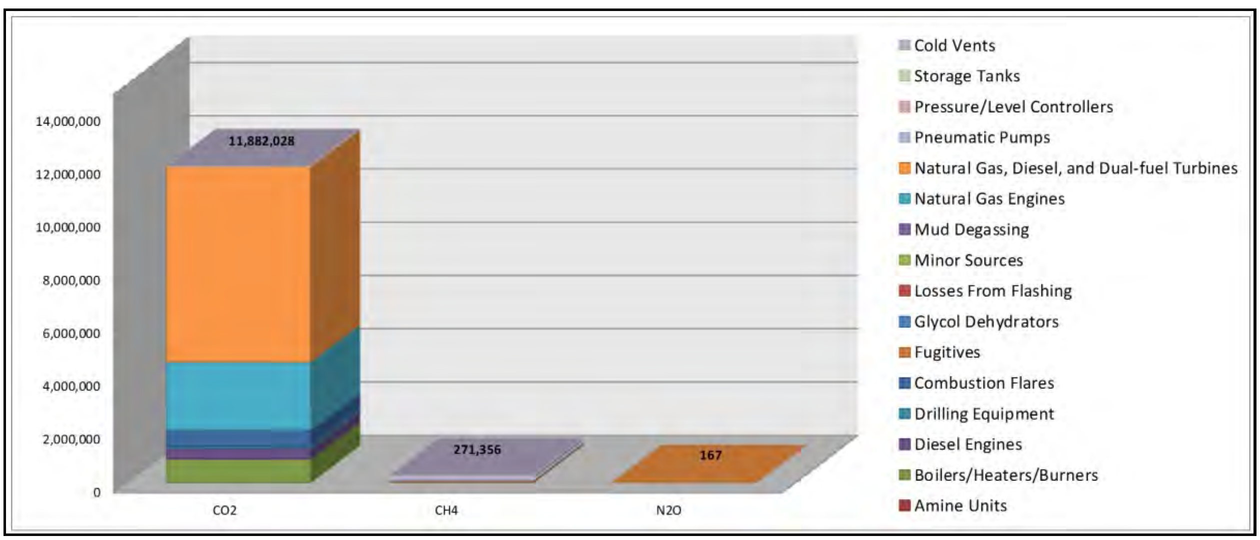


Figure 4-5. 2011 Greenhouse Gases (TPY) from Platform Sources.

The Year 2011 GWEI results for criteria pollutant and greenhouse gas emissions (in tons/year) from non-platform sources (not pictured) indicate that support vessels emit the majority of the greenhouse gas emissions, as well as the highest emitter of both NO_x and PM_{10} criteria pollutants.

4.1.2 Environmental Consequences

The impact-producing factors and their potential impacts identified for routine activities, accidental events, cumulative impacts, and incomplete or available information would apply, in general, to Alternatives A-D. These analyses are then applied to each alternative based on the varying degrees of forecasted levels of activities by geographical area and water depth. Following this environmental consequences discussion, there will be a summary of the potential impacts as they relate to the alternatives.

As discussed in the air quality introduction, the following list of impact-producing factors can occur in routine activities, accidental events, and cumulative impacts. The impact-producing factors include (1) OCS oil- and gas-related emissions sources related to drilling and associated vessel support, production, and the connected action of vessel support, flaring and venting, decommissioning, and oil spills; (2) non-OCS oil- and gas-related emissions such as State oil and gas programs, onshore industrial and transportation sources, and natural events; and (3) the incremental contribution of all postlease activities as a result of a single proposed lease sale. These impact-producing factors can produce greenhouse gas and fugitive emissions, which are discussed below.

Greenhouse Gases and Fugitive Emissions

Greenhouse Gases Including Downstream Gas

Chief among drivers of climate change are increasing atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases, such as methane (CH_4) and nitrous oxide (N_2O). These greenhouse gases reduce the ability for solar radiation to re-radiate out of the Earth's atmosphere and into space. Although all three have natural sources, these three greenhouse gases comprise the majority of greenhouse gases released from anthropogenic sources; CO_2 and N_2O are released in association with combustion and CH_4 and N_2O are released as a byproduct of agriculture and also oil and gas production. Hydrofluorocarbons and sulfur hexafluoride are two fluorinated greenhouse gases that are used on the OCS, but they are used in trace amounts and are at no time deliberately emitted into the atmosphere.

The activities associated with a proposed action would increase global greenhouse gas emissions from the use of vessels, drilling equipment, and other activities that burn fossil fuels. In addition, CH_4, also known as natural gas, is removed from wells and brought onto OCS facilities along with oil being produced. Sometimes CH_4 is released as a fugitive gas that can escape unintentionally from leaks in equipment used by operators. Operators have the four following methods of managing natural gas removed from wells: (1) production – selling the natural gas, provided there is a sufficient quantity, favorable market conditions, and infrastructure (e.g., natural gas pipelines) to justify production; (2) reinjection – the natural gas is directed back into the reservoir to aid in oil extraction; (3) venting – the deliberate release of natural gas into the atmosphere; and (4) flaring – burning the natural gas, converting it to CO_2 and water, and in some cases, also releasing N_2O and black carbon. This practice is rare on the OCS.

Because each greenhouse gas impacts the atmosphere at a different strength and for a different period of time, for analytical purposes, they typically are converted to what the strength would be if emissions were exclusively CO_2; this is referred to as the CO_2-equivelent (CO_2e) to facilitate comparison. CH_4 and N_2O are much more effective climate forcers than CO_2, meaning 1 ton of CH_4 or N_2O has a greater impact on climate change than 1 ton of CO_2. However, CH_4 and N_2O are removed from the atmosphere through natural processes more efficiently than CO_2. Accounting for these factors, CO_2e conversion for CH_4 and N_2O are 25 and 298, respectively (Brander, 2012). This means that 1 ton of CH_4 is estimated to have the same warming potential as 25 tons of CO_2, and 1 ton of N_2O would have the same impact as 298 tons of CO_2. Because black carbon is not a greenhouse gas and functions differently, it is not possible to convert it using the CO_2e method. However, because black carbon is a specific kind of $PM_{2.5}$, it is possible to use the $PM_{2.5}$ concentration to estimate the maximum amount of black carbon released. BOEM has regulatory authority on the OCS for $PM_{2.5}$, along with several other air quality pollutants.

As a result of exploration, development, and production of oil and gas on the OCS, the activities associated with a proposed action are expected to release greenhouse gases and black carbon from the use of combustion engines in vessels, construction, drilling, and other equipment, as well as through the deliberate or accidental release of CH_4. Emissions estimates for the activities associated with a proposed action, and for cumulative BOEM-related OCS emissions, were calculated using the Offshore Environmental Cost Model. These estimates are for the high-price scenario, which would likely result in the highest level of potential emissions for a proposed action. Cumulative numbers include current operations, the activities associated with a proposed action, and expected future development beyond a proposed action. Unlike the greenhouse gases, which warm the planet generally, black carbon's potential to contribute to climate change has a spatial component. Compared with the 2012-2017 Five-Year Program, the activities associated with a proposed action would result in an overall increase in the rate of CO_2e emissions from OCS oil- and gas-related activities.

In addition to the direct emissions from OCS oil- and gas-related operations presented above, BOEM has evaluated greenhouse gas emissions covering the lifecycle of OCS oil and gas production and consumption. This includes both the "downstream" consumption and onshore processing of oil and gas products, as well as the "upstream" emissions from offshore exploration, development, and production.

The expected greenhouse gas emissions for the low- and high-price scenarios include numerous assumptions (Wolvovsky and Anderson, 2016); therefore, while being a reasonable approximation, these numbers are an estimate and not a forecast. However, because the methodology used to compare the two price scenarios and the No Action Alternative are the same, the analysis can be assumed to provide a relative comparison. There is a significant degree of uncertainty in these numbers, and they do not take into account future Federal, State, and/or local economic, social, policy, regulatory, and legislative changes that could affect the amount of greenhouse gases released. In addition, this analysis is bounded by U.S. consumption and the upstream domestic and overseas production supporting American consumption. This means that the likely overseas reduction in consumption under the No Action Alternative is not calculated in this analysis.

On April 22, 2016, the United States joined the Paris Agreement, a United Nations-brokered agreement to keep global temperatures within 2 °C (36 °F) of the pre-industrial climate, and preferably within 1.5 °C (35 °F) (United Nations Framework Convention on Climate Change, 2016). A recent study (McGlade and Ekins, 2015) states that, to prevent the planet from warming beyond 2 °C (36 °F), emissions of greenhouse gases must be kept below 1,100 billion tons of CO_2e between 2011 and 2050. McGlade and Elkins (2015) also discuss the need to greatly reduce the amount of oil and gas extraction to stay under this threshold, with particular emphasis on not drilling in the Arctic. It should be noted that the 2 °C (36 °F) warming threshold would still result in significant impacts on the world's ecosystems and to humanity (Hansen et al., 2016).

The U.S. has pledged to reduce emissions by filing an Intended Nationally Determined Contributions with the United Nations. The American Intended Nationally Determined Contributions commitment is to reduce net greenhouse gas emissions by 17 percent below 2005 levels by 2020 and by 26‑28 percent by 2025 (United Nations Framework Convention on Climate Change, 2016). In addition, the Obama Administration set a target to reduce U.S. greenhouse gas emissions by at least 80 percent by 2050 (The White House, 2015). In 2005, the U.S. had net emissions of 6,680,300,000 metric tons of CO_2e (Brander, 2012).

The activities associated with the proposed action's lifecycle emissions fluctuate over the course of the 2017-2022 Five-Year Program in the GOM, with early emissions largely coming from OCS sources. The greenhouse gas emissions would peak in the 2030s and 2040s, at the same time as production peaks. Overall, the greenhouse gases from the activities associated with the proposed action would be similar to but slightly lower than the No Action Alternative in both low- and high-price scenarios. This similarity is due to the economic substitution effects from onshore and overseas sources expected under the No Action Alternative.

Additional sector-specific goals, such as the United States' commitment with Canada and Mexico to achieve 50 percent of electricity from noncarbon sources (The White House, 2016) and other yet-to-be determined measures, could significantly affect how oil and gas products are used and the emissions resulting from that consumption. Policies already determined and implemented have been included in the lifecycle analysis. The high- and low-price scenarios are intended to provide the upper and lower bounds of possible emissions scenarios. Overall, implementation of U.S. climate goals through future policies and regulations would be expected to reduce overall oil and gas demand, making it unlikely that the estimated emissions presented for the high-price scenario would be realized.

Fugitive Emissions

Fugitive emissions are not intentionally released through a stack, vent, or flare, but they are instead caused by leaks or intermittently escapes from pressurized equipment from sealed surfaces in various components of the facility. Fugitive emissions are mainly comprised of VOCs and methane (CH_4). Sources of fugitive emissions typically include valves, flanges, connectors, pumps, and compressor seals, but they may also include other platform components such as pneumatic controllers. Fugitive emissions can occur during all phases of OCS oil- and gas-related activity.

According to the Year 2011 GWEI study, fugitive emissions constitute one of the largest VOCs and CH_4 emissions sources from offshore oil and gas platforms, behind only cold vents. The BSEE personnel have indicated that the infrared camera surveys, performed to detect hydrocarbon leaks during inspections of offshore platforms, show very few, if any, hydrocarbon leaks. This could imply that the current emission factors may be overestimating VOC and methane emissions. Several State coastal areas have been designated nonattainment for ozone. Since ozone is formed by the combination of VOCs and NO_x, the OCS emissions inventory for VOCs needs to be as accurate as possible. In addition, the Government Accountability Office has published *Opportunities Exist to Capture Vented and Flared Natural Gas, Which Would Increase Royalty Payments and Reduce Greenhouse Gases* (U.S. Government Accountability Office, 2010) looking to reduce CH_4 emissions by the installation of control technology on platforms. Before control technology is required, the OCS emissions inventory for CH_4 also needs to be as accurate as possible.

Based on the results of the emission inventory study, as well as correspondence with BSEE, and the GAO report, BOEM wants to further assess emissions from fugitive equipment leaks on offshore oil and gas platforms operating on the Gulf of Mexico OCS. Under BOEM's Contract Number M16PC00010, "Fugitive Emissions Update in the Outer Continental Shelf," the objective is to visit offshore production platforms to identify and conduct the testing of fugitive equipment leaks in order to develop updated VOC, select hazardous air pollutant, and methane emission factors. These updated emission factors would be used by BOEM to develop improved and contemporary emissions inventories that will be used for a variety of purposes, including future photochemical grid modeling conducted by states in the Gulf of Mexico region for State Implementation Plan compliance demonstrations. However, if the OCS emissions inventories are overestimating VOC and methane emissions, then possibly control technologies would not be required. These study results are projected to be available by spring of 2019. Otherwise, BOEM would determine the appropriate use of control technologies on the platforms during postlease reviews.

4.1.2.1 Routine Activities

The primary routine impact-producing factors associated with the proposed action that could potentially affect air quality and that also could contribute to climate change include (1) drilling and production and the associated vessel support, (2) flaring and venting, and (3) decommissioning of facilities. These routine activities result in pollutant emissions. Emissions of air pollutants from these activities would occur during exploration, development, production, and decommissioning activities.

Drilling and Production with Associated Vessel Support

Since both drilling and production activities include associated vessel support, the activities are analyzed together in this section. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper wellbore hole. During drilling, diesel engines are used to power the drilling (top drive) assembly, draw works, electrical generators, mud pumps, vessel propulsion (drillships and support vessels)), and dynamic positioning systems of the drilling rig (if a dynamic positioning semisubmersible or dynamic positioning drillship is used). Combustion of fuel to run the engines generates NAAQS criteria pollutants, VOCs, and greenhouse gases. More information about the pollutants that are generated by specific equipment and activities is available in the *Year 2011 Gulfwide Emission Inventory Study* (Wilson et al., 2014). As illustrated in **Figure 3-2**, during a 50-year analysis period, exploratory drilling mainly occurs during the first decade and development drilling extends throughout the first and second decade.

We know from **Chapter 3** that, during production, pollutants emitted during routine activities may be combustion products of burning fuel to power pumps, compressors, or generators, or they may consist of fugitive VOCs, which escape from the un-combusted hydrocarbons. The platform emission sources include boilers, turbines, pneumatic pumps, diesel engines, combustion flares, fugitives, glycol dehydrators, natural gas engines, pressure/level controllers, storage tanks, cold vents, and others. As illustrated in **Figure 3-2**, during a 50-year analysis, most production occurs during the second and third decade. Because the levels of activity in the 2011 GWEI are projected to be less than a proposed lease sale, these emission values are used to project potential impacts as described below.

The OCS emissions in tons per year for the criteria pollutants and for the greenhouse gases from platform sources are indicated in **Figures 4-4 and 4-5**. The distribution of emissions across various platforms sources would be expected to be similar. These figures show the following: criteria pollutants – the major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant; and greenhouse gases – the major pollutant emitted is CO_2, while N_2O is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x and CO_2; platform operations are also the major contributors of VOC emissions. As a result of a proposed lease sale, multiple platforms would be installed on the leases, and platform construction emissions would contribute appreciable amounts of all pollutants over the resulting lease sale's 50-year analysis period. Emissions from a singular platform construction are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. Drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 90-day per well drilling period. Support vessels for OCS oil- and gas-related activities, as described in **Chapter**

3.1.4.4, include emissions of NO_x, CO, and CO_2. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and offshore facilities; a smaller percentage of the emissions occur during idling at the platform.

Currently, there are minor impacts occurring to air quality from drilling and production with associated vessel support impacts as shown in the model. Therefore, because the projected activities in this scenario for a proposed lease sale are less than the current 2011 GWEI activities, the impacts would be **minor**. The activities' impacts would vary in intensity based on the type and location of the activity.

Flaring and Venting

Reasonably foreseeable flaring and venting emissions operations occur intermittently for short periods of time over the life of the lease. Flaring systems are also used to vent natural gas during well testing or during repair/installation of production equipment. The BSEE operating regulations at 30 CFR § 250.1160 provide for some limited volume, short-duration flaring, or venting of some natural gas volumes upon approval by BSEE. These operations may occur for short periods of time (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. The potential impacts from these emergency operations are described in the "Accidental Events" chapter below and in **Chapter 3.2.3**.

Flaring may involve the disposal of sweet gas or sour gas. Sweet gas is natural gas that does not contain hydrogen sulfide (H_2S), while sour gas is natural gas that does contain H_2S. During the flaring of gas containing H_2S, the gas entering the flare would largely combust to SO_2. The contribution of flaring sour gas to SO_2 is regulated in 30 CFR part 250 subpart K. The SO_2 levels from reasonably foreseeable flaring are evaluated as part of the postlease plans review process.

Hydrogen sulfide released to the air can come from natural sources such as swamps, bogs, and volcanoes. Hydrogen sulfide can also be released from industrial sources such as petroleum refineries, natural gas plants, kraft paper mills, manure treatment facilities, waste-water treatment facilities, and tanneries. The concentration of H_2S occurring naturally in crude oil varies from formation to formation and even varies to some degree within the same reservoir. The natural gas in deepwater reservoirs has been mainly sweet (i.e., low in sulfur content), but the oil averages between 1 and 4 percent sulfur content by weight. By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km (93 mi) of the Breton Wilderness Area Class I area. The BSEE regulations at 30 CFR § 250.490(f) describe safety precautions for employees operating in an H_2S area. Hydrogen sulfide is a naturally occurring compound that is formed from the breakdown of organic matter in low oxygen environments. The effects of H_2S depend on the magnitude, duration, and frequency of exposure, as well as the susceptibility of the individual organism or environment. The human nose is very sensitive and can detect extremely low levels of H_2S. A rotten egg odor characterizes H_2S at very low concentrations. However, prolonged exposure to low levels of H_2S can cause skin irritation and olfactory paralysis. Therefore, relying on odor or sense of smell would not be a reliable warning signal to detect H_2S presence. Short-term exposure to high concentrations of H_2S can cause death. Portable monitors worn by workers, as well as visual and audible alarms and H_2S sensors on platforms to activate when the presence of H_2S is detected, can help to prevent loss of life. According to the NPS, Gulf Islands National Seashore visitors have complained about H_2S odors. BOEM expects that concentrations at the park, resulting from OCS sources of H_2S, to be at very low nuisance levels. The source of odors in the park may include releases from the local marsh muds or nearby State oil and gas activity. Therefore, several contributing factors could be responsible for the odors at Gulf Islands National Seashore.

Impacts to air quality from reasonably foreseeable flaring and venting would be **minor** because the activity is short in duration during a 50-year analysis period, and release likely dissipates before reaching coastal areas due to distance. The impacts would vary in intensity based on the type of flare and location of the activity.

Decommissioning

During a 50-year analysis period, most decommissioning occurs during years 20-40. Decommissioning emissions are due mainly to engines on vessels used in the decommissioning process for propulsion, electrical power, and ancillary mechanical equipment and activities. These emissions include the following pollutants: CO, NO_2, PM, SO_2, CO_2, CH_4, N_2O, and VOCs. There are two primary methodologies used in the GOM for cutting decommissioning targets: nonexplosive and explosive severance. Nonexplosive methods include abrasive cutters, mechanical cutters, diamond wire cutting devices, and cutting facilitated by commercial divers using arc/gas torches. Though a relatively slow process and potentially dangerous for offshore workers, nonexplosive-severance activities have little to no impact on air quality. Explosive-severance activities use specialized charges to achieve target severance. Unlike most nonexplosive methods, severance charges can be deployed on multiple targets and detonated nearly simultaneously, effecting rapid severances. Though a relatively faster yet safer process for offshore workers with the omission of diver cutting, the detonation of cutting charges occurs mainly underwater and, therefore, would have little impact on air quality. The impacts would vary in intensity based on the type and location of the activity. The main concern of air quality from decommissioning is the exhaust from support equipment. The less time that heavy equipment must be employed during decommissioning, the less air quality would be negatively impacted. Overall, impacts to air quality from decommissioning would be **minor**.

4.1.2.2 Accidental Events

The greatest impact-producing factors associated with a proposed action that could potentially affect air quality from a reasonably foreseeable accidental event include (1) emergency flaring and venting, and (2) oil spills. Accidental air emissions are described in **Chapter 3.2.3**.

Emergency Flaring and Venting

Emergency flaring is distinguished from routine flaring by the magnitude, frequency, and duration of flaring events. Emergency flaring events are the result of operating conditions that are outside normal process and equipment operations. Emergency flaring is generally characterized by infrequent occurrence, high-emission rates, and short durations. Potential impacts to air quality are not expected to be significant, except in the rare case of a catastrophic event, which is not part of a proposed action and not reasonably foreseeable. Emergency flaring may be conducted to manage excess natural gas during an accidental event, such as damage to a pipeline that transports the gas to shore, or a process upset. In the absence of safety flares, plants would be at a higher risk for fires and explosions. The flare is operated temporarily until the emergency situation is resolved. Flaring would result in the release of NO_x emissions from the flare; SO_2 emissions would be dependent on the sulfur content of the crude oil; and particulate matter from the flare would affect visibility.

Venting would result in the release of mainly CH_4 emissions. Emergency venting may be necessary where flaring of the gas is not possible or in situations precluding the use of a flare gas system, such as insufficient hydrocarbon content in the gas stream to support combustion or a lack of sufficient gas pressure to allow it to enter the flare system. Therefore, the potential impacts of a reasonably foreseeable accidental gas release analyzed in this Supplemental EIS would be localized and short term, and would have no impact to coastal areas, including the Bradwell Bay Wilderness Area, Breton Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area, or the Padre Island National Seashore and Gulf Islands National Seashore. The accidental event's impacts on air quality over the OCS and adjacent onshore areas on accidental gas releases are expected to be **minor**.

The accidental release of hydrocarbons related to a proposed lease sale would result in the emission of air pollutants. The OCS accidents would 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, hydrogen sulfide, and methane. These pollutants are discussed above. These accidental events may potentially affect the air quality at the Bradwell Bay Wilderness Area, Breton Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area, as well as the Padre Island National Seashore and Gulf Islands National Seashore, during a 50-year analysis period.

Emergency flaring may be conducted to manage excess natural gas during an accidental event such as damage to a pipeline that transports the gas to shore or a process upset. In the absence of safety flares, plants would be at a higher risk for fires and explosions. The flare is operated temporarily until the emergency situation is resolved. Flaring would result in the release of NO_x emissions from the flare; SO_2 emissions would be dependent on the sulfur content of the crude oil; and particulate matter from the flare would affect visibility.

Oil Spills

Accidental oil spills, though not considered a routine OCS oil- and gas-related activity, have the potential to occur during each phase of oil and gas operations. In April 2010, the *Deepwater Horizon* explosion and oil spill was a catastrophic event that occurred on the Gulf of Mexico OCS. The impacts on air quality from the *Deepwater Horizon* explosion and oil spill have been well documented. BOEM does not expect accidental events to resemble the *Deepwater Horizon* explosion and oil spill. BOEM is not analyzing the rare, catastrophic *Deepwater Horizon* explosion and oil spill as an accidental event in this chapter but rather is using the information to describe the potential impacts common to spills and accidental events regardless of size. Additionally, BOEM has assessed the potential impacts resulting from a low-probability catastrophic event, and the analysis is presented in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b). To date, air monitoring conducted following the *Macondo* loss of well control and spill has not found any pollutants at levels expected to cause long-term harm (USEPA, 2010). The loss of well control and blowouts are rare events and of a short duration. Potential impacts to air quality are not expected to be significant, except in the rare case of a catastrophic event, which is not reasonably foreseeable and not part of a proposed action. Therefore, potential impacts as a result of the much smaller reasonably foreseeable accidental spills analyzed in this Supplemental EIS would be localized and short term, and would have no impact to coastal areas, including the Bradwell Bay Wilderness Area, Breton Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area, as well as the Padre Island National Seashore and Gulf Islands National Seashore. The accidental event's impact on air quality over the OCS and adjacent onshore areas on oil spills is therefore expected to be **minor**.

In the Gulf of Mexico, evaporation from an oil spill would result in concentrations of VOCs in the atmosphere, including chemicals that are classified as being hazardous. Benzene, toluene, ethylbenzene and xylene (BTEX) are a category of VOCs that occur naturally in crude oil, as well as during the process of making of gasoline and other fuels from crude oil. 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 VOCs, such as BTEX, 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. In hazardous conditions, the Occupational Safety and Health Administration and USCG regulations require workers to use breathing protection. The hazard to workers can also be reduced by limiting exposure through limited work shifts, rotating workers in close vicinity of the spill site, and pointing vessels into the wind. While the reasonably foreseeable spills analyzed as part of this Supplemental EIS are significantly smaller than the catastrophic *Deepwater Horizon* explosion and oil spill, air samples collected during that event by individual offshore workers of British Petroleum (BP), the Occupational Safety and Health Administration (OSHA), and the USCG showed levels of BTEX that were mostly under detection levels. All samples had concentrations below the OSHA permissible exposure limits and the more stringent American Conference of Governmental Industrial Hygienists threshold limit values (U.S. Dept. of Labor, OSHA, 2010). Therefore, the reasonably foreseeable oil spills would be expected to be even smaller.

The VOC emissions that result from the evaporation of oil contribute to the formation of particulate matter ($PM_{2.5}$) in the atmosphere (Brock et al., 2012). In addition, VOCs could cause an increase in ozone levels, especially if the release were to occur on a hot, sunny day with sufficient concentrations of NO_x present in the lower atmosphere. Effects to ozone concentrations would depend on distance of the proposed lease sale area from shore and the accidental spill size. If there were any effects to onshore ozone concentrations to a state, they would likely be temporary in nature and last, at most, the length of time of the spill's duration.

Removal and containment efforts to respond to an ongoing offshore spill would likely require multiple technologies, including source containment, mechanical cleanup, in-situ burning of the slick, and chemical dispersants (**Chapter 3.2.7**). In-situ burning would result in ambient concentrations of CO, CO_2, NO_x, PM_{10}, $PM_{2.5}$, and SO_2 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.

4.1.2.3 Cumulative Impacts

An analysis of the cumulative impacts in the GOM region is described in this chapter. This cumulative analysis considers OCS oil- and gas-related and non-OCS oil- and gas-related activities that could occur and adversely affect air quality during the 50-year analysis period.

Under BOEM Contract Number M14PC00007, "Air Quality Modeling in the Gulf of Mexico Region" study, photochemical grid modeling was conducted to assess the impacts to nearby states of existing and proposed future OCS oil and gas exploration, development, and production. Preliminary results from the modeling conducted for this study have become available and are being included in this Supplemental EIS to disclose potential cumulative and incremental air quality impacts of the proposed lease sales. These preliminary results represent the best available science at this time and are included in **Appendices B-D**. At the lease issuance stage, no activities beyond certain ancillary activities are actually authorized by the lease; therefore, there are few environmental impacts, including air quality, reasonably expected from a proposed lease sale itself (refer to **Chapter 1.2.1**). During postlease activities, BOEM has the authority to disapprove or require additional mitigation to reduce impacts from site-specific activities as additional information becomes available.

The air quality modeling study examines the potential impacts of the proposed lease sales with respect to (1) the NAAQS for the criteria pollutants O_3, NO_2, SO_2, CO, $PM_{2.5}$, PM_{10}; (2) the Class I and Class II PSD increments; and (3) the AQRVs, including visibility and acid deposition (sulfur and nitrogen) in the nearby Class I and sensitive Class II areas.

Results of each impact analysis are compared with applicable "thresholds of concern," which have typically been used in air quality impact evaluations by other Federal actions, including onshore oil and gas leasing programs. The applicable comparison thresholds for criteria pollutant impacts are the corresponding NAAQS. For acid (i.e., sulfur and nitrogen) deposition impacts, thresholds are based on (1) incremental impacts considered sufficiently small as to have no consequential effect on the receiving ecosystems, i.e., Deposition Analysis Thresholds, and (2) critical load levels above which cumulative ecosystem effects are likely to or have been observed. For visibility impacts, thresholds are based on incremental changes in light extinction below the level at which they would be noticeable to the average human observer. Additional information about these various thresholds is provided in relevant chapters in the remainder of this Supplemental EIS.

Overview of Modeling Approach

The Comprehensive Air-quality Model with extensions (CAM) and Community Multiscale Air Quality (CMAQ) photochemical grid models were used to simulate the dispersion and chemical transformation of pollutants over the study area. Similar to other air quality models, CAMx/CMAQ require several input datasets, including meteorology and an emissions inventory. **Figure 4-6** presents an overview of how these project datasets fit together for the "Air Quality Modeling in the Gulf of Mexico Region" study. Photochemical modeling was conducted for two emission scenarios:

(1) a Base Case scenario using the 2012 base year (BY) emissions inventory described in **Appendix C** to evaluate model performance and to define current baseline air quality conditions; and

(2) a Future Year development scenario (FY) using an emissions inventory that includes potential new sources associated with the lease sales analyzed for the Supplemental EIS and the projections of emissions to 2017 for all other sources as described in **Appendix C** to estimate the cumulative and incremental air quality and AQRV impacts of the lease sales analyzed in this Supplemental EIS.

NOTE: Both scenarios used the same 2012 meteorological dataset and the same photochemical model configuration. (*In determining the Base Case [base year] for the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory, 2011 was initially selected based on data availability. Calendar year 2011 emissions data are readily available for most sources from the USEPA's National Emissions Inventory [USEPA, 2017b and 2017c] and the BOEM's Year 2011 Gulfwide Emissions Inventory Study [Wilson et al., 2014]. However, 2011 was an unusually hot and dry year in the Gulf of Mexico region, particularly in Texas, which experienced record heat and dry conditions during the summer of 2011 and which had a very high incidence of wildfires. Therefore, 2012 was selected as the base year as more representative of "typical" conditions in the Gulf of Mexico region.*)

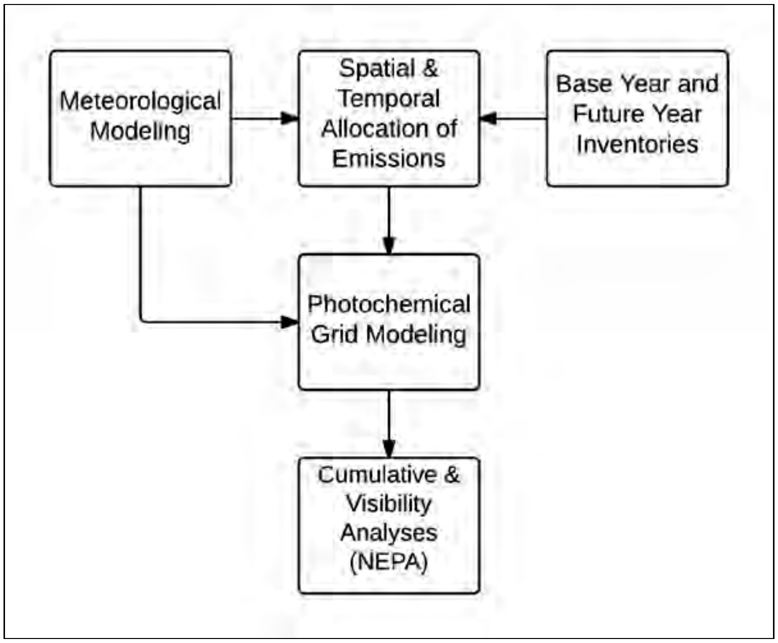


Figure 4-6. Overview of the Gulf of Mexico Region's Cumulative and Visibility Impacts Assessment.

Modeling Input – Meteorological Modeling

Meteorological datasets required to determine the rate that pollutants disperse and react in the atmosphere include spatially and temporally varying parameters such as wind speed, wind direction, air temperature, and humidity, among others. Sources of meteorological information include datasets of measurements gathered at various locations within the Gulf of Mexico region domain, i.e., the area of interest where geographic features influence transport patterns. Results of these meteorological models provide the inputs needed to exercise the photochemical grid air quality dispersion models used in the "Air Quality Modeling in the Gulf of Mexico Region" study. For this study, the Advanced Research version of the Weather and Research Forecasting (WRF) model, as described in **Appendix B**, was applied over a system of nested modeling grids. **Figure 4-7** shows the WRF modeling grids at horizontal resolutions of 36, 12, and 4 km. All WRF grids were defined on a Lambert Conformal Conic (LCC) projection centered at 40° N. latitude, 97° W. longitude with true latitudes at 33° N. latitude and 45° N. latitude (the "standard RPO" projection). In **Figure 4-7**, the outermost domain (outer box) with 36-km resolution includes the entire continental U.S. and parts of Canada and Mexico, and captures synoptic-scale (storm system-scale) structures in the atmosphere. The inner 12-km regional grid (d02) covers the southeastern U.S. and is used to ensure that large-scale meteorological patterns across the region are adequately represented and to provide boundary conditions to the 4-km domain. The 4-km domain (d03) is centered on the coastal areas of the southeastern U.S. and over-water portions of the Gulf of Mexico. The 4-km domain area, which includes parts of Alabama, Georgia, Louisiana, Mississippi, and Texas, and all of Florida, as well as the WPA, CPA, and EPA, and part of the Atlantic Ocean, was the main focus of the emissions inventory efforts. However, the focus of this Supplemental EIS analysis are the coastal areas adjacent to the WPA, CPA, and EPA, which include Texas, Louisiana, Mississippi, Alabama, and Florida.

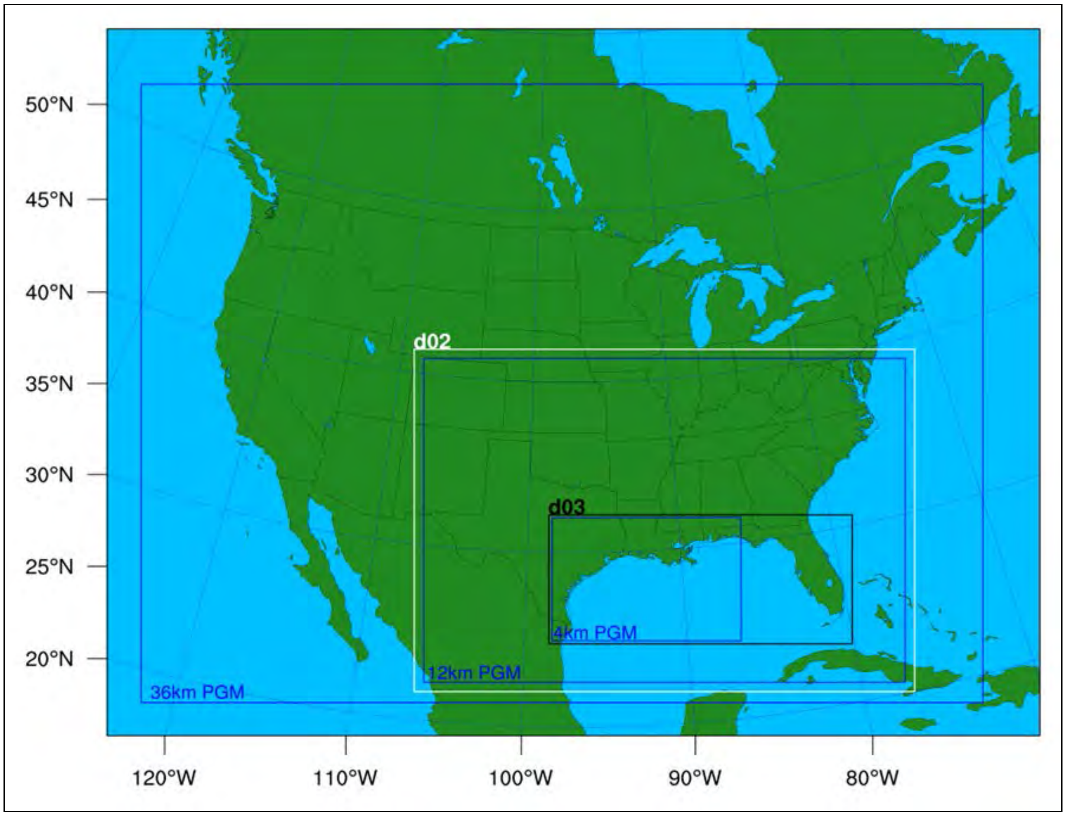


Figure 4-7. Geographic Domain of the "Air Quality Modeling in the Gulf of Mexico" Region Study.

Modeling Input – Emissions Inventories

Analysis of the cumulative air quality impacts of this Supplemental EIS required the development of both a contemporary base year emissions inventory for the base case analysis and a projected future year inventory that includes emissions from all cumulative sources, as well as additional emissions anticipated to occur under this Supplemental EIS' alternative in which additional exploratory drilling and construction of new shallow and deepwater platforms to support oil and gas production would occur. Both the base case and future year cumulative source inventories represent comprehensive compilations of pollutant emissions from all human activities as well as emissions from biogenic and geogenic sources. Specific details on the development of the emission inventory are presented in **Appendix C**. The scope of the air pollutant emissions inventory for the "Air Quality Modeling in the Gulf of Mexico Region" study is defined in terms of pollutants, representative time periods for the base case and future year analysis, geographical domain, and sources to be included.

Pollutants included in the inventories were selected to support analysis of air quality impacts in terms of impacts on attainment of the NAAQS and on AQRVs, including acid deposition and visibility. The selected pollutants are as follows: the NAAQS criteria pollutants – CO, NO_x (which includes NO and NO_2 and is stated in terms of equivalent mass of NO_2), $PM_{2.5}$, fine plus coarse PM (PM_{10}), and SO_2; criteria precursors – VOCs (which are precursors to the formation of ozone and organic particulates) and ammonia (NH_3) (which is a precursor to particulate matter formation). As previously mentioned in **Chapter 4.1.1**, lead (Pb) was not included in the inventory. While the cumulative air quality impact analysis did not focus specifically on air toxics, the compilation of VOC emissions by source type, together with VOC speciation profiles by source type, provides a mechanism for estimating emissions of individual air toxic species.

Overview of Modeling Results

The post-processed results for comparison to the NAAQS, PSD increments, and visibility and acid deposition thresholds are described below. The results in this section are still preliminary, but are being used to disclose the potential cumulative impacts to coastal areas.. Specific cumulative impact analysis results from the "Air Quality Modeling in the Gulf of Mexico Region" study are presented in **Appendix D**.

The CAMx future year scenario model and ozone and particulate matter source apportionment modeling outputs were post-processed for comparison against the NAAQS and PSD concentration increments, and other thresholds of concern as discussed below. For analyzing the NAAQS and AQRV impacts at Class I and sensitive Class II areas, the thresholds of concern used were as defined by the Federal Land Manager that manages each Class I/II area.

Source apportionment provides a means of assessing the contributions of specified sources or categories of sources to predicted ozone and PM concentrations and their precursors under the air quality conditions being simulated. Source contributions were calculated for ozone and PM using the Ozone and Particulate Source Apportionment Technology (OSAT and PSAT) routines included in CAMx. Source apportionment analyses were applied to the future year scenario in order to analyze the pre- and postlease OCS oil- and gas-related impacts to short-term and annual NAAQS, AQRVs, and PSD increments. While BOEM selected nine source categories for the CAMx future year source apportionment simulation as listed in **Table 4-4**, only four are appropriate for this Supplemental EIS analysis because they apply to the Gulf of Mexico region.

Table 4-4. Source Categories for Source Apportionment Calculations.

Category ID	Sources
SC3	Additional BOEM OCS oil and gas production platforms associated with this Supplemental EIS (with Action)
SC4	Additional BOEM oil and gas production support vessels and helicopters associated with this Supplemental EIS (with Action)
SC5	BOEM's OCS oil and gas production platforms, support vessels, and helicopters under the base case (No Action)
SC6	All other marine vessel activity in the Gulf of Mexico not associated with OCS oil and gas development, exploration, or production

SC = source category.

4.1.2.3.1 Impacts Assessment

NAAQS Impacts

The impacts for the NAAQS criteria pollutants ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), fine particulate matter with aerodynamic diameter less than 2.5 µm ($PM_{2.5}$), and fine plus coarse particulate matter with aerodynamic diameters less than 10 µm (PM_{10}) are discussed below.

Comparison to the NAAQS

Results of each impact analysis are compared with applicable “thresholds of concern,” which have typically been used in air quality impact evaluations by other Federal actions, including onshore oil and gas leasing programs. The applicable comparison thresholds for criteria pollutant impacts are the corresponding NAAQS (**Table 4-5**).

The CAMx future year scenario predicted that the total concentrations from all emission sources were post-processed for comparison to the applicable NAAQS in two different ways. First, the CAMx predictions were compared directly against each NAAQS. This is referred to as the “absolute” prediction comparison. These absolute prediction comparisons may be misleading in cases in which the model exhibits significant prediction bias. In recognition of this, USEPA modeling guidance (USEPA, 2007 and 2014) recommends using the model in a relative sense when projecting future year ozone, $PM_{2.5}$, and regional haze levels, and USEPA has developed the Modeled Attainment Test Software (MATS; Abt., 2014) for making such future year projections. This approach uses the ratio of future year to current year modeling results to develop Relative Response Factors (RRFs) that are applied to observed current year Design Values (abbreviated as either DVC or DVB) to make future year Design Value (DVF) projections (i.e., DVF = DVC x RRF). The MATS was applied to the prediction of both ozone and $PM_{2.5}$ DVFs.

Table 4-5. NAAQS and PSD Increments.

Pollutant	Pollutant/Averaging Time	NAAQS	PSD Class I Increment[1]	PSD Class II Increment[1]
CO	1-hour[2]	**35 ppm** 40,000 µg/m^3	--	--
CO	8-hour[2]	**9 ppm** 10,000 µg/m^3	--	--
NO_2	1-hour[3]	**100 ppb** 188 µg/m^3	--	--
NO_2	Annual[4]	**53 ppb** 100 µg/m^3	2.5 µg/m^3	25 µg/m^3
O_3	8-hour[5]	**0.070 ppm** 137 µg/m^3	--	--
PM_{10}	24-hour[6]	**150 µg/m^3**	8 µg/m^3	30 µg/m^3
PM_{10}	Annual[7]	--	4 µg/m^3	17 µg/m^3
$PM_{2.5}$	24-hour[8]	**35 µg/m^3**	2 µg/m^3	9 µg/m^3
$PM_{2.5}$	Annual[9]	**12 µg/m^3**	1 µg/m^3	4 µg/m^3

Pollutant	Pollutant/Averaging Time	NAAQS	PSD Class I Increment[1]	PSD Class II Increment[1]
SO_2	1-hour[10]	**75 ppb** 196 μg/m^3		
SO_2	3-hour[11]	**0.5 ppm** 1,300 μg/m^3	25 μg/m^3	512 μg/m^3
SO_2	24-hour	--	5 μg/m^3	91 μg/m^3
SO_2	Annual[4]	--	2 μg/m^3	20 μg/m^3

μg/m^3 = microgram per cubic meter; CO = carbon monoxide; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; O_3 = ozone; $PM_{2.5}$ = particulate matter less than or equal to 2.5 μm; PM_{10} = particulate matter less than or equal to 10 μm; ppb = parts per billion; ppm = parts per million; PSD = Prevention of Significant Deterioration; SO_2 = sulphur dioxide.

[1] The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
[2] No more than one exceedance per calendar year.
[3] 98th percentile, averaged over 3 years.
[4] Annual mean not to be exceeded.
[5] Fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years, NAAQS promulgated December 28, 2015.
[6] Not to be exceeded more than once per calendar year on average over 3 years.
[7] 3-year average of the arithmetic means over a calendar year.
[8] 98th percentile, averaged over 3 years.
[9] Annual mean, averaged over 3 years, NAAQS promulgated December 14, 2012.
[10] 99th percentile of daily maximum 1-hour concentrations in a year, averaged over 3 years.
[11] No more than one exceedance per calendar year (secondary NAAQS).

Ozone

The ozone NAAQS is defined as an 8-hour averaging time that is expressed as a 3-year average of the 4th highest maximum daily average. Since only one calendar year of modeling results are available for the base year and future year outcome, the future year 4th highest maximum daily average 8-hour ozone concentration is used as a pseudo-NAAQS comparison metric. The USEPA's Model Attainment Test Software (MATs) was used to make future year ozone future design values projections using the CAMx 2012 Base Case and Future Year Scenario modeling results.

The impacts to air quality from ozone for of all proposed and existing oil and gas emissions from Gulf of Mexico OCS sources and their support vessels/aircraft (Source Group C) are **moderate** because the future year design values were above the current year design value (which was already above the NAAQS). The modeling suggests that the maximum contribution of all proposed and existing oil and gas emissions from Gulf of Mexico OCS sources and their support vessels/aircraft (Source Group C) occur in Galveston, Texas (a nonattainment area).

The impacts to air quality from O_3 for Source Group B (new platforms and associated support vessels and aircraft under this Supplemental EIS) are **minor** because the future year design values were lower than the current year design values. The modeling suggests that the maximum contribution of Source Group B is centered in the GOM offshore of Louisiana; maximum impacts from the State seaward boundaries inland along the coast of Cameron Parish, Louisiana. Source

Group A (new platforms under this Supplemental EIS) maximum contributions occur in the same location, but the support vessel and helicopter activities (from Source Group B) are responsible for the greater impacts landward of the State seaward boundary.

NOTE: *For the ozone impacts assessment, please note that the States will not designate under the 2015 ozone standard of 70 ppb until 2017, with the earliest attainment date of March 2021 for marginal areas. For this impacts assessment, the non-OCS source emissions were based on the USEPA's 2017 emission projections, with a future modeled year of 2017 and compared with the 70-ppb standard. This assessment is assuming the standard will be attained in advance of the actual attainment date but wanted to give maximum OCS oil and gas impacts under the new 70-ppb ozone standard.*

Particulate Matter (PM)

$PM_{2.5}$

There are two $PM_{2.5}$ NAAQS: one for the 24-hour averaging time that is expressed as a 3-year average of the annual 98th percentile in a year and an annual average over 3 years. With 1 year of photochemical grid modeling, the annual 98th percentile would correspond to the 8th highest 24-hour $PM_{2.5}$ concentration in a year. As described for the ozone NAAQS analysis, the MATS was used to calculate DVFs for the 24-hour and annual $PM_{2.5}$ NAAQS.

All future year modeled concentrations for 24-hour and annual $PM_{2.5}$ are below the NAAQS. The impacts to air quality from 24-hour $PM_{2.5}$ and annual $PM_{2.5}$ are **minor** because the future year design values were lower than the current year design values at all sites except one. While the annual $PM_{2.5}$ current year modeled concentration exceeded the NAAQS in Harris County, Texas, the projected future year design value at this location is below the NAAQS.

24-hour $PM_{2.5}$: All current and future year design values are below the NAAQS, and the future year design values are projected to be lower than the current year design values at all sites. The modeling suggests that the highest 24-hour $PM_{2.5}$ impacts occur at the State seaward boundary off the coast of Louisiana. There were no monitoring sites with the 24-hour $PM_{2.5}$ in excess of the NAAQS, with future year modeling projecting no design value exceedances. The maximum contributions due to emissions from all existing and proposed GOM platform and support equipment to the 8th highest 24-hour $PM_{2.5}$ concentrations occurs right on the State seaward boundary off the coast of Houma, Louisiana.

Annual Average $PM_{2.5}$: The modeling suggests that the highest annual $PM_{2.5}$ impacts occur right at the State seaward boundary off the coast of Louisiana. There was one monitoring site with annual $PM_{2.5}$ design value concentrations above the NAAQS (in Harris County (Houston), Texas) but reduced to below the NAAQS in the future year. The maximum contribution to annual $PM_{2.5}$ future design values due to emissions from all existing and proposed GOM platform and support equipment occurs at the State seaward boundary off the coast of Louisiana.

PM_{10}

There is only one PM_{10} NAAQS: one for the 24-hour averaging time that is expressed as a 3-year average not to be exceeded more than once per calendar year. With 1 year of photochemical grid modeling, the annual 98th percentile will correspond to the 8th highest 24-hour $PM_{2.5}$ concentration in a year. The impacts to air quality from PM_{10} are **minor** because, while there are concentrations increases in water farther offshore, no overall standards were exceeded.

24-Hour PM_{10}: The OCS oil- and gas-related impacts for the 24-hour PM_{10} are similar to the 24-hour $PM_{2.5}$ future year modeling, projecting no future design value exceedances. The modeled 2nd highest daily average PM_{10} concentrations can be compared with the 24-hour average PM_{10} NAAQS for the base and future scenarios and the base-future differences. The modeling suggests areas of elevated PM_{10} are evident in urban and port areas and in fire zones along the Gulf Coast of Texas and Louisiana (impacts of fires on PM_{10} are also seen). The PM_{10} decreases between the current and future year are modeled along the Louisiana coast, with increases in waters farther offshore associated with new emissions from proposed action sources. The maximum contribution of all oil and gas platforms and support vessels and helicopters (Source Group C) are below the NAAQS, and the maximum contribution of the new platforms and associated support vessels and aircraft under this Supplemental EIS (Source Group B) are below the NAAQS.

Nitrogen Dioxide (NO_2)

There are two nitrogen dioxide NAAQS: one for the 1-hour averaging time that is expressed as a 3-year average of the annual 98th percentile in a year and an annual average over 3 years. With 1 year of photochemical grid modeling, the annual 98th percentile would correspond to the 8th highest 24-hour NO_2 concentration in a year. Results are included below for both the 1-hour NO_2 and the annual NO_2 averaging times. All modeled concentrations for NO_2 are below the NAAQS. The impacts to air quality from 1-hour NO_2 and annual NO_2 are **minor** because overall, concentrations decrease between the base and future year scenarios at most locations. While there was in increase between the base and future year scenarios for annual NO_2 in Vermilion Parish, Louisiana, no standards were exceeded.

1-hour NO_2: All modeled 1-hour NO_2 concentrations are below the NAAQS. The overall, concentrations decrease between the base and future year scenarios at most locations. The modeling suggests that the maximum contributions from new platforms and support vessels and helicopters associated with this Supplemental EIS (Source Group B) are dominated by vessel and possibly helicopter traffic in the port areas, most notably in Vermilion Parish, Louisiana; and the maximum combined contributions from new and existing platforms and support vessels and helicopters (Source Group C) are dominant in the area of the LOOP.

Annual NO_2: These results are similar to those for 1-hour NO_2. The maximum impacts of new and existing platforms and support vessels and helicopters associated with this Supplemental EIS (Source Group C) showed increases between the base and future year scenarios to occur near the entrance to the Freshwater Bayou Canal in Vermilion Parish, Louisiana, and somewhat larger increases modeled in the Permian Basin of west Texas. However, overall no standards were exceeded.

Sulfur Dioxide (SO_2)

There are two sulfur dioxide NAAQS: one for a 1-hour averaging time that is expressed as a 3-year average of the annual 99^{th} percentile in a year and a 3-hour average not to be exceeded more than once per year. All modeled concentrations for SO_2 are below the NAAQS. The impacts to air quality from 1-hour SO_2 and 3-hour SO_2 are **minor** because overall, concentrations decrease between the base and future year scenarios at most locations as sources retire or apply control equipment.

1-hour SO_2: All modeled values are below the NAAQS. While maximum contributions are located from sources in areas with deepwater platforms, concentrations decrease in most locations in the future year scenario as sources are retired or apply control equipment with projected maximum impacts all below the NAAQS.

3-hour SO_2: All modeled values are below the NAAQS. These results are similar to those for the 1-hour SO_2 described above.

Carbon Monoxide (CO)

There are two carbon monoxide NAAQS: a 1-hour averaging time and an 8-hour average not to be exceeded more than once per year. All modeled concentrations for SO_2 are below the NAAQS. The impacts to air quality from 1-hour CO_2 and 8-hour CO are **minor** because overall, concentrations decrease between the base and future year scenarios at all locations.

1-hour CO: The modeled 1-hour CO design values (based on the annual 2^{nd} highest daily maximum 1-hour average) for the base, future, and future-base scenarios show all values are below the NAAQS.

8-hour CO: The modeled 8-hour CO design values (based on the annual 2^{nd} highest non-overlapping running 8-hour average) for the base, future, and future-base scenarios show the maximum predicted 8-hour design value in the future year occurs at the entrance to the Freshwater Bayou Canal in Vermilion Parish, Louisiana, but no over standard was exceeded.

Incremental Impacts of PSD Pollutants with Respect to PSD Class I and Class II Increments

As mentioned in the **Chapter 4.1.1**, the WPA, CPA, and EPA include national parks and Federal wilderness areas where air quality and AQRVs (primarily visibility) are protected more stringently than under the NAAQS. The Class I areas, compared with Class II areas, have lower PSD increments that new sources may not exceed and that are protected against excessive increases in several AQRVs, including visibility impairment. **Table 4-6** lists those areas that are located along the Gulf Coast and, thus, are of greatest interest to this analysis.

The incremental AQ/AQRV contributions associated with emissions from each source group listed in **Table 4-4** were calculated for the Class I and sensitive Class II areas listed in **Table 4-6**. The selected areas include all Class I and sensitive Class II areas within the 4-km modeling domain plus additional Class I areas within the 12-km modeling domain (Bradwell Bay).

The Class I and sensitive Class II increments analyses results are expressed in terms of the maximum increment consumption over all Class I and sensitive Class II areas within the 4-km modeling domain. Incremental impacts of each Source Group at Class I and sensitive Class II areas were calculated for all pollutants for which PSD increments have been set (NO_2, SO_2, PM_{10}, and $PM_{2.5}$) and are discussed below.

Table 4-6. Class I and Sensitive Class II Areas in Gulf Coast and Nearby States.

Type	Name	Agency	State	Modeling Domain
Class I	Breton Wilderness	FWS	LA	4 km
Class II	Breton NWR	FWS	LA	4 km
Class II	Gulf Islands NS	NPS	MS, FL	4 km
Class II	Padre Island NS	NPS	TX	4 km
Class I	Bradwell Bay	FS	FL	12 km

FL = Florida; FS = Forest Service; FWS = Fish and Wildlife Service; LA = Louisiana; MS = Mississippi; NPS = National Park Service; NS = National Seashore; NWR = National Wildlife Refuge; TX = Texas.

Comparison at the Class I and Sensitive Class II Areas

The maximum contribution of new oil and gas production sources under this Supplemental EIS were reported for each Class I and sensitive Class II area and were compared against the PSD increments given in **Table 4-5**. Comparisons of impacts from a proposed action with maximum allowed PSD increments are presented here as an evaluation of a “threshold of concern” for potentially significant adverse impacts, but they do not represent a regulatory PSD increment consumption analysis. (*Note: This analysis does not constitute a regulatory PSD increment consumption analysis as would be required for major sources subject to the New Source Review program requirements of the Clean Air Act. Under the Clean Air Act, a PSD increment consumption analysis requires major stationary sources subject to PSD review to demonstrate that emission increases from the proposed source, in conjunction with all other emissions increases or reductions in the impacted area (typically within 50 km [31 mi]), will not cause or contribute to concentrations of air pollutants that exceed PSD increments. The PSD increments have been established for* NO_x, SO_2, *and PM in Class I and* sensitive *Class II areas. Actions to be authorized by BOEM under this Supplemental EIS do not typically constitute major stationary sources and do not typically trigger PSD permits or review. However, a comparison of ambient concentrations from an accumulation of new oil and gas sources within the entire study area to PSD increments at specific Class I and* sensitive *Class II areas is included in this analysis for information purposes. This information is presented to aid State agencies in tracking potential minor source increment consumption and to aid Federal Land Managers or Tribal governments responsible for protecting air resources in Class I areas).*

The CAMx source apportionment results for individual source categories were used to evaluate the incremental impacts of each of a set of hierarchical source groups as defined in **Table 4-6**. Note that Source Group B represents all new direct emissions associated with this Supplemental EIS, and Source Group C represents these sources in addition to all existing OCS platforms and associated support vessel and aircraft activity.

The impacts to Class I areas from contributions of new platforms and its associated support vessels and aircraft are **minor** because proposed activities exceed the 24-hour $PM_{2.5}$ Class I PSD increments by 10 percent at the Breton Wilderness Area, which are a result of support vessels and helicopter traffic associated with the activities. The impacts to Class I areas from contributions of all activities from past, present, and future lease sales are **moderate** because proposed activities exceed the annual and 24-hour $PM_{2.5}$, 24-hour PM_{10}, and annual NO_2 Class I PSD increments at the Breton Wilderness Area. BOEM has been in consultation with FWS and will be conducting further refined modeling. It is anticipated that these air quality results will be updated in a Supplemental EIS as soon as these data are available.

The impacts to sensitive Class II areas from contributions of all activities as a result of a single proposed lease sale are **minor** because, while maximum increases occur at the Gulf Islands National Seashore for all PSD pollutants and averaging times and increases occur for annual NO_2 at the Breton Wilderness Area, there are no exceedances of the PSD Class II increment. The impacts to sensitive Class II areas from contributions of all activities from past, present, and future lease sales are **moderate** because proposed activities exceed the annual 24-hour $PM_{2.5}$ Class II PSD increments at the Gulf Islands National Seashore.

Class I Areas

For all source groups described in **Table 4-7**, the maximum contributions for all PSD pollutants and averaging times occur at the Breton Wilderness Area Class I area. Concentration increments from Source Groups A and B are less than the maximum allowed PSD increments for all pollutants and averaging times, except for the 24-hour $PM_{2.5}$ increment from Source Group B at the Breton Wilderness Class I area where the maximum impact exceeds the Class I PSD increment. The difference in the maximum Source Group A 24-hour average $PM_{2.5}$ increment and the maximum Source Group B 24-hour average $PM_{2.5}$ indicates that support vessels or helicopter traffic associated with new offshore platforms, rather than emissions from the platforms themselves, are largely responsible for pushing the maximum impact above the Class I PSD increment at Breton Wilderness Area. However, when the 24-hour $PM_{2.5}$ impact from Source Group B is averaged over all grid cells covering the Breton Wilderness Class I area, the impact is below the Class PSD increment. The maximum impacts from Source Group C exceeds the annual and 24-hour $PM_{2.5}$, 24-hour PM_{10}, and annual NO_2 Class I PSD increments at the Breton Wilderness Area..

Sensitive Class II Areas

For all source groups described in **Table 4-7**, the maximum contributions occur at the Gulf Islands National Seashore for all PSD pollutants and averaging times except annual NO_2, which occurs at the Breton Wilderness Area. The cumulative impacts (Source Group C) exceed the annual 24-hour $PM_{2.5}$ Class II PSD increments at the Gulf Islands National Seashore.

Table 4-7. Source Group for Incremental Impacts Analysis.

Source Group	Included Source Categories	Comment
A	SC3	New oil and gas platform sources under this Supplemental EIS
B	SC3, SC4	Add support vessels and aircraft associated with new platform sources
C	SC3, SC4, SC5	Add oil and gas platforms and associated support vessels and aircraft under the No Action Alternative
D	SC3, SC4, SC5, SC6	Add all other marine vessel activity in the GOM

AQRV Impacts – Including Visibility and Acid Deposition

While visibility and acid deposition are not directly regulated by BOEM, an analysis of the potential impacts is provided below.

Results of each impact analysis are compared with applicable "thresholds of concern," which have typically been used in air quality impact evaluations by other Federal actions, including onshore oil and gas leasing programs. The applicable comparison thresholds for visibility impacts are based on incremental changes in light extinction below the level at which they would be noticeable to the average human observer. The applicable comparison thresholds for acid (i.e., sulfur and nitrogen) deposition impacts are based on (1) incremental impacts considered sufficiently small as to have no consequential effect on the receiving ecosystems, i.e., Deposition Analysis Thresholds, and (2) critical load levels above which cumulative ecosystem effects are likely to or have been observed.

Comparison to Visibility and Acid Deposition

Visibility impacts were calculated for each source group using incremental concentrations as quantified by the CAMx PSAT tool. For each source group, the estimated visibility degradation at the Class I areas and sensitive Class II areas due to the source group are presented in terms of the number of days that exceed a threshold change in deciview relative to background conditions. The number of days with a deciview greater than 0.5 and 1.0 are reported.

The preliminary results of impacts of all activities as a result of a single proposed lease sale to visibility impairment from a proposed lease sale is expected to be **minor** to **moderate** as modeled results show exceedances of the visibility thresholds at several of the Class I and sensitive Class II areas in the Gulf of Mexico region. The preliminary results of impacts of all activities as a result of all contributions of all activities from past, present, and future lease sales to visibility impairment from a proposed lease sale is expected to be **minor** to **moderate** as modeled results show exceedances of the visibility thresholds at several of the Class I and sensitive Class II areas in the Gulf of Mexico region.

The preliminary results of impacts of all activities as a result of a single proposed lease sale to acid deposition is expected to be **minor** to **moderate** as modeled results show incremental nitrogen deposition exceeds the western and eastern Deposition Analysis Thresholds at all three locations (i.e., the Breton Wilderness Area, Gulf Islands National Seashore, and Padre Island National Seashore). Additionally, incremental sulfur deposition is below the Deposition Analysis Thresholds in all cases except the sulfur deposition at the Breton Wilderness Area and Gulf Islands National Seashore, which exceed the western Deposition Analysis Thresholds but not the eastern Deposition Analysis Thresholds.

The preliminary results of impacts of all from contributions of all activities from past, present, and future lease sales to acid deposition is expected to be **minor** to **moderate** as modeled results show cumulative maximum nitrogen deposition to continue exceeding the critical load thresholds under the future year scenario for all areas except the Padre Island National Seashore. Additionally, cumulative sulfur deposition values are lower, and larger sulfur emission reductions help to reduce sulfur deposition from above the critical load to below the critical load at the Breton Wilderness Area and Breton National Wildlife Refuge (based on maximum grid cell values). Nevertheless, the maximum grid cell sulfur deposition still exceeds the critical load at the Gulf Islands National Seashore by a small margin.

Visibility

For visibility impacts, thresholds are based on incremental changes in light extinction below the level at which they would be noticeable to the average human observer. Incremental visibility impacts were calculated for each source group, as well as the cumulative impact of all sources combined. The changes in light extinction from CAMx model concentration increments due to emissions from each source group were calculated for each day at grid cells that intersect Class I and sensitive Class II areas within the 12/4-km modeling domain-km (7/2-mi) modeling domain. For Source Group A, the annual 8th highest change in deciview exceed the 1.0 threshold at the Breton Wilderness Area, Breton National Wildlife Refuge, and Gulf Islands National Seashore. Incremental impacts for Source Group B are larger and include days with the 8th highest change in deciview greater than 1.0 at the Padre Island National Seashore in addition to the areas mentioned above, as well as values greater than 0.5 at the Chassahowitzka Wilderness Area and St. Marks National Wildlife Refuge. For Source Group A, the annual 8th highest deciview exceed the 1.0 threshold at the Breton Wilderness Area, Breton National Wildlife Refuge, and Gulf Islands National Seashore. Incremental impacts for Source Group B are larger and include days with 8th highest deciview greater than 1.0 at Padre Island National Seashore in addition to the areas mentioned above as well as values greater than 0.5 at Chassahowitzka Wilderness Area and St. Marks National Wildlife Refuge.

Acid Deposition

The CAMx-predicted that wet and dry fluxes of sulfur- and nitrogen-containing species were processed to estimate total annual sulfur (S) and nitrogen (N) deposition values at each Class I and sensitive Class II area. The maximum annual S and N deposition values from any grid cell that intersects a Class I receptor area was used to represent deposition for that area, in addition to the average annual deposition values of all grid cells that represent a Class I receptor area. Although the convention in the past has been to report just the maximum deposition in any receptor in a Class I/II area, since deposition relates to the total amount deposited across an entire watershed, the average metric may be considered a more relevant parameter for evaluating potential environmental effects. Maximum and average predicted S and N deposition impacts are reported separately for each source group.

As a screening analysis, incremental deposition values in Class I and II areas for combined Source Groups A (new platforms associated with the highest emissions year of the 10 proposed lease sales) and B (new platforms and associated support vessels and helicopters associated with the 10 proposed lease sales) were compared to the eastern and western U.S. Deposition Analysis Thresholds. Comparison of deposition impacts from cumulative sources to the Deposition Analysis Thresholds is not appropriate. Deposition results were also obtained for all other sensitive areas throughout the 12-km (7-mi) modeling domain, but the highest deposition values all occurred within the 4-km (2-mi) domain. The dividing line between the eastern and western Deposition Analysis Thresholds specified in the FLAG guidance is the Mississippi River, which makes sense for most locations in the U.S.; however, it is not necessarily clear which Deposition Analysis Threshold would be most appropriate for coastal locations along the Gulf Coast, so results are compared here against both Deposition Analysis Thresholds.

Incremental nitrogen deposition exceeds the western and eastern Deposition Analysis Thresholds at all three locations (i.e., the Breton Wilderness Area, Gulf Islands National Seashore, and Padre Island National Seashore). Incremental sulfur deposition is below the Deposition Analysis Thresholds in all cases except the sulfur deposition from Source Group B at the Breton Wilderness Area and Gulf Islands National Seashore, which exceeds the western Deposition Analysis Thresholds but not the eastern Deposition Analysis Thresholds.

Cumulative nitrogen deposition from all sources combined for the base case and future year scenarios were compared against applicable critical load levels in each Class I and II area for which critical loads were identified. Cumulative nitrogen deposition is projected to decrease in all areas between the 2012 base case and the 2017 future year, which is consistent with an overall reduction in NO_x emissions. Nevertheless, maximum nitrogen deposition is modeled to continue exceeding the critical load thresholds under the future year scenario for all areas except the Padre Island National Seashore. Sulfur deposition values are lower, and larger sulfur emission reductions help to reduce sulfur deposition from above the critical load to below the critical load at the Breton Wilderness Area and Breton National Wildlife Refuge (based on maximum grid cell values). Nevertheless, the maximum grid cell sulfur deposition still exceeds the critical load at the Gulf Islands National Seashore by a small margin.

OCS Oil- and Gas-Related Impacts

This section includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales. Emissions contributing to air quality degradation come from many sources. Air pollutants on the NAAQS list are commonly referred to as criteria pollutants because they are ubiquitous. Although these pollutants occur naturally, elevated levels are usually the result of anthropogenic activities. The OCS oil- and gas-related activities that could impact air quality include the following: platform construction and emplacement; platform operations; drilling activities; flaring; service-vessel trips; fugitive emissions; the release of oil, condensate, natural gas, and chemicals used offshore, or pollutants from the burning of these products; and a low-probability catastrophic spill, which is not part of the proposed action and not likely expected to occur. Based on the air quality modeling results from the "Air Quality Modeling in the Gulf of Mexico Region" study, cumulative impacts would be **moderate** because, while there are exceedances to the thresholds of concern, the impacts are just enough to push over the standard.

In the air quality modeling study, Source Group C represents all proposed (new) and existing oil- and gas-related emissions from Gulf of Mexico OCS sources and their support vessels/aircraft. According to the modeling results, the impacts of criteria pollutants from Source Group C to air quality are below the NAAQS for all pollutants, except ozone which shows an increase in the future year design values occurring in Galveston, Texas, which is a nonattainment area. At the Galveston, Texas, monitor, the contribution of Source Group A (new platforms) alone was sufficient to bump the future year design value from just below the NAAQS to just above the NAAQS (recall comparisons to the 70-ppb NAAQS are made after truncating design values to the nearest ppb).

According to the modeling results, the incremental impacts of PSD pollutants from Source Group C to the Class I area exceed the annual and 24-hour $PM_{2.5}$, 24-hour PM_{10}, and annual NO_2 Class I PSD increments at the Breton Wilderness Area. The incremental impacts of PSD pollutants from Source Group C to the sensitive Class II area exceed the annual 24-hour $PM_{2.5}$ Class II PSD increments at the Gulf Islands National Seashore.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil- and gas-related impacts include other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program. Onshore emission sources from non-OCS oil- and gas-related activities include power generation, industrial processing, manufacturing, refineries, commercial and home heating, and motor vehicles (**Chapter 3.3.2.6**). The total impact from the combined onshore and offshore emissions would have an effect on the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana.

State oil and gas programs (**Chapter 3.3.2.1**) onshore, in territorial seas, and in coastal waters also generate emissions that affect the air quality of any state. These emissions are regulated by State agencies and/or the USEPA. Reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts and, as a result, constitute minor impacts to the air quality of any state.

Other major factors influencing offshore environments, such as sand borrowing (**Chapter 3.3.2.7.6**), commercial transportation (**Chapter 3.3.2.3**), military vessels, and recreational vessels also generate emissions that can affect air quality. These emissions are regulated by State agencies and/or the USEPA. Reductions have been achieved through the use of low sulfur fuels and catalytic reduction and, as a result, constitute slight impacts to onshore air quality.

Hurricanes (**Chapter 3.3.2.10.2**) mainly cause damage to offshore infrastructures and pipelines, which may result in an oil spill. A hurricane would cause minor effects on the onshore air quality since air emissions in the event of a hurricane are temporary sources. For the cumulative scenario, the emissions from an oil spill and the associated response activities and infrastructure repair activities are expected to be the same as a proposed lease sale and to have lesser effects on the onshore air quality.

Additionally, recent information shows that intercontinental dust transport may have impacts on the GOM's air quality. For example, dust from Central America and North Africa has been found in the Texas atmosphere. Fine particulates ($PM_{2.5}$), such as ammonium sulfate, can be suspended in the atmosphere and can impair visibility and adversely affect human health. Once in the atmosphere, these fine particulates can be transported for long distances. It has been observed that a substantial amount of the fine particulates observed in Texas comes from Mexico and Central America, and enters into the United States across Texas' southern border. As a result, it reduces the visibility at Big Bend and Guadalupe Mountains National Parks, both Class I (pristine with respect to visibility) areas. The results of air dispersion modeling indicate that as much as half of the visibility impairment (occurring on 20% of the most visibility impaired days) at Big Bend comes from international transport (State of Texas, Commission on Environmental Quality, 2014). The trans-Atlantic transport of North African dust by summertime trade winds occasionally increases ambient particulate matter (PM) concentrations in Texas above air quality standards (Bozlaker et al., 2013). These results indicate that an increase in visibility impairment in Texas is likely due to transport of dust rather than OCS oil- and gas-related emission sources.

The activities associated with a proposed action would increase global greenhouse gas (GHG) emissions from the use of vessels, drilling equipment, and other activities that burn fossil fuels. In addition, methane (CH_4,) also known as natural gas, is removed from wells and brought onto OCS oil- and gas-related facilities along with oil being produced. Sometimes CH4 is released as a fugitive gas that can escape unintentionally from leaks in equipment used by operators. As a result of exploration, development, and production of oil and gas on the OCS, the activities associated with a proposed action are expected to release GHGs and black carbon from the use of combustion engines in vessels, construction, drilling, and other equipment, as well as through deliberate or accidental release of CH_4. In addition to the direct emissions from OCS oil and gas operations presented above, BOEM has evaluated GHG emissions covering the lifecycle of OCS oil and gas production and consumption. This includes both the “downstream” consumption and onshore processing of oil and gas products, as well as the “upstream” emissions from offshore exploration, development, and production. This Supplemental EIS tiers from and updates the 2017-2022 GOM Multisale EIS, which tiers from the Five-Year Program EIS. In the Five-Year Program EIS, the potential impacts of the Program’s activities on climate change were assessed in Chapter 4.2.1 (Climate Change), which specifically addressed the GOM proposed lease sales in that analysis (USDOI, BOEM, 2016b).

Incremental Contribution of a Single Proposed Lease Sale to Overall Cumulative Impacts

In the air quality modeling study, incremental contributions are categorized as the impacts of pollutants from new platforms and their associated support vessels and aircraft. The forecasted data used to support modeling analyses include emissions resulting from the 10 proposed lease sales annualized by using BOEM’s Resource Evaluation’s mid-case scenario. To understand how these results would apply to a single proposed lease sale, the level of projected activity was compared between the modeled highest year of the 10 proposed lease sales to a single proposed lease sale. A regionwide lease sale has not previously been analyzed, and historic trend data are limited. In the scenario in **Chapter 3.1**, the projected activities of a single regionwide lease sale is based on a range of historic observations and provides a reasonable expectation of oil and gas production anticipated from a single proposed lease sale. The projected activities of 10 proposed regionwide lease sales’ mid-case scenario, which was used in the model, falls within the range of a single proposed lease sale. This is conservative because the current price of oil equals the low range of the scenario. Using these assumptions, the potential impacts of a single proposed lease sale would be **minor** because the affected resource could be avoided with proper mitigation. The modeling results show that ozone exceeds the NAAQS in Galveston, Texas, and 24-hour $PM_{2.5}$ exceeds the Class I PSD increment at the Breton Wilderness Area. The impacts were sufficient to increase the future year design value from just below the NAAQS for ozone and over the Class I PSD increment, respectively.

In the air quality modeling study, Source Group B represents new platforms and emissions and their support vessels and aircraft. According to the modeling results, the impacts of criteria pollutants from Source Group B to air quality are below the NAAQS for all pollutants, except for ozone. At the Galveston, Texas, monitor, the contribution of Source Group A (new platforms) alone was sufficient to bump the future year design value from just below the NAAQS to just above the NAAQS.

The impacts to Class I areas from contributions of new platforms and their associated support vessels and aircraft show that proposed activities exceed the 24-hour $PM_{2.5}$ Class I PSD increments by 10 percent at the Breton Wilderness Area, which are a result of support vessels and helicopter traffic associated with the activities.

The impacts to sensitive Class II areas from contributions of all activities as a result of a single proposed lease sale are **minor** because, while maximum increases occur at the Gulf Islands National Seashore for all PSD pollutants and averaging times and increases occur for annual NO_2 at the Breton Wilderness Area, there are no exceedance of the PSD Class II increment.

4.1.2.4 Incomplete or Unavailable Information

This chapter discusses the incomplete or unavailable information needed to assess the impacts from OCS oil- and gas-related activities. Relevant final air modeling study results are unavailable at this time. However, BOEM has used preliminary results, which are provided in **Appendices B-D** in its place. These preliminary results were incorporated into the analysis and is the best science available. Furthermore, BOEM relied on data gathered from recent Gulf of Mexico OCS emission inventories, along with scenarios or estimates of future production. The scenarios provide (1) the assumptions for and estimates of future activities, (2) the rationale for the scenario assumptions and estimates, and (3) the type, frequency, and quantity of emissions from offshore sources associated with a proposed lease sale. Finally, emissions as a result of a proposed lease sale would be regulated at the postlease stage under air quality plan reviews. Additional monitoring measures and air quality dispersion modeling can be requested of the operator if a further analysis is needed and mitigation would be required as necessary.

BOEM determined the projected total emissions that would result from the activities on a lease based on estimated emissions from various OCS non-platform and OCS platform equipment types, such as diesel engines and generators, and the level of offshore activity projected in **Chapter 3.1**. These same emissions estimates were used as inputs for modeling scenarios to predict future impacts. The final study results are not available in time for this Supplemental EIS, but BOEM expects that they would be included in future EIS documents. To address data gaps and current impacts, BOEM used the preliminary results, emissions inventory data, available studies, postlease plan information, and current proposed lease sale scenario data, as well as previous proposed action scenario data, to reach the impact conclusions.

The air quality in the GOM can be affected by the pollution emitted from OCS oil- and gas-related sources as well as non-OCS oil- and gas-related sources. These pollution sources can also emit a wide variety of pollutants. To improve air quality and reduce air pollution, the Clean Air Act Amendments set regulatory limits on pollutants that help to ensure basic health and environmental protection from air pollution. To assess the amount of pollution being emitted, pollutants have to be measured. To determine impacts from these pollutants, emission-related conditions (e.g., rate of emission, height, and distance of sources from coastline) and environmental conditions (e.g., wind speed and direction, humidity, temperature, and height of the atmospheric surface layer where pollutants are transported) are calculated.

Emissions from activities related to prior lease sales are represented by the 2011 GWEI database. Emissions from BOEM's proposed lease sales are estimated from the exploration and development scenario and have been included in the emission inventory that will be used in the model to determine routine impacts. The "Air Quality Modeling in the Gulf of Mexico Region" study includes development of meteorological datasets appropriate for air quality modeling of the study area (which includes a proposed lease sale), comprehensive emissions inventory of all sources in the GOM region, and air quality modeling for the cumulative impacts and visibility assessment. Given that BOEM does not have the final results from the ongoing air quality modeling study yet, for this Supplemental EIS, BOEM relied on emissions inventory data, available studies on OCS oil- and gas-related activities, postlease exploration and development plan information, and the preliminary modeling results to fill data gaps. This approach was adequate because it assessed a combination of pollutants from OCS oil- and gas-related activities, non-OCS oil- and gas-related activities, and non-oil and gas activities.

4.1.2.5 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

As mentioned in **Chapter 3**, for a proposed lease sale under **Alternative A**, BOEM projects that no more activity would occur than has resulted in the past from the highest CPA lease sale combined with the highest WPA lease sale. The contribution of routine and accidental events of a proposed lease sale to air quality would result in **minor** impacts because most impacts on the affected resource could be avoided with proper mitigation. The emission sources would not produce emissions sufficient to overwhelm the effects of wind and transport in a single area, causing deterioration of air quality over the regionwide OCS. The incremental contribution of a single regionwide proposed lease sale would likely have a **minor** impact on coastal areas because most impacts on the affected resource could be avoided with proper mitigation. The support vessels and aircraft associated with new platforms are a leading contributor to the increased impacts in the area.

4.1.2.6 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Since this Alternative excludes the available unleased blocks in the WPA, it would result in activity concentrated in the CPA/EPA. As mentioned in **Chapter 3**, for a proposed lease sale under **Alternative A**, BOEM projects that no more activity would occur than has resulted in the past from the highest CPA lease sale combined with the highest WPA lease sale. Therefore, because most activity is forecast to occur in the CPA/EPA, the impacts as a result of Alternative B would be very similar to Alternative A. The incremental contribution of a single CPA/EPA proposed lease sale would likely have a **minor** impact on coastal nonattainment areas because most impacts on the affected resource could be avoided with proper mitigation.

4.1.2.7 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Since this Alternative excludes the available unleased blocks in the CPA/EPA, it would result in activity concentrated in the WPA. As mentioned in **Chapter 3**, a maximum of 13 percent of the oil production and associated activity and 19 percent of the gas production and associated activity would occur in the WPA. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA under Alterative B, the smaller area could decrease impacts to communities from production platforms and also increase total emissions due to travel distances for marine vessels; the potential impacts would remain **minor**. The incremental contribution of a single WPA proposed lease sale would likely have a **minor** impact on coastal areas because most impacts on the affected resource could be avoided with proper mitigation.

4.1.2.8 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D would have the same analysis and potential impacts as Alternative A, B, or C because there are so few unleased blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations. The difference between Alternatives A, B, and C with and without any combination of these stipulations is **minor** for air quality. The impacts under Alternative D would not be much different and likely not even measurable when compared with the other alternatives.

4.1.2.9 Alternative E—No Action

For Alternative E, the cancellation of a proposed lease sale would result in no new activities associated with a proposed lease sale; therefore, the incremental impacts would be **none**. There could, however, be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative.

4.2 WATER QUALITY

Summary

BOEM has reexamined the analysis for water quality presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for water quality presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of water quality, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.2 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Water quality is a term used to describe the condition or environmental health of a waterbody or resource, reflecting its particular biological, chemical, and physical characteristics and the ability of the waterbody to maintain the ecosystems it supports and influences. It is an important measure for both ecological and human health. For the purposes of this analysis, the GOM is divided into coastal and offshore waters. Coastal waters are defined to include all bays and estuaries from the Rio Grande River in Texas to the Florida Bay. Offshore waters are defined to include those waters extending from outside the barrier islands to the Exclusive Economic Zone, located within State waters and the Federal OCS. The inland extent is defined by the Coastal Zone Management Act. Offshore waters are divided into three regions: the continental shelf west of the Mississippi River; the continental shelf east of the Mississippi River; and deep water (>1,000 ft; 305 m).

Protective Measures for Water Quality

The USEPA (Regions 4 and 6) regulates all waste streams generated from offshore oil- and gas-related activities. Section 403 of the Clean Water Act requires that National Pollutant Discharge Elimination System (NPDES) permits be issued for discharges to the territorial seas (baseline to 3 mi [5 km]), the contiguous zone, and the ocean in compliance with USEPA's regulations for preventing unreasonable degradation of the receiving waters.

The authority for the NPDES program is given at 40 CFR part 125 subpart M, "Ocean Discharge Criteria." The purpose of the NPDES program is to prevent the unreasonable degradation of the marine environment as described in 40 CFR § 125.122. In accordance with definitions stated at 40 CFR § 125.121, "unreasonable degradation of the marine environment" means (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; (2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or (3) loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

Regulated wastes include drilling fluids, drill cuttings, deck drainage, produced water, produced sand, well treatment fluids, well completion fluids, well workover fluids, sanitary wastes, domestic wastes, and miscellaneous wastes. The bulk of waste materials produced by offshore oil- and gas-related activities are produced water (formation water) and drilling muds and cuttings (USEPA, 2009b). There are two general NPDES permits that cover the Gulf of Mexico. Permit GMG290000, issued by USEPA Region 6, covers the WPA and most of the CPA; and Permit GEG460000, issued by USEPA Region 4, covers the EPA and a small part of the CPA. The USEPA Regions' jurisdictional areas are shown in Figure 3-10 of the 2017-2022 GOM Multisale EIS.

To meet the goal of preventing unreasonable degradation of the marine environment, Section B of the NPDES permits specifies effluent limitations and monitoring requirements for offshore oil and gas facilities. Discharged regulated wastes may not contain free oil or cause an oil sheen on the water surface, and the oil/grease concentration may not exceed 42 milligrams per liter (mg/L) daily maximum or 29 mg/L monthly average. Discharge of drilling fluids containing oil additive or formation oil is prohibited, except that which adheres to cuttings and certain small volume discharges. Barite used in drilling fluids may not contain mercury or cadmium at levels exceeding certain concentrations (1.0 mg/kg mercury and 3.0 mg/kg cadmium). Discharged regulated wastes must also be characterized using a whole effluent toxicity test, where a population of mysid shrimp or inland silverside minnows are exposed to a certain concentration of the waste stream, and mortality of the population must not exceed 50 percent. The NPDES permits allow a mixing zone as defined at 40 CFR § 125.121 to meet compliance using an approved plume model. The NPDES permits require no discharge within 1,000 m (3,281 ft) of an area of biological concern. Region 4 also requires no discharge within 1,000 m (3,281 ft) of any federally designated dredged material ocean disposal site.

Analysis

Coastal water impacts associated with routine activities include increases in turbidity resulting from pipeline installation and navigational canal maintenance, discharges of bilge and ballast water from support vessels, and runoff from shore-based facilities. Offshore water impacts associated with routine activities result from the discharge of drilling muds and cuttings, produced water, and residual chemicals used during workovers. The discharge of drilling muds and cuttings causes temporary increased turbidity and changes in sediment composition. The discharge of produced water results in increased concentrations of some metals, hydrocarbons, and dissolved solids. Structure installation and removal and pipeline placement disturb the sediments and cause increased turbidity. In addition, offshore water impacts result from supply and service-vessel bilge and ballast water discharges.

The activity associated with a proposed lease sale could contribute a small percentage of activity in addition to existing and future OCS oil- and gas-related activities. The specific discharges, drill muds, cuttings and produced water, and accidents resulting in spills would occur in proportion to production and, therefore, would add a small increase to the currently anticipated impacts. Furthermore, the vessel traffic and related discharges associated with a proposed lease sale are a fraction of the current ongoing commercial shipping and military activity in the Gulf of Mexico. The impact of discharges, sediment disturbances, and accidental releases are a small percentage of the current overall activity and the overall impacts to coastal and offshore waters.

Impacts on water quality from operational discharges related to a proposed lease sale are expected to be minimal because of the following: (1) USEPA regulations to prevent unreasonable degradation of the marine environment; (2) prohibitions on discharge of some waste types; (3) prohibitions on discharge near sensitive biological communities; (4) monitoring requirements and toxicity testing; (5) mixing zone and dilution factors; (6) operational discharges are temporary in nature; and (7) any effects from elevated turbidity would be short term, localized, and reversible. As such, assuming compliance with applicable regulations, the impacts from the discharge of regulated wastes from routine operations would require no additional mitigation.

Impact-Level Definitions

For the purpose of the following discussion, the significance of impact-producing factors on water quality is discussed below. The criteria for significance reflect consideration of the context and intensity of impact (40 CFR § 1508.27) based on four parameters: detectability (i.e., measurable or detectable impact); duration (i.e., short term, long term); spatial extent (i.e., localized, extensive); and severity (i.e., severe, less than severe). For water quality, the significance criteria have been broadly defined as follows:

- **Negligible** – Impacts are defined as short-term (less than 1 year), localized contaminants and turbidity that present little to no detectable impact.
- **Minor** – Impacts are defined as detectable, short-term, localized, or extensive but less than severe; however, detectable contaminant concentrations may exceed regulatory levels. Minor impacts may have little to no effect on marine life.
- **Moderate** – Impacts are defined as detectable, short term, extensive, and severe; or impacts are detectable, short term or long term, localized and severe; or impacts are detectable, long term, extensive, or localized but less than severe. Moderate impacts may result in acute or chronic effects to marine life.
- **Major** – Impacts are defined as detectable, short term or long term, extensive, and severe; however, major impacts may result in acute or chronic effects to marine life and may potentially cause human health effects.

The OCS oil- and gas-related, impact-producing factors listed in **Table 4-8** below help the reader quickly identify the level of potential impacts for each of these factors. This table also illustrates the impact-level conclusions for each impact-producing factor reached in this chapter's impact analysis.

Table 4-8. Water Quality Impact-Producing Factors That Are Reasonably Foreseeable.

Water Quality	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Geological Sampling	Negligible	Negligible	Negligible	Negligible	None
Bottom Area Disturbance	Negligible	Negligible	Negligible	Negligible	None
Operational Discharges and Wastes	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	None
Pipeline Installation	Negligible	Negligible	Negligible	Negligible	None
Decommissioning and Removal Operations	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Drilling Fluid Spills	Minor	Minor	Minor	Minor	None
Chemical and Waste Spills	Minor	Minor	Minor	Minor	None
Oil Spills					
Without Mitigation	Moderate	Moderate	Moderate	Moderate	None
With Mitigation	Moderate	Moderate	Moderate	Moderate	None
Cumulative Impacts					
Incremental Contribution[2]	Negligible	Negligible	Negligible	Negligible	None
OCS Oil and Gas Program[3]	Negligible				
Non-OCS Oil and Gas[4]	Negligible				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.2 of the 2017-2022 GOM Multisale EIS.
[2] This impact level is the incremental contribution of a single proposed lease sale to all cumulative impacts in the GOM.
[3] This impact level is the cumulative impacts of all past, present, and reasonably forseeable OCS oil- and gas-related activities in the GOM.
[4] This impact level is the cumulative impacts of all past, present, and reasonably foreseeable activities in the GOM.

The impacts of OCS Program-related routine operational discharges (Chapter 3.1.5.1 of the 2017-2022 GOM Multisale EIS and summarized in **Table 4-8** of this Suppplemental EIS) on water quality are considered **negligible** (beyond 1,000 m; 3,281 ft) to **moderate** (within 1,000 m; 3,281 ft) of the source. The potential impacts from OCS Program-related oil spills on water quality are considered **moderate**, even with the implementation of mitigating measures. This is because activities to address oil spills may cause secondary impacts to water quality, such as the introduction of additional hydrocarbons into the dissolved phase through the use of dispersants and the sinking of hydrocarbon residuals from burning. The impacts from a proposed action are a small addition to the cumulative impacts on water quality when compared with inputs from hypoxia, potentially leaking shipwrecks, chemical weapon dumpsites, natural oil seeps, and natural turbidity. The incremental contribution of the routine activities and accidental events associated with a proposed action to the cumulative impacts on water quality is expected to be **negligible** for any of the action alternatives. For Alternative E, the cancellation of a proposed lease sale would result in no new activities associated with a proposed lease sale; therefore, the incremental impacts would be **none**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of water quality can be found in Chapter 4.2 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The level of impacts to water quality from a proposed action would be similar for Alternatives A, B, C, and D. Under Alternative E, there would be no new activities associated with a proposed lease sale; however, activities associated with past lease sales and non-OCS oil- and gas-related activities would continue.

Incomplete or Unavailable Information

In preparation for this Supplemental EIS, BOEM has reviewed the latest information available relative to the potential impact-producing factors on water quality, which is presented in **Chapter 3**. Much of the information pertaining to water quality impacts from the *Deepwater Horizon* oil spill and response has been discussed in previous NEPA documents, and water quality has recovered from the *Deepwater Horizon* oil spill and response. BOEM has identified incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on water quality. Much of this information relates to non-OCS oil- and gas-related impacts. Specifically, potentially polluting shipwrecks and chemical weapon disposal areas may cause potential impacts to water quality and the marine environment. There are no publicly available data regarding these potential impacts because no agency has been tasked with this responsibility. It is not foreseen that this information would be publicly available to include in this NEPA analysis regardless of the costs or resources needed. BOEM has used the best available scientific information to date and believes that any additional information would not likely change the ranking of impacts and is not essential to a reasoned choice among alternatives.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including Google Scholar Alerts) were examined to assess recent information regarding water quality that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for water quality presented in the 2017-2022 GOM Multisale EIS with the understanding that no new information on water quality has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for water quality presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.3 Coastal Habitats

4.3.1 Estuarine Systems (Wetlands and Seagrass/Submerged Vegetation)

Summary

BOEM has reexamined the analysis for estuarine systems presented in the 2017-2022 GOM Multisale EIS based on the information presented below. No new information was discovered that would alter the impact conclusion for estuarine systems presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of estuarine systems, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with the proposed action are presented in Chapter 4.3.1 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

The estuarine system is the transition zone between freshwater and marine environments. It can consist of many habitats, including wetlands and submerged vegetation. While some seagrass species can be found farther offshore, the majority is within the coastal area of the GOM and will be covered in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from routine OCS oil- and gas-related activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts impacts. The impact-level definitions and the analyses supporting these conclusions are discussed below.

Analysis

In this chapter, BOEM reviewed and analyzed routine OCS oil- and gas-related activities and reasonably foreseeable accidental events. Routine activities associated with a proposed lease sale that take place on the OCS, where wells are drilled and platforms and pipelines are installed, would not impact the wetlands or submerged vegetation that is located miles away. Other routine activities that support offshore oil and gas exploration, such as increased vessel traffic (**Chapter 3.1.2.5**), maintenance dredging of navigation canals (Chapter 3.1.3.3.4 of the 2017-2022 GOM Multisale EIS), pipeline installation (**Chapter 3.1.2.2**), disposal of OCS oil- and gas-related wastes (Chapter 3.1.5.1 of the 2017-2022 GOM Multisale EIS), and construction and maintenance of support infrastructure in the coastal areas (**Chapter 3.1.2.2**), could potentially impact wetlands. Of these impact-producing factors, vessel traffic was not analyzed with respect to seagrass and submerged vegetation because OCS vessels (due to their size and use of commercial ports) are generally not in areas shallow enough to have large submerged vegetation beds. An analysis of the potential impacts from accidental events, primarily oil spills, associated with a proposed lease sale is summarized in this chapter, as is the incremental contribution of a proposed action to the cumulative impacts to wetlands and submerged vegetation. Cumulative impacts were analyzed for OCS oil- and gas-related activities and for other sources that could affect wetlands and submerged vegetation communities (i.e., human impacts, storms, and vessel traffic). Additional factors that could affect estuarine systems include subsidence and sea-level rise.

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to wetlands and submerged vegetation:

- **Negligible** – Little to no measurable impacts in the surrounding habitat (i.e., wetland segment and seagrass bed).
- **Minor** – Noticeable but short-term and localized impacts.
- **Moderate** – Damage to coastal habitats that is noticeable, spatially extensive, and long term or permanent.
- **Major** – Widespread, permanent loss of habitat; changes in species composition and abundance and/or altered ecological function well beyond that of normal variability. Changes would likely be both long lasting and spatially extensive for such an effect.

The potential magnitude for each of these impact-producing factors is provided in **Table 4-9** to help the reader quickly identify the level of potential impacts for each of these factors.

Table 4-9. Estuarine Systems Impact-Producing Factors That Are Reasonably Foreseeable.

Estuarine Systems	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Pipeline Construction and Maintenance	Negligible	Negligible	Negligible	Negligible	None
Navigation Channel Maintenance Dredging	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Vessel Operation (support use of navigation channels)	Moderate	Moderate	Minor	Moderate	None
Construction and Use of Coastal Support Infrastructure	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Oil Spills	Minor	Minor	Minor	Minor	None
Disposal of OCS Oil- and Gas-Related Wastes	Negligible	Negligible	Negligible	Negligible	None
Cumulative Impacts					
Incremental Contribution[2]	Moderate	Moderate	Minor	Moderate	None
OCS Oil and Gas[3]	Major				
Non-OCS Oil and Gas[4]	Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.3.1 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as the proposed action, but they are not related to the OCS Oil and Gas Program.

The impacts to estuarine systems from routine activities associated with a proposed action are expected to be **minor** to **moderate**. **Minor** impacts would be due to the projected low probability for any new pipeline landfalls (0-1 projected), the minimal contribution to the need for maintenance dredging, the mitigating measures expected to be used to further reduce or avoid these impacts (e.g., the use of modern techniques such as directional drilling). However, impacts caused by vessel operations related to a proposed action over 50 years would be **moderate** considering the permanent loss of hundreds of acres of wetlands. Overall, impacts to estuarine habitats from oil spills associated with activities related to a proposed action would be expected to be **minor** because of the distance of most postlease activities from the coast, the expected weathering of spilled oil over that distance, the projected low probability of large spills near the coast, the resiliency of wetland vegetation, and the available cleanup techniques.

Cumulative impacts to estuarine habitats are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in Chapter 4.3 of the 2017-2022 GOM Multisale EIS and human and natural impacts. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Storms will continue to impact the coastal habitats and have differing impacts. The incremental contribution of a proposed action to the cumulative impacts on estuarine habitats is expected to be **minor** to **moderate** depending on the selected alternative. Under Alternative E, the cancellation of a proposed lease sale would result in no new activities associated with a proposed lease sale. There could, however, be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of estuarine habitats can be found in Chapter 4.3 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The impacts to estuarine systems from routine activities and accidental events associated with a proposed action are expected to be **minor** to **moderate**, depending on the alternative. The impacts of a proposed action on coastal wetlands under Alternative A is expected to be **moderate**. The impacts of Alternative B would be similar to those of Alternative A, except that there would be **negligible** impacts to coastal wetlands and submerged vegetation in Texas because no new OCS oil- and gas-related activity is forecasted in the WPA along the Texas coast with this alternative. For this reason, the incremental contribution of Alternative B to the cumulative impacts on coastal wetlands is expected to be **moderate**. The impacts of Alternative C would be less than those of Alternative A, as only a fraction of the resulting activity forecast for Alternative A is projected under Alternative C. For this alternative, there would be **negligible** impacts to coastal wetlands and submerged vegetation in Louisiana; **negligible** impacts to Mississippi, Alabama, and the panhandle of western Florida; and incrementally more impacts to the wetlands and submerged vegetation of Texas, compared with Alternative A. Therefore, because the significance of impact-producing factors on estuarine habitats would be less for Alternative C than for Alternative A, the incremental contribution of Alternative C to the cumulative impacts on coastal wetlands is expected to be **minor**. The impacts of Alternative D would be nearly identical to those of Alternative A because the available unleased blocks with topographic features do not contain wetlands or submerged vegetation and are too distant (over 25 km; 16 mi) from the coast to have indirect impacts either. If a proposed action does not occur (Alternative E), there would be no additional impacts to estuarine habitats; however, cumulative impacts from all sources, including OCS oil- and gas-related and non-OCS oil- and gas-related sources, would be the same as the cumulative for Alternative A, or **major**. This major impact is due to cumulative OCS oil- and-gas-related spills resulting from all past and present leasing activities, including the millions of barrels that entered the Gulf of Mexico from the *Deepwater Horizon* oil spill. There could be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**.

Incomplete or Unavailable Information

BOEM has identified incomplete or unavailable information regarding estuarine habitat. There is incomplete information about impacts resulting from routine activities, as the scenario forecast is only an estimate and many global factors can affect OCS oil- and gas-related activity. There also remains unavailable information about the future rates of oil spills, as well as spill locations and volumes of oil.

There are unknowns regarding the future restoration efforts that are being planned, such as what projects would ultimately be constructed and how successful they may be. In addition, the future rates of relative sea-level rise are not known with certainty, and thus, resulting impacts to wetlands are unknown. Future rates of coastal development are unknown, as is the extent of impacts to estuarine systems thereof.

BOEM acknowledges that there remains incomplete or unavailable information that may be relevant to reasonably foreseeable significant impacts on estuarine systems. This incomplete or unavailable information includes potential data on the *Deepwater Horizon*, explosion, oil spill, and response that may be forthcoming. As there is substantial information available since the *Deepwater Horizon* explosion, oil spill, and response, which is included in the 2017-2022 GOM Multisale EIS, BOEM believes that the incomplete or unavailable information regarding the effects of the *Deepwater Horizon* explosion, oil spill, and response on estuarine systems would likely not be essential to a reasoned choice among alternatives. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline contemplated in the NEPA analysis for this Supplemental EIS. BOEM's subject-matter experts have used what scientifically credible information is available in their analyses and applied it using accepted scientific methodology.

Many studies have been produced that demonstrate the effects of exposure of wetland plants to crude oil, covering a wide range of exposure intensity, longevity, and oil characteristics. Much has been learned about the different survival and recovery rates of various plant species. In addition, studies have been produced regarding the long-term impacts of canal dredging and pipeline installation on wetlands. A proposed lease sale would result in a relatively minor addition to existing routine activities and accidental events, and therefore, the incremental contribution to wetland impacts from a proposed lease sale would be **minor** to **moderate** (depending on the alternative), given what is currently known.

The potential for impacts from changes to the affected environment (post-*Deepwater Horizon*) and cumulative impacts remains whether or not the No Action or an action alternative is chosen, and therefore, the incremental contribution from a proposed action would be **minor** relative to cumulative impacts. BOEM used reasonably accepted scientific methodologies to extrapolate from existing information in completing this analysis and formulating the conclusions presented here.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including the U.S. Department of the Interior, Geological Survey; National Wetlands Research Center; Gulf of Mexico Alliance; NOAA; Journal of Marine Science and Engineering; Marine Pollution Bulletin; and scientific publication databases including Science Direct, Elsevier, and JSTOR) were examined to assess recent information regarding estuarine systems that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for estuarine systems presented in the 2017-2022 GOM Multisale EIS with the understanding that no new information on estuarine systems has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for estuarine systems presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.3.2 Coastal Barrier Beaches and Associated Dunes

Summary

BOEM has reexamined the analysis for coastal barrier beaches and associated dunes presented in the 2017-2022 GOM Multisale EIS based on the information presented below. No new information was discovered that would alter the impact conclusion for coastal barrier beaches and associated dunes presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of coastal barrier beaches and associated dunes, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action, are presented in Chapter 4.3.2 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

The coastal barrier beaches and associated dunes are those beaches and dunes that line the coast of the northern GOM, including both barrier islands and beaches on the mainland. Barrier beaches and associated dune habitats from Texas to the Florida panhandle may be impacted by activities resulting from a proposed action. These areas are comprised of the following geologic subareas:

- the barrier island complex of southern Texas;
- the Chenier Plain of eastern Texas and western Louisiana;
- the Mississippi River Delta complex of southeastern Louisiana;
- the barrier-island and Pleistocene Plain complex of Mississippi and Alabama; and
- the Florida panhandle.

Barrier islands make up more than two-thirds of the northern GOM shore (Morton et al., 2004). These shorelines are usually sandy beaches that can be divided into several interrelated environments. Generally, beaches consist of a shoreface, foreshore, and backshore. The shoreface slopes downward and seaward from the low-tidal water line, under the water. The nonvegetated foreshore slopes up from the water to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and may be sparsely vegetated. The dune zone of a barrier landform can consist of a single low dune ridge, several parallel dune ridges, or a number of curving dune lines that may be stabilized by vegetation. These elongated, narrow landforms are composed of wind-blown sand and other unconsolidated, predominantly coarse sediments.

Analysis

In this chapter, BOEM reviewed and analyzed OCS oil- and gas-related routine activities and reasonably foreseeable accidental events. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts (**Table 4-10**). The impact-level definitions and the analyses supporting these conclusions are discussed below. Routine activities associated with a proposed action that take place on the OCS, where wells are drilled and platforms and pipelines are installed, would not impact the coastal barrier beaches, which are located from 3 to greater than 200 nmi (3.5 to 230.2 mi; 5.6 to 370.4 km) away. Other routine activities that support offshore oil and gas exploration, such as increased vessel traffic, maintenance dredging of navigation canals, pipeline installation, and construction of support infrastructure in the coastal areas, could potentially impact beaches and dunes. An analysis of the potential impacts from accidental events, primarily oil spills but also trash and debris, associated with a proposed action is summarized in this chapter, as is the incremental contribution of a proposed action to the cumulative impacts to beaches and dunes. Cumulative Impacts were analyzed for OCS oil- and gas-related activities and for other sources that could affect coastal barrier beaches and dunes (i.e., human impacts, storms, vessel traffic, subsidence, and sea-level rise).

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to coastal beaches and dunes:

- **Negligible** – Little to no measurable impacts in species composition and abundance and/or altering of beach profile or ecological function.
- **Minor** – Measureable but short-term and localized impacts to species composition and abundance and/or altering of beach profile or ecological function.
- **Moderate** – Damage to coastal habitats (impacts to species composition and abundance and/or altering of beach profile or ecological function) that is detectable, spatially extensive, but temporary and not severe. Can also be used to describe localized land loss.
- **Major** – Severe, bringing about detectable changes in species composition and abundance and/or altering of beach profile or ecological function well beyond that of normal variability. Changes would likely need to be both long lasting and spatially extensive to have such an effect.

The potential magnitude for each of these impact-produring factors is provided in **Table 4-10** to help the reader quickly identify the level of potential impacts for each of these factors.

Table 4-10. Coastal Barrier Beaches and Associated Dunes Impact-Producing Factors.

Coastal Barrier Beaches and Associated Dunes	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Pipeline Construction and Maintenance	Negligible	Negligible	Negligible	Negligible	None
Navigation Channel Maintenance Dredging	Minor	Minor	Minor	Minor	None
Vessel Operation (Support Use of Navigation Channels)	Negligible	Negligible	Negligible	Negligible	None
Construction and Use of Coastal Support Infrastructure	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Oil Spills	Minor	Minor	Minor	Minor	None
Disposal of OCS Oil- and Gas-Related Wastes	Negligible	Negligible	Negligible	Negligible	None
Cumulative Impacts					
Incremental Contribution[2]	Minor	Minor	Minor	Minor	None
OCS Oil and Gas[3]	Major				
Non-OCS Oil and Gas[4]	Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.3.2 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

The impacts to coastal barrier beaches and dunes from routine activities associated with a proposed action are expected to be **minor** due to the minimal number of projected onshore pipelines, the minimal contribution to vessel traffic and to the need for maintenance dredging, and the mitigating measures that would be used to further reduce or avoid these impacts. The greater threat from an oil spill to coastal beaches is from a coastal spill as a result of a nearshore vessel accident or pipeline rupture, and cleanup activities. Overall, impacts to coastal barrier beaches and dunes from oil spills associated with OCS oil- and gas-related activities related to a proposed action would be expected to be **minor** because of the distance of most of the resulting activities from the coast, expected weathering of spilled oil, projected low probability of large spills near the coast, and available cleanup techniques.

Cumulative impacts to coastal barrier beaches and dunes are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in Chapter 4.3.2 of the 2017-2022 GOM Multisale EIS and other human and natural impacts. Cumulative OCS oil- and-gas-related spills resulting from all past and present leasing activities, including the millions of barrels that entered the Gulf of Mexico from the *Deepwater Horizon* oil spill, are estimated to have had a **major** impact on coastal barrier beaches and dunes. However, the incremental increase in impacts from reasonably foreseeable oil spills related to a proposed action is expected to be **minor**. The incremental contribution of a proposed action to the cumulative impacts on coastal barrier beaches and dunes is expected to be **minor**. Non-OCS oil- and gas-related activities, such as development pressures in the coastal regions of the GOM, have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Efforts to stabilize the GOM shoreline through the construction of manmade structures can deprive natural restoration of barrier beaches through sediment nourishment and sediment transport, which have adversely impacted coastal beach landscapes. Storms will continue to impact the coastal habitats and have differing impacts. Under Alternative E, the cancellation of a proposed lease sale, the resulting additional impacts to coastal barrier beaches and dunes would be **negligible**; however, cumulative impacts from all sources, including OCS oil- and gas-related and non-OCS oil- and gas-related sources, would remain. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of coastal barrier beaches and associated dunes can be found in Chapter 4.3.2 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Impacts from most routine activities and accidental events related to a proposed action under Alternative A would be expected to be **minor** since most routine activities are located far from coastal beaches. The impacts of Alternative B would be similar to those of Alternative A, except that there would be **negligible** impacts to coastal barrier beaches and dunes in Texas because no OCS oil- and gas-related activity is forecast in the WPA along the Texas coast with this alternative. The impacts of Alternbative C would be less than those under Alternative A, as only a fraction of the resulting activity forecasted for Alternative A is projected for Alternative C. For this alternative, there would be **negligible** incremental impacts to coastal barrier beaches and dunes in Louisiana; and zero to **negligible** impacts to Mississippi, Alabama, and the panhandle of western Florida; and incrementally more impacts to the beaches and dunes of Texas. However, Alternative C would have less potential for impact than Alternative A or B as the level of projected OCS oil- and gas-related activities and impact-producing factors are much less in the WPA. The impacts of Alternative D would be nearly identical to those of the alternative it is combined with because the available unleased blocks with topographic features do not contain coastal barrier beaches and dunes and are too distant (over 25 km; 16 mi) from the coast to have indirect impacts. The incremental contribution of Atlernatives A-D to the cumulative impacts to coastal barrier beaches and associated dunes is expected to be **minor**. If a proposed lease sale does not occur (Alternative E), there would be no additional impacts to barrier beaches and associated dunes as a result of a proposed lease sale; however, cumulative impacts of current and past activities, however, would continue to occur under this alternative. There could be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**.

Incomplete or Unavailable Information

BOEM acknowledges that there remains incomplete or unavailable information regarding coastal barrier beaches and associated dunes in the GOM. There is incomplete information about routine impacts, as the scenario forecast is only an estimate and many global factors can affect OCS oil- and gas-related activity. There also remains unavailable information about future rates of oil spills, as well as the locations and volumes of oil. Future rates of coastal development are unknown, as is the extent of such impacts to coastal barrier beaches. There are also unknowns regarding the future restoration efforts being planned, such as what specific projects would ultimately be constructed and how successful they may be. In addition, the future rates of relative sea-level rise are not known with certainty (Hausfather, 2013); thus, the resulting impacts to coastal barrier beaches and associated dunes are unknown.

A large body of information regarding impacts of the *Deepwater Horizon* explosion, oil spill, and response upon coastal barrier beaches and associated dunes has been developed and continues to be developed through the NRDA process, but information remains incomplete. As there is substantial information available since the *Deepwater Horizon* explosion, oil spill, and response, which has been analyzed for the 2017-2022 GOM Multisale EIS, BOEM believes that the incomplete or unavailable information regarding the effects of the *Deepwater Horizon* explosion, oil spill, and response on coastal barrier beaches and dunes would likely not be essential to a reasoned choice among alternatives. The incomplete information would not be available within the timeframe contemplated by the NEPA analysis of this Supplemental EIS. However, much is known about the extent of the oiling of beaches and the continuing degradation of the remaining oil.

BOEM has determined that the information is not essential to a reasoned choice among alternatives. BOEM's subject-matter experts have used what scientifically credible information is available in their analyses and applied it using accepted scientific methodology. Many studies have been produced that demonstrate the effects of exposure of beaches to crude oil, covering a wide range of exposure intensity, longevity, and oil characteristics. Much has been learned about the effect of oil-spill cleanup on beaches and the degradation rates of oil over time. In addition, studies have been produced regarding the long-term impacts of navigation canal dredging on beaches and barrier islands. A proposed lease sale would result in a relatively minor addition to existing routine activities and accidental events, and therefore, the incremental increase in impacts to coastal barrier beaches and dunes from a proposed lease sale would be **minor** given what is currently known. The potential for impacts from changes to the affected environment (post-*Deepwater Horizon*) and cumulative impacts remains whether or not the No Action or an action alternative is chosen.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including the U.S. Department of the Interior, Geological Survey; National Wetlands Research Center; Gulf of Mexico Alliance; NOAA;, Louisiana State University; and scientific publication databases including Science Direct, Elsevier, and JSTOR) were examined to assess recent information regarding coastal barrier beaches and associated dunes that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for coastal barrier beaches and associated dunes presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on coastal barrier beaches and associated dunes has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for coastal barrier beaches and associated dunes presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.4 Deepwater Benthic Communities

Summary

BOEM has reexamined the analysis for deepwater benthic communities presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for deepwater benthic communities presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of deepwater benthic communities, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.4 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

BOEM defines "deepwater benthic communities" as including both chemosynthetic communities (chemosynthetic organisms plus seep-associated fauna) and deepwater coral communities (deepwater coral plus associated fauna). These communities are typically found in water depths of 984 ft (300 m) or deeper throughout the GOM, although deepwater benthic habitats are relatively rare compared with ubiquitous soft bottoms.

Chemosynthetic communities are based on the presence of various organisms that do not depend on photosynthetic processes for metabolism. In the GOM, they are formed around natural hydrocarbon seepages. Most GOM deepwater corals require exposed hard substrate for attachment and growth. They often co-occur on authigenic substrates (substrates that have been generated where they are found) created by chemosynthetic processes; however, deepwater coral also routinely colonize other natural or artificial hard substrates not associated with hydrocarbon seepage.

Protective Measures for Deepwater Benthic Communities

Protective measures have been developed over time based on the nature and sensitivity of various benthic habitats and their associated communities, as understood from decades of BOEM-funded and other environmental studies. NTL 2009-G40, "Deepwater Benthic Communities," provides operators with relevant information and consolidates guidance for the avoidance and protection of the various types of potentially suitable habitat for chemosynthetic organisms and deepwater coral. As detailed in NTL 2009-G40, all plans submitted for permitted deepwater (300 m [984 ft] or greater) activities are reviewed for the presence of deepwater benthic communities that may be impacted by the proposed activity. Lessees must provide site-specific survey and narrative information regarding sensitive benthic features with each exploration plan, development operations coordination document, and development and production plan. These plans are reviewed by subject-matter experts on a case-by-case basis to determine whether a proposed operation could impact a benthic community. If an impact from drilling or other seafloor disturbance (e.g., anchors, anchor chains, rig emplacement, pipeline emplacement) is judged likely based on site-specific information derived from the geohazard survey data, BOEM's databases and studies, other published research, or another creditable source, the operator would be required to relocate the proposed operation (i.e., distancing) or undertake other appropriate mitigations to prevent such an impact. As detailed above, BOEM's subject-matter experts make use of the best available datasets to identify probable habitat that could support deepwater chemosynthetic and coral communities, including BOEM's publicly available database of water-bottom anomalies (USDOI, BOEM, 2015). This analysis assumes continuation of the protective measures outlined in NTL 2009-G40.

Analysis

This chapter presents an analysis of the potential impacts on deepwater benthic communities as a result of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to cumulative impacts. The analysis is not exhaustive of all possible impacts of routine activities and accidental events; rather, it focuses on those most relevant for decisionmakers. Potential impacts from a catastrophic oil spill, including long-term impacts and recovery, are detailed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b).

Because of the similarity and overlap of the effects of many activities that occur in the OCS, the primary, reasonably foreseeable routine and accidental impact-producing factors for deepwater benthic habitats can be grouped into three main categories:

(1) bottom-disturbing activities (Chapter 3.1.3.3.2 of the 2017-2022 GOM Mulitsale EIS; routine and accidental);

(2) drilling-related sediment and waste discharges (Chapter 3.1.5.1 of the 2017-2022 GOM Multisale EIS; routine and accidental); and

(3) oil spills (**Chapter 3.2.2**; accidental).

Cumulative impacts were also considered in two steps: impacts resulting from OCS oil- and gas-related activities (same as routine activities and accidental events); and impacts resulting from non-OCS oil- and gas-related sources, namely fishing and climate change.

Some impact-producing factors relevant to deepwater benthic communities are already analyzed in greater detail in other chapters. Refer to **Chapter 4.7** ("Fishes and Invertebrate Resources") for additional analyses. Several additional impact-producing factors described in **Chapter 3** were evaluated for potential impacts on deepwater benthic communities. These impact-producing factors were not carried forward for full analysis because any potential effects were judged to be either not reasonably foreseeable or having such a miniscule impact that they would not rise to even the level of negligible impact. Refer to Chapter 4.4 of the 2017-2022 GOM Multisale EIS for discussion on the impact-producing factors not carried forward for full analysis.

The impact significance criteria and resulting conclusions presented in **Table 4-11** focus on the overall functioning, resilience, and ecosystem level importance of deepwater benthic communities throughout U.S. waters of the GOM. The potential magnitude of impact for each of these impact-producing factors that are reasonably foreseeable is provided in **Table 4-11** to help the reader quickly identify the level of potential impacts for each impact-producing factor, shown in the table both with and without the anticipated BOEM mitigations to make clear the considerable difference that results from these mitigations. The impact-level definitions and the analyses supporting these conclusions are discussed below. Postlease, site-specific analyses would focus more on potential localized impacts of individual development activities (e.g., proposed drilling of a well) to individuals, discrete communities, and small patches of benthic habitat. Those analyses would also detail site-specific protective mitigations required prior to approval of such activities.

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to deepwater benthic communities:

- **Negligible** – Impacts to deepwater benthic communities are largely undetectable. There is some potential for even undetectable impacts to cause slight changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of GOM deepwater benthic communities.
- **Minor** – Impacts to deepwater benthic communities are detectable but cannot be clearly distinguished from natural variation. Such impacts could result in changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but would be spatially localized, short term in duration, and would not alter the overall status of GOM deepwater benthic communities.
- **Moderate** – Impacts to deepwater benthic communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive but are expected to only temporarily alter the overall status of GOM deepwater benthic communities; long-term recovery to pre-impact levels is likely.
- **Major** – Impacts to deepwater benthic communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive and noticeably alter the overall status of GOM deepwater benthic communities such that long-term recovery to pre-impact levels is unlikely.

Table 4-11. Deepwater Benthic Communities Impact-Producing Factors That Are Reasonably Foreseeable.

Deepwater Benthic Communities	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Bottom-Disturbing Activities and Drilling-Related Sediment and Waste Discharges					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Minor to Major	Minor to Moderate	Minor to Moderate	Minor to Major	None
Accidental Impacts					
Bottom-Disturbing Activities and Drilling-Related Sediment and Operational Waste Discharges					
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Without Mitigation	Minor to Major	Minor to Moderate	Minor to Moderate	Minor to Major	None
Oil Spills					
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Without Mitigation	Minor to Major	Minor to Moderate	Minor to Moderate	Minor to Major	None
Cumulative Impacts					
Incremental Contribution[2]	Negligible	Negligible	Negligible	Negligible	None
OCS Oil and Gas Program[3]	Negligible to Minor				
Non-OCS Oil and Gas Activities[4]	Negligible to Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.4 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

The OCS oil- and gas-related, impact-producing factors for deepwater benthic communities can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) noncatastrophic oil spills. These impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. However, impacts from individual routine activities and accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Moreover, use of the expected site-specific plan reviews/mitigations will distance activities from deepwater benthic communities, greatly diminishing the potential effects. Therefore, at the regional, population-level scope of this analysis, and assuming adherence to all expected regulations and mitigations, the incremental contribution would be expected to be **negligible** for any of the action alternatives. Impacts from accidental events would be expected to be **negligible** to **minor** for any of the action alternatives. The expected OCS oil- and gas-related activities from a proposed action would also contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative effects experienced by deepwater benthic communities, but only by a **negligible** amount. Under Alternative E, the potential for impacts would be **none** because new impacts to deepwater benthic communities related to a cancelled lease sale would be avoided entirely. The overall OCS oil- and gas-related cumulative impacts to deepwater benthic communities are estimated to be **negligible** to **minor**. Non-OCS oil- and gas-related activities such as commercial fishing (currently negligible) and shifting baseline environmental conditions related to climate change (currently negligible but likely to increase to major over time should current trends continue or worsen) could cause more noticeable impacts on deepwater benthic communities over the next 50 years. A full analysis of deepwater benthic communities can be found in Chapter 4.4 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

At the regional, population-level scope of this analysis, and assuming adherence to all expected regulations and mitigations, impacts from reasonably foreseeable routine activities would be expected to be **negligible** for any of the action alternatives. For Alternative B, proposed OCS oil- and gas-related activities would also contribute incrementally, but only a **negligible** amount, to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative effects experienced by deepwater benthic communities, assuming the continuation of expected mitigation practices. Alternative C would not fundamentally alter the conclusions reached for Alternative A, but it would reduce the potential impacts of a proposed lease sale in the available unleased blocks in the CPA/EPA. Although the area proposed for leasing in the WPA is relatively smaller than the proposed area of the CPA/EPA and would experience less projected OCS oil- and gas-related activity (refer to **Chapter 3**), deepwater benthic communities are found throughout all deep waters of the GOM and, therefore, the impacts associated with Alternative C could still potentially cause some population-level effects. Alternative D would do relatively little to reduce the impacts as a result of the routine activities, accidental events, or cumulative impacts to deepwater benthic communities. Deepwater benthic communities are generally found in depths >300 m (984 ft), and the vast majority of lease blocks covered by the exclusion areas in Alternative D are in shallower waters. It is believed that existing mitigation practices would continue to be applied to the proposed activities under Alternatives A-D, reducing the expected level of impacts from a single proposed lease sale to **negligible** for any of the action alternatives. Under Alternative E, a proposed lease sale would be cancelled; therefore, the potential for impacts of that proposed action would be **none** because new impacts to deepwater benthic communities related to a cancelled lease sale would be avoided entirely but existing activity would continue. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative.

Incomplete or Unavailable Information

For decades, BOEM has funded research related to deepwater benthic environments in order to further the scientific understanding necessary for informed decisionmaking. However, due in part to the inherent difficulty of data collection in deepwater environments, there is (and likely always would be) incomplete or unavailable information about deepwater benthic communities. BOEM has specifically identified incomplete information for OCS oil- and gas-related impacts related to the following: locations of deepwater benthic communities in the GOM; toxicity of oil and dispersants to deepwater benthic organisms; long-term effects of the totality of the presence of OCS oil- and gas-related infrastructure; long-term effects associated with various climate change-related factors; cascading ecological effects and interactions between deepwater benthic communities and deepwater fish communities; and long-term impacts from the *Deepwater Horizon* explosion, oil spill, and response (refer to the *Catastrophic Spill Events Analysis* white paper [USDOI, BOEM, 2017b]).

BOEM's databases of confirmed deepwater benthic communities and 3D seismic water-bottom anomalies are used when reviewing deepwater exploration and development plans. As part of postlease, site-specific development plans, operators must provide a variety of high-resolution survey data, including assessments of potential habitat for sensitive benthic communities. If data are sparse or additional detail is needed, site-specific video or photographic surveys can be requested and used to develop appropriate mitigations. While extremely helpful, BOEM's databases and survey data are not comprehensive of all deepwater benthic communities. For example, available information may not always be of sufficient resolution to identify small areas of scattered hard substrate, such as dead clam shells, that may support small patches of deepwater benthic habitat, as discussed by Quattrini et al. (2013).

To help fill data gaps about locations of deepwater benthic communities, BOEM may also be able to make use of additional datasets created by other Federal agencies. For example, NOAA's Deep Sea Coral Research and Technology Program and NOAA's National Centers for Coastal Ocean Science have been compiling a database of known observations of deepwater corals and sponges (USDOC, NOAA, 2015). This database of confirmed deepwater coral observations could be used as an ancillary information source during site-specific plan reviews. However, even with the continued additions of observation records over time, it is unlikely that the majority of deepwater coral communities would be directly observed and documented because of the inherent logistical difficulties involved in deepwater research and data collection. Past research by NOAA (Kinlan et al., 2013) has also included efforts to predictively model suitable habitat for deepwater coral and sponges based on the best available physical/environmental datasets. Future research may improve on these efforts and expand to include chemosynthetic communities. New datasets and models such as these, once they are complete, scientifically vetted, and publicly available, could provide helpful ancillary information to further assist BOEM's site-specific evaluations.

BOEM will continue to analyze and support the continued collection of the best available scientific information related to deepwater benthic communities. However, the best available information does not provide all of the data necessary for a complete understanding of these communities. For example, there is incomplete information with respect to potential long-term effects resulting from exposure to spilled oil, including potential impacts of a catastrophic spill such as the *Deepwater Horizon* oil spill. Known information about the potential impacts of a theoretical catastrophic spill is detailed in the *Catastrophic Spill Events Analysis* white paper (USDOI, BOEM, 2017b), and further information was made available with the publication of NOAA's *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement* in 2016 (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The content of that report was reviewed as part of this analysis. Some information related to impacts specific to the *Deepwater Horizon* explosion, oil, spill, and response, such as long-term monitoring results, is still incomplete or unavailable. Impending reports are not expected to reveal additional significant effects that would alter the overall conclusions about reasonably foreseeable impact-producing factors associated with a proposed action. In completing this analysis and in making conclusions, BOEM used the best available science to determine the range of reasonably foreseeable impacts, applying accepted scientific methodologies to both integrate existing information and extrapolate potential outcomes. Therefore, BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including literature from relevant peer-reviewed journals and reports) were examined to assess recent information regarding deepwater benthic communities that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for deepwater benthic communities presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on deepwater benthic communities has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for deepwater benthic communities presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.5 *SARGASSUM* AND ASSOCIATED COMMUNITIES

Summary

BOEM has reexamined the analysis for *Sargassum* and associated communities presented in the 2017-2022 GOM Multisale EIS based on the information presented below. No new

information was discovered that would alter the impact conclusion for *Sargassum* and associated communities presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of *Sargassum* and associated communities, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with the proposed action are presented in Chapter 4.5 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Sargassum is a genus of large brown seaweed (a type of algae) that floats in island-like masses (USDOC, NOAA, Office of Ocean Exploration and Research, 2014). In the Gulf of Mexico, *Sargassum* and the organisms that reside within or around the matrix of plants are some of the most widely distributed and easily recognizable species in the GOM. *Sargassum*, as pelagic algae, is a widely distributed resource that is ubiquitous throughout the northern GOM and northwest Atlantic, and is part of a cycle that spans most of the Northern Hemisphere of the Atlantic Ocean, including the Caribbean Sea. As such, *Sargassum* might be potentially vulnerable to OCS oil- and gas-related activities, and it is necessary to examine the potential impact-producing factors and determine the susceptibility to these impacts as they relate to a proposed action.

Sargassum in the GOM is comprised of *S. natans* and *S. fluitans* (Lee and Moser, 1998; Stoner, 1983; Littler and Littler, 2000) and is characterized by a brushy, highly branched thallus with numerous leaf-like blades and berrylike pneumatocysts (Coston-Clements et al., 1991; Lee and Moser, 1998; Littler and Littler, 2000). The *Sargassum* cycle is expansive, encompassing most of the western Atlantic Ocean and the Gulf of Mexico with the growth, death, and decay of these plant and epiphytic communities, which may play a substantial role in the global carbon cycle (Gower and King, 2008).

To facilitate a discussion on the spatial extent of the *Sargassum* cycle and to put the impact-producing factors in context, **Figure 4-8** depicts how these plants move around the Northern Hemisphere. The *Sargassum* loop system initiates in the Sargasso Sea. Atmospheric conditions create wind patterns that push *Sargassum* south, into the Caribbean Sea where it is pushed west by the oceanic and atmospheric currents carrying it into the Gulf of Mexico. There it washes ashore on the Gulf Coast or gets swept out the Florida Strait via the Gulf Stream (Gower et al., 2013; Frazier et al., 2015). **Figure 4-8** represents the spatial extent of *Sargassum*, demonstrating that there is a high degree of connection among the Gulf of Mexico OCS planning areas and other oceanic basins and large-scale oceanic features (e.g., Gulf Stream).

Figure 4-8. Sargassum Loop System (adapted from Gower et al., 2013, and Frazier et al., 2015).

Analysis

The analysis is focused on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), accidental events, and cumulative activities (**Table 4-12**). The impact-level definitions and the analyses supporting these conclusions are discussed below. During this analysis, many potential impact-producing factors were identified; however, only several posed enough of a potential threat to carry forward to a full analysis. (Refer to Chapter 4.5 of the 2017-2022 GOM Multisale EIS for a discussion of these analyses.) As such, only the following impact-producing factors were identified as having the potential to impact *Sargassum* and were carried forward to a full analysis:

- vessel operations (**Chapter 3.2.1.5**; routine and accidental, including discharges);
- chemical and drilling-fluid spills (**Chapter 3.2.1.1**; accidental only);
- oil spills (**Chapter 3.2.2**; accidental only); and
- oil-spill cleanup (**Chapter 3.2.3**; accidental only).

Impact-Level Definitions

For this analysis, the following criteria were used to categorize the effects of impact-producing factors to *Sargassum* and associated communities:

- **Negligible** – Impacts are undetectable or limited in scale to the immediate area of the impact-producing factor. This may include mortality of the plants or animals associated with *Sargassum*. Such impacts may result in changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of *Sargassum* or associated communities in the GOM.
- **Minor** – Impacts are detectable and result in changes beyond the immediate area of the impact-producing factor. Such impacts could result in noticeable changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but would be spatially localized, short term in duration, and would not alter the overall status of *Sargassum* or associated communities in the GOM.
- **Moderate** – Impacts cause substantial, population-level changes in species composition, community structure, and/or ecological functioning beyond the immediate area of the impact-producing factor. These impacts would be expected to be spatially extensive and may impact communities that rely on *Sargassum* for the transportation of larvae, settlement, or food beyond the area of the impact-producing factor. However, impacts to *Sargassum* and associated communities are expected to be temporary, and there would be no disruption of the global *Sargassum* cycle.
- **Major** – Impacts result in the loss of *Sargassum* over large sections of the GOM. This would result in substantial, population-level changes in species composition, community structure, and/or ecological functioning for *Sargassum* and communities that rely on *Sargassum* for the transportation of larvae, settlement, or food beyond the area of the impact-producing factor. These impacts would be expected to be spatially extensive and possibly disrupt the global *Sargassum* cycle.

The potential magnitude of impact for each of these impact-producing factors is provided in **Table 4-12** to help the reader quickly identify the level of potential impacts for *Sargassum* and its associated communities.

Table 4-12. *Sargassum* and Associated Communities Impact-Producing Factors That Are Reasonably Foreseeable.

Sargassum and Associated Communities	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Vessel Operations	Negligible	Negligible	Negligible	Negligible	None
Drilling Operations	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Drilling Operations	Negligible	Negligible	Negligible	Negligible	None
Vessel Operations	Negligible	Negligible	Negligible	Negligible	None
Oil Spill and Cleanup	Negligible	Negligible	Negligible	Negligible	None
Cumulative Impacts					
Incremental Contribution[2]	Negligible	Negligible	Negligible	Negligible	None
OCS Oil and Gas[3]	Minor to Moderate				
Non-OCS Oil and Gas[4]	Negligible				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.5 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

Several impact-producing factors can affect *Sargassum*, including vessel-related operations, oil and gas drilling discharges, operational discharges, accidental spills, non-OCS oil- and gas-related vessel activity, and coastal water quality. Routine vessel operations and accidental events that occur during drilling operations or vessel operations, and oiling due to an oil spill were the impact-producing factors that could be reasonably expected to impact *Sargassum* populations in the GOM. All of these impact-producing factors would result in the death or injury to the *Sargassum* plants or to the organisms that live within or around the plant matrix. However, the unique and transient characteristics of the life history of *Sargassum* and the globally widespread nature of the plants and animals that use the plant matrix buffer against impacts that could occur at any given location. Impacts to the overall population of the *Sargassum* community are therefore expected to be **negligible** from either routine activities or reasonably foreseeable accidental events for any of the action alternatives. The incremental impact of a proposed action on the population of *Sargassum* would be **negligible** when considered in the context of cumulative impacts to the population. Under Alternative E, a proposed lease sale would be cancelled and the potential for impacts from routine activities and accidental events would be **none**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. Impacts from changing water quality would be much more influential on *Sargassum* than OCS development and would still occur without the presence of OCS oil- and gas-related activities.

Comparison of Alternatives

Sargassum has a yearly cycle that promotes quick recovery from impacts. Therefore, most routine and accidental impact-producing factors for Alternatives A-D would be expected to result in **negligible** impacts because they only impact a small percentage of the population and because impacts would be limited in size and scope as new plants rapidly replace the impacted plants. Under Alternative E, a proposed lease sale would be cancelled and the potential for impacts from routine activities and accidental events would be **none**. Under Alternative E, impacts to *Sargassum* would be limited to cumulative impacts associated with past, present, and future OCS oil- and gas-related development and non-OCS oil- and gas-related activities.

Incomplete or Unavailable Information

Although much is known about *Sargassum* and its life history, incomplete or unavailable information still remains. This incomplete or unavailable information includes information on the effects of *in situ* oil exposure and the factors impacting the movement patterns of *Sargassum.* BOEM used existing information and reasonably accepted scientific methodologies to extrapolate in completing the analysis above. BOEM has determined that there are few foreseeable significant adverse impacts to the *Sargassum* population associated with a proposed action, using publications such as Frazier et al. (2015), Gower and King (2011), Gower et al. (2013), and Powers et al. (2013). Gower and King (2011) and Gower et al. (2013) suggest that *Sargassum* is continually present in the west-central GOM and that it moves in a general west-to-east pattern during the growing season; however, movements at a finer temporal or spatial scale are more difficult to predict. Frazier et al. (2015) built upon these studies and developed a more finite life cycle for *Sargassum* that links the Sargasso Sea *Sargassum* populations with the GOM populations. With respect to the effects of oiling from the *Deepwater Horizon* oil spill, Liu et al. (2014) noted that the toxicity or the presence of oil across the surface waters of the GOM was also variable at any given time, suggesting that it is difficult to predict the effects of *Sargassum* coming into contact with surface oil. Additionally, Lindo-Atichati et al. (2012) suggested that patterns of larval fish in the surface currents in the northern GOM were not consistent spatially or temporally and that they were highly dependent on mesoscale current structures like the Loop Current and associated eddies. Combined, these studies suggest that, as *Sargassum* is passively moved in the surface waters, its presence at any given location or at any given time is difficult to predict, especially as the population grows exponentially during the growing season. Ultimately, the ephemeral and wide-ranging nature across the northern GOM and the reproductive capabilities of *Sargassum* provide a life history that is resilient towards localized or short-term deleterious impacts, such as those expected to be associated with OCS oil- and gas-related routine activities and noncatastrophic oil or synthetic-based fluid spills. Therefore, BOEM has determined that the incomplete information on *Sargassum* is not essential to a reasoned choice among alternatives and that the information used in lieu of the unavailable information is acceptable for this analysis.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including the U.S. Department of the Interior, NOAA, Fisheries and Ocean Canada, Texas A&M University, University of Southern Mississippi, and scientific publication databases including Science Direct, Elsevier, and JSTOR) were examined to assess recent information regarding *Sargassum* and associated communities that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for *Sargassum* and associated communities presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on *Sargassum* and associated communities has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for *Sargassum* and associated communities presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.6 LIVE BOTTOM HABITATS

This chapter describes shallow-water hard/live bottom habitats in Gulf of Mexico OCS planning areas. Hard bottoms are naturally occurring, rocky, consolidated substrates that are geological (e.g., exposed sedimentary bedrock) or biogenic (e.g., carbonate relic coral reef) in origin. These habitats occur throughout the GOM but are relatively rare compared with the soft bottoms that are ubiquitous. Hard bottoms, particularly those having measurable vertical relief, can serve as important habitat for a wide variety of marine organisms. Encrusting algae and sessile invertebrates such as corals, sponges, sea fans, sea whips, hydroids, anemones, ascidians, and bryozoans may attach to and cover hard substrates, thereby creating "live bottoms," a term first coined by Cummins et al. (1962). The attached flora and fauna of live bottoms, such as large sponges and structure-forming corals, further enhance the structural complexity of the benthic environment. Complex structure offers shelter that can be attractive to smaller invertebrates and fishes (Fraser and Sedberry, 2008), which, in turn, can provide food for a variety of larger fishes, including some commercially important fisheries (Szedlmayer and Lee, 2004; Gallaway et al., 2009). Refer to **Chapter 4.7** ("Fishes and Invertebrate Resources") and the *Essential Fish Habitat Assessment* white paper (USDOI, BOEM, 2016d) for more detail. Seagrasses can also be considered a type of live bottom, but they have very different physical characteristics and species assemblages than the above and are thus analyzed separately in **Chapter 4.3.1**.

Defined topographic features (**Chapter 4.6.1**) are a subset of GOM hard bottom habitats that are large enough to have an especially important ecological role, with specific protections defined in the Topographic Features Stipulation. In **Figure 4-9**, the smaller black polygons represent the 38 named topographic features. Pinnacle features are much smaller in size than these topographic features and are found on specific lease blocks in the CPA and EPA (i.e., the areas shown in red in

Figure 4-9), with the highest known concentrations of other live bottom features. The Topographic Features Stipulation and Live Bottom (Pinnacle Trend) Stipulation are described in Appendix D of the 2017-2022 GOM Multisale EIS. The Secretary of the Interior has decided in the Record of Decision for the Five-Year Program to include the Protection of Biologically Sensitive Underwater Features as landscape mitigation for the 10 proposed lease sales in the GOM (USDOI, BOEM, 2017c). Live bottom habitats found outside the stipulation lease blocks are not specifically included in the stipulations, but they are still given site-specific protections by BOEM during site-specific plan reviews (refer to Appendix B of the 2017-2022 GOM Multisale EIS). The GOM live bottoms are not limited to the features/areas identified in **Figure 4-9**.

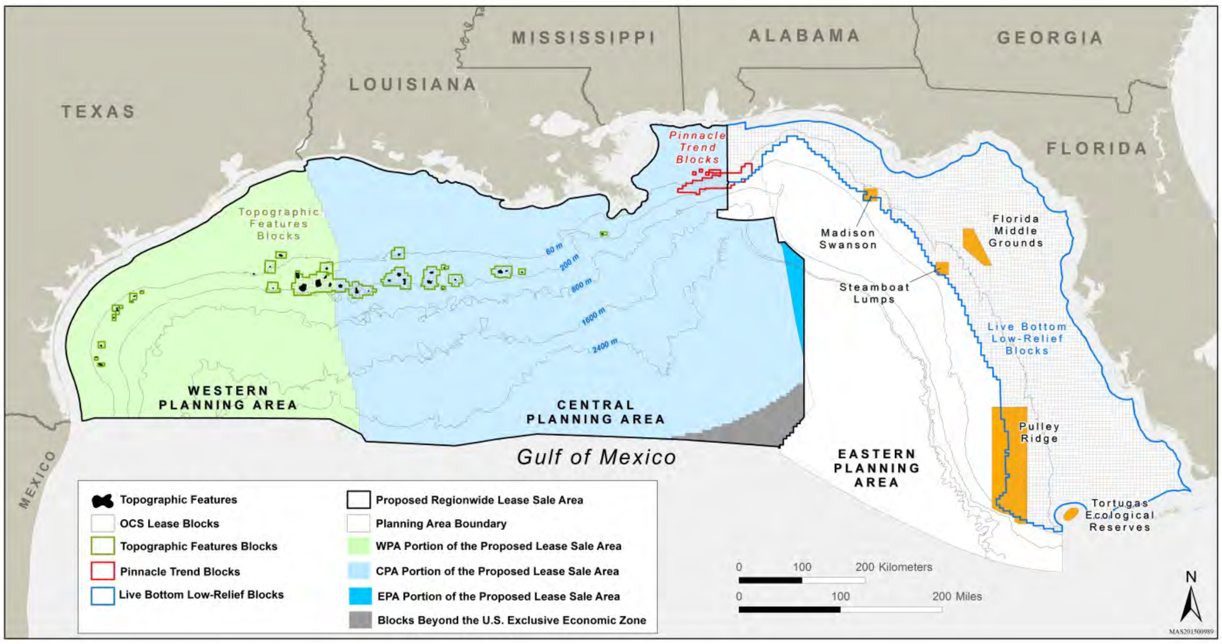


Figure 4-9. Lease Blocks Subject to the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations.

4.6.1 Topographic Features and Associated Communities

Summary

BOEM has reexamined the analysis for topographic features and associated communities presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for topographic features and associated communities presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of topographic features and associated communities, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.6.1 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS. Any new information that has become available since that document was published is presented below.

Introduction

Topographic features (also called banks) are a subset of hard bottom habitats found in the GOM that are large enough in individual size to have a particularly important role in the GOM ecosystem. Although large in size, these features (and hard bottom habitats as a whole) are relatively rare compared with the expansive soft bottoms found throughout the GOM (Parker et al., 1983). Topographic features can be created through the uplift of bedrock by underlying salt diapirs or by the exposure of fossilized barrier islands, or they can be formed from relic carbonate reefs (Rezak and Bright, 1981a and 1981b; Berryhill et al., 1987). Regardless of origin, these subsea banks provide areas of hard substrate that support benthic and fish communities with relatively high biomass, diversity, and abundance. The structurally complex habitats of these features also provide shelter, food, and nursery grounds that support large numbers of commercially and recreationally important fishes (Johnston et al., 2015; Nash et al., 2013). Many of these habitats remain relatively pristine and have a high aesthetic and scientific value, in part because they represent ecological and/or geographic extremes for many species (Rezak and Bright, 1981a; Nash et al., 2013; Johnston et al., 2015).

Topographic features and associated communities in the GOM are subject to an array of environmental conditions, resulting in a large number of ecological community types. This includes a range from the highly productive hermatypic (i.e., reef building) corals found at the Flower Garden Banks to habitats such as Dunn Bar that posess less productive and less diverse benthic habitats, yet are still known to concentrate fishes (Rezak and Bright, 1981b; Nash et al., 2013).

Protective Measures for Topographic Features

Within the Gulf of Mexico, BOEM has identified 38 topographic features with sufficiently unique geography and ecology (Rezak and Bright, 1981a; Rezak et al., 1983) to continue warranting some degree of protection from OCS oil- and gas-related activities. There are 22 topographic features in the WPA, 16 in the CPA, and 0 in the EPA (**Figure 4-9**). In the Gulf of Mexico, topographic features are known to function as large-sized, hard substrate habitats that enable settlement of sensitive benthic organisms, concentrate fishes, and substantially contribute to the ecology of the GOM. Many of these features have been identified as locations of particular value that may require a greater degree of protection from OCS oil- and gas-related activities. As such, beginning in 1973, BOEM's predecessor agency established and implemented a Topographic Features Stipulation (also referred to in this chapter just as "the Stipulation") that applies conditions to OCS oil- and gas-related activities occurring in the vicinity of these features.

Adherence to the provisions of this stipulation helps protect the resources by distancing OCS oil- and gas-related activities away from the most sensitive areas of topographic features in order to minimize any negative impacts of routine activities and accidental events on associated benthic communities. Historically, this stipulation has been applied consistently to all leases in OCS areas with defined topographic features. With the approval of the Five-Year Program, the Topographic Features Stipulation is now a required mitigation. The Stipulation establishes a No Activity Zone around the most ecologically sensitive core area of each identified topographic feature, within which no bottom-disturbing activities are allowed. Additionally, BOEM extends a 500-ft (152-m) buffer around each of these No Activity Zone boundaries, further restricting bottom-disturbing activity. The additional 500-ft (152-m) buffer policy was developed in consultation with NOAA to further protect areas of topographic features that were not originally included in the defined No Activity Zones. In addition, for most of the features, the Stipulation also establishes variably sized concentric shunting zones surrounding the No Activity Zones, within which BOEM requires that drill cuttings and drilling fluids be shunted to near the seafloor to minimize the seafloor area affected by the cuttings and fluids.

Refer to Appendix D of the 2017-2022 GOM Multisale EIS for further details of the Stipulation and NTL 2009-G39, “Biologically-Sensitive Underwater Features and Areas,” which provides information and consolidates guidance to help operators understand BOEM’s requirements related to sensitive shallow-water benthic habitats. These requirements are designed to prevent or limit any impacts resulting from routine activities and accidental events to topographic features. This analysis assumes that these (or functionally equivalent) protections will continue to be a requirement for OCS oil- and gas-related activities resulting from a proposed action throughout the 50-year analysis period. Furthermore, the Secretary of the Interior has decided in the Record of Decision for the Five-Year Program to include the Protection of Biologically Sensitive Underwater Features as landscape mitigation for the 10 proposed lease sales in the GOM (USDOI, BOEM, 2017c).

Analysis

This analysis considers the reasonably foreseeable impacts of a proposed action’s routine activities, accidental events, and incremental contribution to cumulative impacts on GOM topographic features and these physical features’ associated benthic communities (hereafter referred to as “topographic features”) over a 50-year period. Because a catastrophic oil spill is not considered reasonably foreseeable, those potential impacts (including long-term recovery) are addressed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b). The impact significance criteria and resulting conclusions presented here (**Table 4-13**) focus on the overall functioning, resilience, and ecosystem level importance of topographic features throughout U.S. waters of the GOM.

Because of the similarity and overlap of the effects of many OCS oil- and gas-related activities that occur in the OCS, the impact-producing factors considered for topographic features can be divided into three broad categories: drilling and exploration operations; vessel operations; and oil spill and associated cleanup activities. An in-depth analysis of these potential impact-producing factors determined that, although many may occur within the GOM, few could occur at an extent sufficient to cause impacts to the topographic features as a whole (**Table 4-13**), partly because these topographic features are spread widely across the GOM. The potential magnitude of impact for each of the analyzed impact-producing factors is provided in **Table 4-13** to help the reader quickly identify the level of potential impacts for each impact-producing factor. The impact-level definitions and the analyses supporting these conclusions are discussed below. The following impact-producing factors were carried forward to a full analysis for routine activities and accidental events:

- Routine Activities
  - Drilling, exploration, and decommissioning (bottom-disturbing activities)
  - Vessel operation (bottom-disturbing activities)
- Accidental Events
  - Drilling, exploration, and decommissioning
    - Bottom-disturbing activities
    - Chemical and drilling-fluid spills
  - Vessel operation (bottom-disturbing activities)
  - Oil spill and associated cleanup
    - Large and small spills resulting from surface or subsea sources
    - Cleanup operations not related to vessel operations

Of all the possible impact-producing factors, it was determined that bottom-disturbing activities associated with drilling, exploration, and vessel operations were the only impact-producing factors from routine activities that could be reasonably expected to substantially impact topographic features. The impact-producing factors also include the release of sediments and toxins during drilling operations. Oil-spill response-related activities were also considered to be a potential source of impacts to topographic features. Refer to Chapter 4.6.1 of the 2017-2022 GOM Multisale EIS for further detail on the analyses in this chapter and for the analyses that were not carried forward.

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to topographic features and associated communities:

- **Negligible** – Impacts to topographic feature communities are largely undetectable. There is some potential for even undetectable impacts to cause slight changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not impact other topographic features.
- **Minor** – Impacts to topographic feature communities are detectable but cannot be distinguished from natural variation. Such impacts could result in noticeable

changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but would be spatially localized, short term in duration, and recovery would be expected.

- **Moderate** – Impacts to topographic feature communities that result in substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive, spanning across several topographic features, but impacts are expected to result in temporary changes and recovery would be likely.
- **Major** – Impacts to topographic feature communities that result in substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive and noticeably alter the overall status of many topographic features in the GOM. Long-term recovery to pre-impact community structure, species abundance, or ecological function is unlikely.

Table 4-13. Topographic Features and Associated Communities Impact-Producing Factors That Are Reasonably Foreseeable.

Topographic Features	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Bottom-Disturbing Activities Associated with Drilling, Exploration, and Decommissioning					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
Bottom-Disturbing Activities Associated with Vessel Operations					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
Accidental Impacts					
Bottom-Disturbing Activities Associated with Drilling, Exploration, and Decommissioning					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
Chemical and Drilling-Fluid Spills					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
Vessel Operations					
Bottom-Disturbing Activities Associated with Vessel Operations					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None

Topographic Features	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Oil Spills and Associated Cleanup Activities					
Large and Small Spills Resulting from Surface or Subsea Sources					
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
Cleanup Operations Not Related to Vessel Operation					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
Cumulative Impacts					
Incremental Contribution[2]	Negligible	Negligible	Negligible	Negligible	None
OCS Oil and Gas[3]	Negligible				
Non-OCS Oil and Gas[4]	Negligible to Moderate				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.6.1 of the 2017-2022 GOM Multisale EIS.

[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.

[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.

[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

Adherence to the Topographic Features Stipulation (a required mitigation as a result of the Five-Year Program's Record of Decision) is analyzed in each action alternative and detailed in Appendix D of the 2017-2022 GOM Multisale EIS. Application of the Topographic Features Stipulation would assist in preventing or at least minimizing potential impacts to topographic feature communities by increasing the distance of OCS oil- and gas-related activities from these features. The historical application of this stipulation has resulted in **negligible** impacts of a proposed action to topographic features from routine activities and accidental events. The incremental contribution of a proposed action to the overall cumulative impacts is also expected to be **negligible**, with adherence to the required Topographic Features Stipulation. Under Alternative E, the potential for new incremental impacts to topographic features from a cancelled lease sale would be **none** because they would be avoided entirely. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. Impacts ranging from **negligible** to **moderate** may still be expected from non-OCS oil- and gas-related activities factors such as fishing, pollution, and climate change; however, the incremental impact of the proposed activities should not result in a meaningful augmentation of overall expected impacts. A full analysis of topographic features can be found in Chapter 4.6.1 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Overall, given adherence to the Topographic Features Stipulation (which is a required mitigation as a result of the Five-Year Program's Record of Decision), reasonably foreseeable impacts to topographic features from routine activities, accidental events, and the cumulative impacts for any of the action alternatives (i.e., Alternatives A-D) are expected to be **negligible**. Alternative B or C would not fundamentally alter the conclusions reached under Alternative A. Many OCS lease blocks near the features are already leased, and impacts from non-OCS oil- and gas-related activities are not expected to decrease. Under Alternative D, BOEM could hold a lease sale excluding leasing of any and/or all blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations. Topographic features could experience fewer impacts through the additional distancing of OCS oil- and gas-related activities, further reducing the probability of impacts. An accidental spill may still reach a topographic feature, but it is expected that the increased distance would provide more dispersal time as the spill travels the additional distance across unleased blocks. Alternative D would do little to change the overall cumulative impacts to topographic features. Many OCS lease blocks near the features are already leased, and impacts from non-OCS oil- and gas-related activities are not expected to decrease. Under Alternative E, a proposed lease sale would be cancelled. Therefore, the potential for new incremental impacts would be **none** because new OCS oil- and gas-related impacts to topographic features related to the cancelled lease sale would be avoided entirely. However, the level of cumulative impacts could still potentially increase over time, even eventually rising to **moderate**, should current trends of these activities continue or worsen, regardless of whether or not a single proposed lease sale would be held.

Incomplete or Unavailable Information

BOEM recognizes that there is incomplete or unavailable information related to topographic features and associated communities in general and specifically in relation to routine activities, accidental events, and cumulative impacts. However, the information that is known is adequate to come to a determination with respect to reasonably foreseeable impact-producing factors associated with a proposed action.

Research in offshore marine systems is logistically complex and requires substantial resources. As such, the total amount of research on these features and their communities is relatively limited, although BOEM and its predecessor agencies have funded numerous studies over the past 40 years. For example, our understanding of the possible impacts of surface oil spills to topographic features in the GOM was determined by combining research on the depth and concentration of the physical mixing of surface oil with the known depths of topographic features. Even though oil measurements were not collected at every feature under every condition, the available results suggest that topographic features exist at depths deeper than lethal concentrations of oil would be expected (Lange, 1985; McAuliffe et al., 1975 and 1981; Tkalich and Chan, 2002; Rezak et al., 1983; Wyers et al., 1986). Mixing to depth might occur, but it would be limited to unusual combinations of conditions such as when tropical storms pass directly over oiled surface waters (e.g., Silva et al., 2015). Moreover, the amounts of oil/dispersant mixture involved in that situation greatly exceeds the amounts considered in the "Accidental Events" analysis in Chapter 4.6.1 of the of the 2017-2022 GOM Multisale EIS. Given the geographic and temporal scope of a proposed action, it is believed that even impacts resulting from that particular situation would still only have a slight impact on the overall status of the topographic features and associated communities. However, the example demonstrates the point that the body of literature supporting impact analysis is still growing and requires continual review by BOEM.

Since the 1970s, BOEM and its predecessor agencies have supported continuous monitoring of the Flower Garden Banks for any impacts related to OCS oil- and gas-related activities. At the Flower Garden Banks, corals have generally flourished (refer to Johnston et al., 2015, and references therein) even as OCS oil- and gas-related development has occurred, sometimes just outside of the No Activity Zone. Since corals are generally considered to be more fragile than most other types of organisms found on topographic features, it is also reasonable to conclude that topographic features with more resilient organisms than the Flower Garden Banks have not been negatively affected by OCS oil- and gas-related development in the GOM. However, given the ecological sensitivity of benthic communities on topographic features, continued research and monitoring efforts are necessary to maintain a sufficient understanding of the various potential impacts from OCS oil- and gas-related and non-OCS oil- and gas-related activities. A recent example illustrates how conditions could potentially change. In August 2017, a routine National Marine Sanctuary/BOEM long-term monitoring cruise in the East Flower Garden Bank documented a mortality event affecting corals and other benthic organisms in a localized area. At the time of this writing, tissue and water quality samples have been collected but not yet analyzed, and no causes have been indicated. BOEM will continue cooperating with the Sanctuary and other partners to evaluate information as it becomes available and will update future Supplemental EISs as necessary.

BOEM has used existing information and reasonably accepted scientific methodologies to extrapolate from available information in completing this analysis and formulating the conclusions presented here. Known information about potential impacts of a theoretical catastrophic spill is detailed in the *Catastrophic Spill Events Analysis* white paper (USDOI, BOEM, 2017b), and further information was made available with the publication of the Trustees' PDARP/PEIS in 2016 (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The content of that report was reviewed as part of this analysis. Some information related to impacts specific to the *Deepwater Horizon* explosion, oil, spill, and response, such as long-term monitoring results, is still incomplete or unavailable. Impending reports are not expected to reveal additional significant effects that would alter the overall conclusions about reasonably foreseeable impact-producing factors associated with a proposed action. BOEM has determined that such additional information could not be timely acquired and incorporated into the current analysis. However, the currently available body of evidence supports past analyses and does not indicate severe adverse impacts to topographic features linked to the *Deepwater Horizon* explosion, oil, spill, and response for topographic features. Impending reports are not expected to reveal additional significant effects that would alter the overall conclusions about reasonably foreseeable impact-producing factors associated with a proposed action. Therefore, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including literature from relevant peer-reviewed journals and reports) were examined to assess recent information regarding topographic features and associated communitites that may be pertinent to a proposed action. New information relevant to an analysis of the potential impacts of OCS oil- and gas-related activities on topographic features and associated communities has been released since publication of the 2017-2022 GOM Multisale EIS.

In August 2016, a routine National Marine Sanctuary/BOEM long-term monitoring cruise in the East Flower Garden Bank documented a mortality event affecting corals and other benthic organisms in a localized area. At the time of this writing, tissue and water quality samples have been collected and some analyses completed. The Flower Garden Banks National Marine Sanctuary is awaiting reports from the participating laboratories; no specific causes have been identified. BOEM will continue cooperating with the Sanctuary and other partners to evaluate information as it becomes available and will update future Supplemental EISs as necessary.

Conclusion

BOEM has reexamined the analysis for topographic features and associated communities presented in the 2017-2022 GOM Multisale EIS based on the additional information presented above. No new information was discovered that would alter the impact conclusion for topographic features and associated communities presented in the 2017-2022 GOM Multisale EIS, and the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.6.2 Pinnacles and Low-Relief Features and Associated Communities

Summary

BOEM has reexamined the analysis for Pinnacles and low-relief features and associated communities presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for Pinnacles and low-relief features and associated communities presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of Pinnacles and low-relief features and associated communities, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.6.2 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

The terms live bottom and hard bottom are often used interchangeably, but they are actually distinct, since it is possible to have hard bottom that is not live bottom. Hard substrates can form crusts, pavements, pinnacles, ledges, outcrops, and other reefal features (Jenkins, 2011). These harder substrates may or may not be covered by a thin veneer of muddy or sandy sediments that can be deposited and removed over time by currents and storms. Hard substrates with the lowest vertical relief are the most likely to be routinely buried and exposed. Encrusting algae and sessile invertebrates regularly attach to and cover exposed hard substrates, creating live bottoms. For the purposes of the Live Bottom Stipulation, which is a required mitigation as a result of the Five-Year Program's Record of Decision, "live bottom areas" have been defined as communities or areas that contain biological assemblages consisting of sessile invertebrates such as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope (substrate type) favors the accumulation of turtles, fishes, and other fauna. Large, shallow-water coral reefs created via biogenic deposition of calcium carbonate are only known to be present at the southern end of the EPA and on a few topographic features in the WPA and CPA (refer to **Chapter 4.6.1** above). While the general public often thinks of such biogenic coral reefs as the only natural habitat for corals, for most of their geological history, corals have existed in less extensive epibenthic communities that are not built upon large biogenic reefs. These types of corals and associated epibenthic communities are the focus of this chapter on pinnacles and low-relief features.

The Pinnacle Trend is an approximately 64 x 16 mi (103 x 26 km) area in water depths ranging from approximately 200 to 650 ft (60 to 200 m). It is in the northeastern portion of the CPA at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon (**Figures 2-4 and 4-9**). Outside of the Pinnacle Trend area, low-relief, live bottom epibenthic communities occur in isolated locations in shallow waters (<984 ft; 300 m) throughout the GOM wherever there exists suitable hard substrate and other physical conditions (e.g., depth, turbidity, etc.), allowing for community development. Hard bottom habitats occur throughout the GOM but are relatively rare compared with ubiquitous soft bottoms.

Protective Measures for Pinnacle and Low-Relief Features and Associated Communities

Protective measures have been developed over time based on the nature and sensitivity of various live bottom habitats and their associated communities, as understood from decades of BOEM-funded and other environmental studies. These protections were developed into stipulations historically applied to OCS leases in areas with known concentrations of live bottom features. The Pinnacle Trend is a specific series of high- and low-relief hard/live bottom features occurring just east of the Mississippi River. BOEM has historically and consistently applied the Live Bottom (Pinnacle Trend) Stipulation to 74 OCS lease blocks covering this area. As of the approval of the Five-Year Program, the Live Bottom (Pinnacle Trend) Stipulation is a required mitigation. The CPA blocks directly adjacent to the stipulation blocks are included in a proposed action and some of the alternatives; therefore, potential impacts of routine activities and accidental events originating in those adjoining blocks are analyzed here. A full list of the stipulation blocks with required mitigation can be found in Appendix D of the 2017-2022 GOM Multisale EIS.

Live bottom habitats are found outside the blocks where the Topographic Features and Live Bottom Stipulations have been historically applied. Such habitats are not specifically included in those stipulations (now a required mitigation as a result of the Five-Year Program's Record of Decision), but they are still routinely given protections during site-specific NEPA reviews of permitted activities, as described in NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas." That NTL provides information and consolidates guidance to help operators understand BOEM's requirements related to sensitive benthic habitats both within and outside the required mitigation blocks.

Lessees must provide site-specific seafloor survey data and interpretive information (including about hard bottom features) with each EP, DOCD, and DPP. Site-specific NEPA reviews are conducted on these plans by BOEM's subject-matter experts on a case-by-case basis to determine whether a proposed operation could impact a live bottom feature. If an impact is judged likely based on site-specific information derived from BOEM's studies/databases, other published research, geohazard survey data, or another creditable source, the operator may be required to distance/relocate the proposed operation or undertake other mitigations to prevent an impact. This analysis assumes continuation of the protective measures outlined in NTL 2009-G39, as they are routinely applied (when and where appropriate) during all site-specific plan reviews. The Live Bottom Stipulation, which historically was applied to individual lease sales at the discretion of the decisionmaker and has been consistently applied to the same lease blocks for decades, is now a required mitigation as a result of the Five-Year Program's Record of Decision. The types of potential impacts to pinnacle and low-relief feature communities described in this chapter would become more likely and more severe without the continued application of these stipulations.

Analysis

This analysis considers the impacts of routine activities, accidental events, and a proposed action's incremental contribution to cumulative impacts on GOM pinnacle and low-relief features and their associated benthic communities (or just "feature communities" for short) over a 50-year period. This analysis is not exhaustive of all possible impacts of routine activities and accidental events; rather, it focuses on those related to a proposed action. A summary of the potential magnitude of impact for each of these impact-producing factors is provided in **Table 4-14** to help the reader quickly identify the level of potential impacts for each relevant impact-producing factor. The impact-level definitions and the analyses supporting these conclusions are discussed below. Because a catastrophic oil spill is not considered reasonably foreseeable, those potential impacts (including long-term recovery) are addressed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b). The impact significance criteria and resulting conclusions presented here (**Table 4-14**) focus on the overall functioning, resilience, and ecosystem level importance of live bottom pinnacle and low-relief feature communities throughout U.S. waters of the GOM. Postlease, site-specific analyses would focus more on the potential localized impacts of individual development activities (e.g., proposed drilling of a specific well) to individuals, discrete communities, and small patches of live bottom habitat. Those analyses would also detail site-specific protective mitigations required prior to approval of such activities. Appendix B of the 2017-2022 GOM Multisale EIS provides detail on some of the potential site-specific mitigations that could be applied as necessary.

The primary relevant, reasonably foreseeable impacts of routine activities and accidental events to live bottom Pinnacle Trend and low-relief features and associated communities described in this chapter can be grouped into the following three general categories:

(1) bottom-disturbing activities (routine and accidental);

(2) drilling-related sediment and waste discharges (routine and accidental); and

(3) oil spills (accidental).

These impacts are analyzed in detail under the “Routine Activities” and “Accidental Events” sections in Chapter 4.6 of the 2017-2022 GOM Multisale EIS and are summarized below. Cumulative impacts were also considered in two steps: cumulative impacts resulting from OCS oil- and gas-related activities and impacts resulting from non-OCS oil- and gas-related activities. Some impact-producing factors relevant to live bottom communities (such as anthropogenic sounds) are analyzed in detail in Chapter 4.7 (“Fishes and Invertebrate Resources”) of the 2017-2022 GOM Multisale EIS. Some theoretically possible impact-producing factors were not carried forward for full analysis in the 2017-2022 GOM Multisale EIS because any potential effects were judged to be either not reasonably foreseeable or having such a miniscule impact that they would not rise to the level of negligible impact. Refer to Chapter 4.6.2 of the 2017-2022 GOM Multisale EIS for more detail on these analyses.

Impact-Level Definitions

For this analysis, the definitions below were used to categorize impacts to pinnacles and low-relief features and associated communities.

- **Negligible** – Impacts to pinnacle and low-relief feature communities are largely undetectable. There is some potential for even undetectable impacts to cause slight changes to a local community’s species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of GOM pinnacle and low-relief feature communities.
- **Minor** – Impacts to pinnacle and low-relief feature communities are detectable but cannot be distinguished from natural variation. Such impacts could result in noticeable changes to a local community’s species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of GOM pinnacle and low-relief feature communities.

- **Moderate** – Impacts to pinnacle and low-relief feature communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive, but they are expected to only temporarily alter the overall status of GOM pinnacle and low-relief feature communities such that long-term recovery to pre-impact levels is likely.

- **Major** – Impacts to pinnacle and low-relief feature communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive and to noticeably alter the overall status of GOM pinnacle and low-relief feature communities such that long-term recovery to pre-impact levels is unlikely.

Table 4-14. Pinnacles and Low-Relief Features and Associated Communities Impact-Producing Factors That Are Reasonably Foreseeable.

Pinnacles and Low-Relief Features	Magnitude of Potential Impact1				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Bottom-Disturbing Activities and Drilling-Related Sediment and Waste Discharges					
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Without Mitigation	Minor to Major	Minor to Moderate	Negligible to Minor	Negligible to Minor	None
Accidental Impacts					
Bottom-Disturbing Activities and Drilling-Related Sediment and Operational Waste Discharges					
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible	Negligible	None
Without Mitigation	Minor to Major	Minor to Moderate	Negligible to Minor	Negligible to Minor	None
Oil Spills					
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible	Negligible	None
Without Mitigation	Minor to Major	Minor to Moderate	Negligible to Minor	Negligible to Minor	None
Cumulative Impacts					
Incremental Contribution[2]	Negligible to Minor	Negligible to Minor	Negligible	Negligible	None
OCS Oil and Gas[3]	Negligible to Minor				
Non-OCS Oil and Gas[4]	Minor to Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.6.2 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

The impact-producing factors for pinnacles and low-relief live bottom features and associated communities can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) oil spills. These impact-producing factors have the potential to damage individual pinnacle and low-relief features and associated benthic communities if insufficiently distanced or otherwise mitigated. The Live Bottom Stipulation (which is a required mitigation as a result of the Five-Year Program's Record of Decision), along with site-specific reviews of permit applications and associated distancing requirements, would mitigate potential impacts to the communities as a result of both routine activities and accidental disturbances. At the broad geographic and temporal scope of this analysis, and assuming adherence to all expected lease stipulations and typically applied regulations and mitigations, routine activities are expected to have largely localized and temporary effects. Although accidental events have the potential to cause severe damage to specific pinnacle and low-relief feature communities, the number of such events is expected to be very small. Therefore, at the regional, population-level scope of this analysis, the incremental contribution of impacts from reasonably foreseeable routine activities and accidental activities to the overall cumulative impacts is expected to be **negligible** to **minor**. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative effects experienced by pinnacle and low-relief feature habitats. Under Alternative E, the potential for impacts to pinnacle and low-relief feature communities related to a cancelled lease sale would be **none** because new impacts would be avoided entirely. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. The OCS oil- and gas-related cumulative impacts to pinnacle and low-relief feature communities are estimated to be **negligible** to **minor**. A full analysis of pinnacles and low-relief features can be found in Chapter 4.6.2 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Overall, given adherence to the Live Bottom (Pinnacle Trend) Stipulation (which is a required mitigation as a result of the Five-Year Program's Record of Decision), reasonably foreseeable impacts to pinnacle and low-relief feature communities from routine activities, accidental events, and the cumulative impacts for any of the action alternatives (i.e., Alternatives A-D) are expected to be **negligible** or **negligible** to **minor**, depending on the alternative. Alternative B would not fundamentally alter the overall conclusion reached under Alternative A for incremental impacts from a lease sale. Many OCS lease blocks near the features are already leased, and non-OCS oil- and gas-related activities are not expected to decrease. Under Alternative C, BOEM could hold a lease sale excluding the CPA/EPA available unleased blocks and would only offer all available unleased blocks in the WPA. Alternative C would not fundamentally alter the conclusions reached under Alternative A or B, but it would reduce the potential impacts of a proposed lease sale of the available unleased CPA/EPA blocks, including known high concentrations of pinnacle and low-relief feature communities in the Pinnacle Trend blocks and other portions of the northeastern CPA (**Figure 4-9**). Under Alternative D, BOEM could hold a lease sale excluding leasing on any and/or all blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations. Known pinnacle and low-relief features in the Pinnacle Trend area would be further protected by the increased distancing of OCS oil- and gas-related activities, reducing the probability of impacts. An accidental spill may still reach a feature, but it is expected that the increased distance would provide more dispersal time as the spill travels the additional distance across unleased blocks. Under Alternative E, a proposed lease sale would be cancelled. Therefore, the potential for new incremental impacts would be **none** because new OCS oil- and gas-related impacts to pinnacle and low-relief feature communities related to a cancelled lease sale would be avoided entirely. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative.

Incomplete or Unavailable Information

BOEM recognizes that there is incomplete or unavailable information related to GOM live bottom habitats in general and specifically in relation to routine activities, accidental events, and cumulative impacts for OCS oil- and gas-related activities and cumulative non-OCS oil- and gas-related activities. However, the information that is known is adequate to come to a determination with respect to reasonably foreseeable impact-producing factors associated with a proposed action.

Research in offshore marine systems is logistically complex and requires substantial resources to conduct. The total amount of research on live bottom habitats has therefore been limited, although BOEM and its predecessor agencies have funded numerous studies over the past 40 years. An example of incomplete knowledge about this resource would be that the exact distribution of GOM live bottom habitats at any given time is not perfectly understood. This is due in part to limits on data collection but also due to the frequent burial and exposure of low-relief hard bottoms. To help address this knowledge gap, BOEM requires operators to provide detailed, updated, site-specific survey information about potential live bottom habitats; this information is reviewed by subject-matter experts prior to approval of individual proposed activities, and appropriate protective mitigations are applied where appropriate.

Although BOEM has acquired and applies a large amount of knowledge about possible impacts to live bottom habitats, a perfect understanding of all conceivable impacts is unattainable. For example, only recently did a study (Silva et al., 2015) provide compelling evidence that the mixing of a surface oil/dispersant mixture to the depths of the Pinnacle Trend live bottom features can actually occur, given a very unusual combination of conditions, and could then have a localized impact. Given the geographic and temporal scope of a proposed action, it is believed that even impacts resulting from that particular scenario would still only have a slight impact on the overall status of GOM pinnacle and low-relief feature communities. Moreover, the amount of oil/dispersant mixture in that catastrophic situation greatly exceeded the amounts considered in the "Accidental Events" analysis in Chapter 4.6.2 of the 2017-2022 GOM Multisale EIS. However, the example demonstrates the point that the body of literature supporting impact analysis is still growing and requires continual review by BOEM.

Known information about potential impacts of a theoretical catastrophic spill is detailed in the *Catastrophic Spill Events Analysis* white paper (USDOI, BOEM, 2017b), and further information was made available with the publication of Trustees' PDARP/PEIS in 2016 (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The content of that report was reviewed as part of this analysis. Some information related to impacts specific to the *Deepwater Horizon* explosion, oil, spill, and response, such as long-term monitoring results, is still incomplete or unavailable. Impending reports are not expected to reveal additional significant effects that would alter the overall conclusions about reasonably foreseeable impact-producing factors associated with a proposed action. Therefore, BOEM has determined that it is not possible to obtain this information within the timeframe contemplated for the NEPA analysis in this Supplemental EIS, regardless of the cost or resources needed.

BOEM will continue to analyze and support collection and analysis of the best available scientific information related to live bottom habitats. BOEM used reasonably accepted scientific methodologies to extrapolate from existing information in completing this analysis and formulating the conclusions presented here. BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including literature from relevant peer-reviewed journals and reports) were examined to assess recent information regarding Pinnacles and low-relief features and associated communities that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for Pinnacles and low-relief features presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new relevant information on Pinnacles and low-relief features and associated communities has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for Pinnacles and low-relief features and associated communities presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.7 FISHES AND INVERTEBRATE RESOURCES

Summary

BOEM has reexamined the analysis for fish and invertebrate resources presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for fish and invertebrate resources presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of fish and invertebrate resources, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with the proposed action are presented in Chapter 4.7 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS. Any new information that has become available since that document was published is presented below.

Introduction

Fish and invertebrate resources of the GOM comprise a large and diverse group of species (Felder et al., 2009). The distribution of fishes and invertebrates varies widely, and species may be associated with different habitats at various life stages. This analysis highlights behaviors and habitat preferences, but it does not attempt to provide a comprehensive list of all potentially impacted fauna. For purposes of this analysis, habitat preferences can be divided into three broad categories: estuarine; coastal; and oceanic. Exposure to specific impact-producing factors generated by OCS oil- and gas-related routine activities and accidental events can vary among these categories. Coastal and oceanic resources are further broken into benthic and pelagic zones to address differences in potential exposure to impact-producing factors within a given habitat category. Ichthyoplankton bridges all three categories. Egg and larval stages of most fishes and invertebrates can be found in the upper layer of the water column, exposing these species' early life stages to similar impact-producing factors. For these reasons, the description of the affected environment for fish and invertebrate resources is broken into estuarine, coastal, and oceanic habitats, with ichthyoplankton being treated separately due to the potentially broader distribution of egg and larval lifestages across these habitats. A detailed description of the affected environment for fish and invertebrate resources can be found in in Chapter 4.7.1 of the 2017-2022 GOM Multisale EIS, along with a brief discussion of the federally managed species.

Analysis

This chapter provides a summary of the information detailed in the 2017-2022 GOM Multisale EIS regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts described in **Chapter 3** and their potential effects on fish and invertebrate resources that would potentially result from a proposed action or the alternatives. This analysis applies to all considered alternatives. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), the distribution of fishes and invertebrate species is nonrandom; species are associated with habitat preferences. However, within the Gulf of Mexico, the distribution of species may generally be considered even throughout their range of habitat within the planning areas. As such, the potential for impacts to populations is independent of the planning area(s) analyzed. Differences in the specific populations potentially exposed to impact-producing factors and the potential impacts may be more easily estimated as specific sites and activities become known. Therefore, because of the diversity and distribution of species in the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. However, Alternative E would have no impacts as a proposed action would not be implemented; therefore, the only impacts would be those associated with the continuing effects from past lease sales and non-OCS oil- and gas-related activities.

Preliminary analysis of the routine OCS oil- and gas-related activities and reasonably foreseeable accidental events identified eight impact-producing factors with the potential to affect marine fishes and invertebrates and/or their habitat. Many OCS oil- and gas-related activities affect the environment similarly. For example, vessel traffic, exploratory drilling, geophysical activities, and offshore construction all produce sound. The impact-producing factor, "anthropogenic sound," was analyzed taking all sound-producing OCS oil- and gas-related activities into consideration. The following are impact-producing factors that were considered and analyzed in this resource analysis:

- anthropogenic sound (Chapter 3.3.2.7 of the 2017-2022 GOM Multisale EIS);
- bottom-disturbing activity (Chapter 3.1.3.3.2 of the 2017-2022 GOM Multisale EIS);
- habitat modification; and
- oil spills (**Chapter 3.2.2**).

Two of the eight impact-producing factors that were considered for fishes and invertebrate resources were determined to be insignificant under all reasonably foreseeable circumstances due to the limited exposure and/or response expected for fish and invertebrate resources and are, therefore, not analyzed in this chapter. These impact-producing factors are entrainment (Chapter 3.1.5.1.6 of the 2017-2022 GOM Multisale EIS) and offshore lighting (Chapter 3.1.3.4.3 of the 2017-2022 GOM Multisale EIS). A Joint Industry Biological Baseline Study was completed for USEPA Region 6 in June 2009 (LGL Ecological Research Associates, Inc., 2009), and an industry-wide cooling water intake structure entrainment monitoring study, approved by USEPA Region 6, was completed in 2014 (Continental Shelf Associates, Inc. and LGL Ecological Research Associates, Inc., 2014). The results of these two studies support BOEM's finding that entrainment is insignificant as an impact-producing factor for the purpose of this analysis. Analyses of two additional impact-producing factors that could potentially impact resources ecologically important to fishes and invertebrates were addressed in earlier chapters. Discussions of onshore construction and manufacturing (**Chapters 3.1.2.2 and 4.3**, "Coastal Habitats") and regulated discharges (Chapter 3.1.5.1 of the 2017-2022 GOM Multisale EIS and **Chapter 4.2** of this Supplemental EIS, "Water Quality") were found to sufficiently address the potential for adverse impacts to fish and invertebrate habitats and are not duplicated in this chapter.

Analysis of potential impacts considered the estimated scale of source activities and used the best available science to evaluate how specific impact-producing factors could affect resources within the expected environment. Cumulative impacts (discussed in detail in Chapter 4.7.3 of the 2017-2011 GOM Multisale EIS) were analyzed for OCS oil- and gas-related activities and for other sources that could affect fishes and invertebrates (e.g., coastal development, commercial shipping, fisheries, and environmental). Because of the diversity of fishes and invertebrates, detailed criteria for potential impact levels are not reasonable.

Though two protected fish species (Gulf sturgeon [*Acipenser oxyrhynchus desotoi*] and smalltooth sawfish [*Pristis pectinata*]) are found near the Area of Interest, they inhabit and have critical habitat in onshore waters (i.e., shallow waters near the shoreline). A third protected species, Nassau grouper (*Epinephalus striatus*), is a transient or rarely occurring species in the Area of Interest. These species are not considered to be impacted by a proposed action because they are found away from activities that could cause an impact. The impact-level definitions and analyses supporting these conclusions are discussed below.

Impact-Level Definitions

For this analysis, the potential impact-level criteria can be described in terms of population-level effects.

- **Negligible** – localized and temporary impacts that are expected to be indistinguishable from natural variations in population distribution and abundance.
- **Minor** – localized and temporary impacts that are expected to be indistinguishable from natural variations in population distribution and abundance. Community-level variations may be locally detectable, such as species mix and relative abundance following the removal of OCS oil- and gas-related infrastructure.
- **Moderate** – Impacts would be expected to exceed natural variations in population abundance or distribution, but not result in a long-term decline.
- **Major** – Impacts would be expected to exceed natural variations and inherently result in a long-term decline in populations.

The impact-producing factors analyzed and the impact-level conclusions reached from the analysis in this chapter are presented in **Table 4-15** to help the reader quickly identify the level of potential impacts for fishes and invertebrate resources.

Table 4-15. Fish and Invertebrate Resources Impact-Producing Factors That Are Reasonably Foreseeable.

Fish and Invertebrate Resources	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Anthropogenic Sound	Minor	Minor	Minor	Minor	None
Bottom-Disturbing Activity	Negligible	Negligible	Negligible	Negligible	None
Habitat Modification	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Accidental Impacts					
Oil Spills	Negligible	Negligible	Negligible	Negligible	None
Cumulative Impacts					
Incremental Contribution[2]	Minor	Minor	Minor	Minor	None
OCS Oil and Gas[3]					
Anthropogenic Sound	Minor				
Bottom-Disturbing Activity	Negligible				
Habitat Modification	Negligible to Moderate				
Non-OCS Oil and Gas[4]					
Anthropogenic Sound	Moderate				
Fisheries	Negligible to Moderate				
Habitat Modification	Minor				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.7 of the 2012-2022 GOM Multisale EIS.

[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.

[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.

[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

The distribution of fishes and invertebrates varies widely and species may be associated with different habitats at various life stages, as discussed further in Chapter 4.7 of the 2017-2022 GOM Multisale EIS. The impact-producing factors affecting these resources are anthropogenic sound, bottom-disturbing activities, habitat modification, and accidental oil spills. The impacts from routine activities, excluding infrastructure emplacement, would be expected to be **negligible** or **minor** due to short-term localized effects. The installation of OCS oil- and gas-related infrastructure constitutes a long-term modification of the local habitat and is hypothesized to have resulted over the life of the program in **moderate** changes in the distribution of some species. Although this effect is not necessarily adverse and infrastructure is expected to be decommissioned and sites restored to natural habitat, the cumulative impact over the life of the OCS Program is spatiotemporally extensive. Accidental spills have been historically low-probability events and are typically small in size. The expected impact to fishes and invertebrate resources from accidental oil spills is **negligible**. Commercial and recreational fishing are expected to have the greatest direct effect on fishes and invertebrate resources, resulting in impact levels ranging from **negligible** for most species to potentially **moderate** for some targeted species (e.g., hogfish spp., gray triggerfish [*Balistes capriscus*], and greater amber jack [*Seriola dumerili*]). The analysis of routine activities and accidental events indicates that the *incremental contribution* to the overall cumulative impacts on fishes and invertebrate resources as a result of a single proposed lease sale would be **minor**. Under Alternative E, the expected impacts on fish and invertebrate resources would be **none**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of fish and invertebrate resources can be found in Chapter 4.7 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

With respect to fishes and invertebrate resources, the effects associated with the selection of any of the proposed action alternatives (i.e., Alternatives A-D) would be equal because of the diversity and distribution of fish and invertebrate species throughout the potential area of interest. The analyses assume a nonrandom distribution of species (i.e., distribution is associated with habitat preference and habitat availability) and consider impacts to fishes and invertebrate resources occurring in a wide range of habitats across all planning areas. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), the distribution of fishes and invertebrate species is nonrandom; species are associated with habitat preferences. However, within the Gulf of Mexico, the distribution of species may generally be considered even throughout their range of habitat within the planning areas. As such, the potential for impacts to populations is independent of the planning area(s) analyzed. Differences in the specific populations potentially exposed to impact-producing factors and the potential impacts may be more easily estimated as specific sites and as activities become known. Therefore, at a planning area scale, it is expected that a similar mix of species would be exposed to the analyzed impact-producing factors, regardless of the specific action alternative selected. The activities proposed under Alternatives A-D would directly impact fishes and invertebrate resources within the GOM and would contribute incrementally to the cumulative effects on these resources. Therefore, the analysis of routine OCS oil- and gas-related activities, accidental events, and the cumulative impacts of OCS oil- and gas-related and non-OCS oil- and gas-related activities indicates that the expected overall impact to fishes and invertebrate resources, depending upon the impact-producing factor and the affected species, would range from **negligible** to **moderate** for the period analyzed. For example, muds and cuttings discharged at the surface for a well drilled at a water depth of 5,000 ft (1,524 m) would have a negligible impact on coastal species, such as menhaden, whereas a small spill in coastal waters and subsequent response activities could disrupt a spawning event or temporarily displace coastal fishes from the affected area (minor). Moderate impacts would only be expected if impact-producing factors affected habitat or populations to an extent that would be expected to exceed natural variations in population abundance or distribution but not result in a long-term decline. Under Alternative E, the incremental impacts on fishes and invertebrate resources within the Gulf of Mexico would be **none**; however, impacts would continue from ongoing OCS oil- and gas-related activity.

Incomplete or Unavailable Information

BOEM identified incomplete or unavailable information related to impacts to fishes and invertebrate resources resulting from OCS oil- and gas-related activities and non-OCS oil- and gas-related activities in the GOM. Anthropogenic sound and habitat modification directly or indirectly affect large areas of the GOM and potentially impact thousands of species. However, the response of individuals, groups of conspecifics (members of the same species), and communities are highly variable and inconsistent. In addition, BOEM recognizes that there is incomplete information with respect to potential long-term effects resulting from exposure to spilled oil. Although additional information on these impact-producing factors may be relevant to the evaluation of impacts to fishes and invertebrate resources, BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives. Analyses of routine activities, accidental events, and cumulative impacts drew upon the most current and best available research to assess the potential effects on many species and habitats. The findings collectively indicate that impacts are likely, but limited, and are not expected to induce a population-level response. BOEM recognizes the potential that populations with spatially limited distributions or increased sensitivity to an impact-producing factor may be more severely impacted than current research suggests. However, sufficient data to conduct a thorough assessment of all potentially affected species are not available or obtainable within the timeline contemplated in the NEPA analysis of this Supplemental EIS. BOEM used the best available science to determine the range of reasonably foreseeable impacts and applied accepted scientific methodologies to integrate existing information and extrapolate potential outcomes in completing this analysis and formulating the conclusions presented here.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including Elsevier, PLoS ONE, Taylor and Francis Online, NOAA’s NCCOS Publications Explorer, and Wiley Online Library) were examined to assess recent information regarding fish and invertebrate resources that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for fish and invertebrate resources presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information essential to an analysis of fish and invertebrate resources has been published since the publication of the

2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for fish and invertebrate resources presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.8 BIRDS

Summary

BOEM has reexamined the analysis for birds presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for birds presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of birds, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.8 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

This description of birds focuses on the factors that control the relative vulnerability of different bird groups to impacts. Passerines, or songbirds, represent many of the breeding and wintering birds within the Gulf Coast States. They are only found offshore when migrating across the Gulf of Mexico, and they cannot stop and rest or feed on the water. Some species of birds (some seabirds) live primarily offshore except when breeding and, therefore, are rarely observed in the nearshore environment. The remaining species are found within coastal and inshore habitats and may be more susceptible to potential deleterious effects resulting from OCS oil- and gas-related activities since many of these species largely overlap spatially and temporally with OCS oil- and gas-related activities because of their abundance or density and due to the potential of oil impacting their habitat or food resources.

Analysis

This chapter provides a summary of the information detailed in the 2017-2022 GOM Multisale EIS regarding the impact-producing factors from the routine activities, accidental events, and cumulative impacts described in **Chapter 3** and their potential effects on birds that could potentially be impacted by a proposed action or the alternatives. This analysis would apply to all alternatives considered; however, the level of impacts would be different for each alternative, as discussed below.

The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, production, and decommissioning), as well as accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor. The impact-producing factors considered and analyzed include discharges and wastes, noise, platform severance with explosives, geophysical surveys with airguns, platform presence and lighting, emergency air emissions, platform or pipeline oil spills, spill response, oil- and gas-related activities in State waters, the hypoxic “dead zone” of the Mississippi River, net coastal wetland gain or loss, urbanization, a large tanker spill, military activities, recreation, boat traffic, impacts on bird habitat, collisions with vehicles and buildings, predation by domestic cats, commercial fishing, climate change, and wetland subsidence. The potential magnitude of impact for each of these impact producing factors is provided in **Table 4-16** to help the reader quickly identify the level of potential impacts for each impact-producing factor. The impact-level definitions and the analyses supporting these conclusions are discussed below.

Impact-producing factors considered but not analyzed include obstruction lighting, which is under the jurisdiction of USCG. Other impact-producing factors that were not analyzed because they do not apply to birds include geological ancillary activities, all onshore infrastructure emplacement and presence, offshore platform emplacement, other commissioning activities, and onshore waste disposal.

Seven species found in the area of interest are listed under the ESA, and BOEM has initiated formal consultation with FWS for those species. Those species have life histories that are similar to those of the birds covered in this chapter, but the cumulative impact could be greater. BOEM recognizes this, consults on these species, and requires mitigations that would decrease the potential for greater impacts due to small population size or limited distribution. For more information on the listed bird species, refer to **Chapter 4.9.4** of this Supplemental EIS and Chapter 4.9.4 of the 2017-2022 GOM Multisale EIS.

Impact-Level Definitions

Two concepts important in the impact-level definitions below are populations and population sizes. In ecology, a population is often defined as a group of individuals with similar genes (i.e., species and subspecies). Such a population lives in one or more natural geographic areas where its habitats are located. Human-made areas (e.g., the planning areas) are also important to the analysis. Natural areas overlap with the planning areas. Bird species described in this chapter are considered to have large populations and to be widely distributed Flock size and population, mentioned below in the impact-level definitions, have ranges of impacts that can vary by bird species. Examples of flock sizes and population sizes are given in the “Description of the Environment” section of Chapter 4.8 of the 2017-2022 GOM Multisale EIS. Abundance, as used in this chapter, means the number or biomass (total weight) of a particular species in a general area (this definition is taken from Krebs, 2009). Chronic, as used in this chapter, means of indefinitely high frequency or of indefinitely long duration.

The impact-level definitions for birds are as follows:

- **Negligible** – Impacts would not affect a substantial abundance of birds. Impacts would especially not affect species with low abundances prior to impacts. Estimates of continued population viability, including predicted annual rates of recruitment or survival, would not change. Any impacts would be acute and reversible. Further, no injury to or mortality of a small number of individuals or a small flock would occur.
- **Minor** – Impacts would not affect a substantial abundance of birds. Impacts would especially not affect species with low abundances prior to impacts. Estimates of continued population viability, including predicted annual rates of recruitment or survival, would not change. Additionally, one or both of the two following conditions must be met: (1) small numbers of individuals or small flocks of birds would experience chronic impact-producing factors and would be chronically disturbed or affected, resulting in chronic but reversible behavioral changes; and/or (2) one or more incidents would occur where small numbers of individuals or small flocks of birds would experience injury or mortality, but with no measurable impact on a population.
- **Moderate** – Impacts would affect a substantial abundance of birds. Estimates of continued population viability, including predicted annual rates of recruitment or survival, would not change. Additionally, one or both of the two following conditions must be met: (1) a large flock of birds (e.g., a shorebird flock of 500 or 1,000 birds) would experience chronic impact-producing factors and would be chronically disturbed or affected, resulting in chronic behavioral changes or mortality over time; and/or (2) one or more incidents would occur where substantial numbers of individuals, including large flocks, would experience chronic behavior changes or mortality that would affect a large flock, but with no measurable impact on a population.
- **Major** – Impacts would affect a substantial abundance of birds. Estimates of continued population viability, including predicted annual rates of recruitment or survival, would change. Additionally, one or both of the two following conditions must be met: (1) at least one large population of birds would have a reduction in the estimates of continued population viability, including predicted annual rates of mortality, recruitment or survival, some or all of which would seriously decline (causing sublethal impacts to be irreversible); and/or (2) one or more incidents would occur where at least one large population would experience chronic behavior changes or mortality that would affect a large population and with measurable impact on a population.

Table 4-16. Birds Impact-Producing Factors That Are Reasonably Foreseeable.

Birds	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Discharges and Wastes	Negligible	Negligible	Negligible	Negligible	None
OCS Oil- and Gas-Related Noise and Disturbance	Negligible	Negligible	Negligible	Negligible	None
Platform Severance and Rigs-to-Reefs	Minor	Minor	Minor	Minor	None
Geophysical Surveys with Airguns	Minor	Minor	Minor	Minor	None
Platform Presence and Lighting	Minor	Minor	Minor	Minor	None
Accidental Impacts					
Oil Spills	Moderate	Moderate	Moderate	Moderate	None
Oil-Spill Response	Minor	Minor	Minor	Minor	None
Emergency Air Emissions	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
Incremental Contribution[2]	Moderate	Moderate	Moderate	Moderate	None
OCS Oil- and Gas[3]	Moderate				
Non-OCS Oil- and Gas[4]	Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.8 of the 2017-2022 GOM Multisale EIS. Moderate impact levels could be possible, only if a large oil spill were to occur.

[2] This impact level is the incremental contribution of a single proposed lease sale to all cumulative impacts in the GOM.

[3] This impact level is the cumulative impacts of all past, present, and reasonably forseeable OCS oil- and gas-related activities in the GOM.

[4] This impact level is the cumulative impacts of all past, present, and reasonably foreseeable activities in the GOM.

The affected species of birds include both terrestrial songbirds and many groups of waterbirds. Routine impacts to coastal, marine, and migratory birds that were considered include routine discharges and wastes, noise, platform severance with explosives (barotrauma), geophysical surveys with airguns, platform presence and lighting, construction of OCS oil- and gas-related onshore facilities, and pipeline landfalls. The impacts to birds from routine OCS oil-and gas-related activities are similar wherever they may occur in the GOM, and all are considered **negligible** to **minor**. Negligible to minor impacts would not affect a substantial number of birds. Any impacts would be acute and reversible. Further, no injury to or mortality of a small number of individuals or a small flock would occur. Accidental impacts to birds are caused by oil spills, spill cleanup activities, and emergency air emissions. Seabirds may not always experience the greatest impacts from a spill but may take longer for populations to recover because of their unique population ecology (demography). Some species of seabirds, such as gulls, have larger clutches (laughing gulls usually have 3 eggs per clutch, except in the tropics) and may recover quite quickly. However, many species of seabirds can have a clutch size of just one egg, relatively long life spans, and often have delayed age at first breeding. Because of the latter case, impacts on seabirds from overall accidental events would be expected to be **moderate**. Impacts from overall accidental events on other waterbirds farther inshore would also be expected to be **moderate** because of the extensive overlap of their distributions with oiled inshore areas and shorelines expected from a large oil spill (≥1,000 bbl). Moderate impacts would affect a substantial abundance of birds.

The incremental contribution of a proposed action to the overall cumulative impacts is considered **moderate**, but only because of the potential impacts that could result from a large oil spill (≥1,000 bbl). This conclusion is based on the increment of a proposed action compared with all cumulative OCS oil- and gas-related and non-OCS oil- and gas-related impacts. Alternative E would offer no new lease blocks for exploration and development; therefore, incremental impacts to birds would be **none**. However, there would be continuing impacts associated with the existing oil and gas activities from previously permitted activities and previous lease sales. A full analysis of coastal and migratory birds can be found in Chapter 4.8 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Since Alternative A is regionwide, which includes the WPA, CPA, and EPA portions of the proposed lease sale area, it would have more OCS oil- and gas-related activities than the other alternatives; therefore, it would have more potential for impacts. Impacts from the other alternatives would follow in a graded fashion. However, offshore pelagic seabird habitat is distributed throughout the planning areas. Therefore, activities occurring only in specific planning areas pose similar potential impacts to offshore pelagic seabird populations as do activities occurring in all planning areas. Therefore, because of the diversity and distribution of offshore pelagic seabird species in the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. Alternative E would offer no new lease blocks for exploration and development; therefore, no impacts from a proposed lease sale would occur. However, there would be continuing impacts associated with the existing oil and gas activities from previously permitted activities and previous lease sales.

Incomplete or Unavailable Information

BOEM has identified incomplete or unavailable information related to impacts on birds resulting from OCS oil- and gas-related activities and non-OCS oil- and gas-related activities in the GOM. BOEM's subject-matter experts have used the available scientifically credible evidence presented below and applied accepted scientific methodologies to integrate existing information and extrapolate potential outcomes in completing this analysis and formulating the conclusions presented here.

The impact of artificial light along the coast on birds has not been studied,and it is unkown if it is relevant to evaluating whether adverse mpacts on the human environment are significant, but it is not essential to a reasoned choice of among alternatives. BOEM used available information to fill the data gap. Existing information (Longcore and Rich, 2004) shows that outdoor lights at night can have both lethal impacts from collisions and sublethal impacts from a variety of mechanisms on birds. The impact level of obstruction lighting located on platforms would also need further study. The best available information was obtained from a study done by observers on platforms, from a model of energy reserves of migratory birds, and from several studies of the effect of light on birds. This scientific information presented in the 2017-2022 GOM Multisale EIS was used to conclude that platform lighting, in general, has **minor** impacts.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including websites of 5 Federal agencies [i.e., FWS, USEPA, USGS, NOAA, and BOEM]; 5 State agencies [i.e., Texas Parks and Wildlife Department; Louisiana Department of Wildlife and Fisheries; Mississippi Department of Wildlife, Fisheries, and Parks; Alabama Wildlife and Freshwater Fisheries Division; and Florida Fish and Wildlife Conservation Commission]; and 5 nonprofit stakeholders (i.e., Sierra Club, National Fish and Wildlife Foundation, Nature Conservancy, Barataria-Terrebonne National Estuary Program, and the National Audubon Society]) were examined to assess recent information regarding birds that may be pertinent to a proposed action. Environmental journal articles were also located online using four search engines (i.e., JSTOR, EBSCO, Google Advanced Scholar Search, and Google Advanced Book Search). No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for birds presented in the 2017-2022 GOM Multisale EIS with the understanding that no new information on birds has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for birds presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.9 PROTECTED SPECIES

The Endangered Species Act of 1973 (ESA), as amended, establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. In fulfilling these requirements, each agency must use the best scientific and commercial data available. The FWS and NMFS share responsibility for implementing the ESA.

The Marine Mammal Protection Act of 1972 (MMPA) prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the United States. The NMFS and FWS are also responsible for the MMPA.

For the Gulf of Mexico, NMFS is charged with protecting all cetaceans, while manatees are under the jurisdiction of FWS. Details on BOEM's consultations and coordination with NMFS and FWS are presented in **Chapter 5.2** ("Endangered Species Act").

Protected species, for the purposes of this Supplemental EIS, include ESA- and MMPA-listed species and associated designated critical habitat under the ESA. The species considered in this chapter, pursuant to our consultations and coordination, and within **Table 4-17** are those that could be affected within the Area of Interest and that are subject to the proposed activities under the alternatives. For those species not considered further because they are unlikely to be affected by the proposed activities, refer to Appendix F of the 2017-2022 GOM Multisale EIS. Critical habitats noted within the Area of Interest are shown in **Figure 4-10** and are mentioned in this chapter, but details on many of these habitats can be found in **Chapters 4.3** ("Coastal Habitats"), **4.5** ("*Sargassum* and Associated Communities"), and **4.6** ("Live Bottom Habitats").

Table 4-17. Species within the Gulf of Mexico That Are Protected Under the Endangered Species Act and/or the Marine Mammal Protection Act.

Common Name	Scientific Name		Common Name	Scientific Name
Marine Mammals			Sea Turtles	
Atlantic spotted dolphin*	*Stenella frontalis**		Green sea turtle[2]	*Chelonia mydas*[2]
Blainville's beaked whale*	*Mesoplodon densirostris**		Hawksbill sea turtle[3]	*Eretmochelys imbricata*[3]
Bottlenose dolphin*	*Tursiops truncatus**		Kemp's ridley sea turtle[3]	*Lepidochelys kempii*[3]
Bryde's whale*	*Balaenoptera edeni**		Northwest Atlantic Ocean loggerhead sea turtle[2]	*Caretta caretta*[2]
Clymene dolphin*	*Stenella clymene**		Leatherback sea turtle (Atlantic Northwest)[3]	*Dermochelys coriacea*[3]
Cuvier's beaked whale*	*Ziphius cavirostris**		Beach Mice	
Dwarf sperm whale*	*Kogia sima**		Alabama beach mouse[3]	*Peromyscus polionotus ammobates*[3]
False killer whale*	*Pseudorca crassidens**		Choctawhatchee beach mouse[3]	*Peromyscus polionotus allophrys*[3]
Fraser's dolphin*	*Lagenodelphis hosei**		Perdido Key beach mouse[3]	*Peromyscus polionotus trissyllepsis*[3]
Gervais' beaked whale*	*Mesoplodon europaeus**		St. Andrew beach mouse[3]	*Peromyscus polionotus peninsularis*[3]
Killer whale*	*Orcinus orca**		Birds	
Melon-headed whale*	*Peponocephala electra**		Cape Sable Seaside Sparrow[3]	*Ammodramus maritimus mirabilis*[3]

Pantropical spotted dolphin*	*Stenella attenuate**	Mississippi Sandhill Crane[3]	*Grus canadensis pulla*[3]
Pygmy killer whale*	*Feresa attenuata**	Piping Plover[2]	*Charadrius melodus*[2]
Pygmy sperm whale*	*Kogia breviceps**	Rufa Red knot[2]	*Calidris canutus rufa*[2]
Risso's dolphin*	*Grampus griseus**	Roseate Tern[2]	*Sterna dougallii dougallii*[2]
Rough-toothed dolphin*	*Steno bredanensis**	Whooping Crane[3]	*Grus americana*[3]
Short-finned pilot whale*	*Globicephala macrorhynchus**	Wood Stork[2]	*Mycteria americana*[2]
Sperm whale[1]	*Physeter macrocephalus*[1]	Corals	
Spinner dolphin*	*Stenella longirostris**	Elkhorn coral[2]	*Acropora palmata*[2]
Striped dolphin*	*Stenella coeruleoalba**	Staghorn coral[2]	*Acropora cervicornis*[2]
West Indian manatee[1]	*Trichechus manatus*[1]	Boulder star coral[2]	*Orbicella franksi*[2]
		Lobed star coral[2]	*Orbicella annularis*[2]
		Mountainous star coral[2]	*Orbicella faveolata*[2]

* This species is protected under the Marine Mammal Protection Act (MMPA).
[1] This species/subspecies is listed under the Endangered Species Act (ESA) as "endangered" and is also protected under the MMPA.
[2] This species/subspecies is listed under the ESA as "threatened."
[3] This species/subspecies is listed under the ESA as "endangered."

The analyses of the reasonably foreseeable potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in the chapters below. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define impact-levels for each impact-producing factor for protected species, as summarized in **Table 4-18**. The impact-level definitions and the analyses supporting these conclusions are discussed below. These impacts are across all action alternatives (i.e., Alternatives A, B, C, and D) except for beach mice and protected corals. Beach mice are not found in the WPA; therefore, they are not relevant for Alternative B, and the ranges given for potential impacts to protected corals are based on whether or not stipulations are placed on leases.

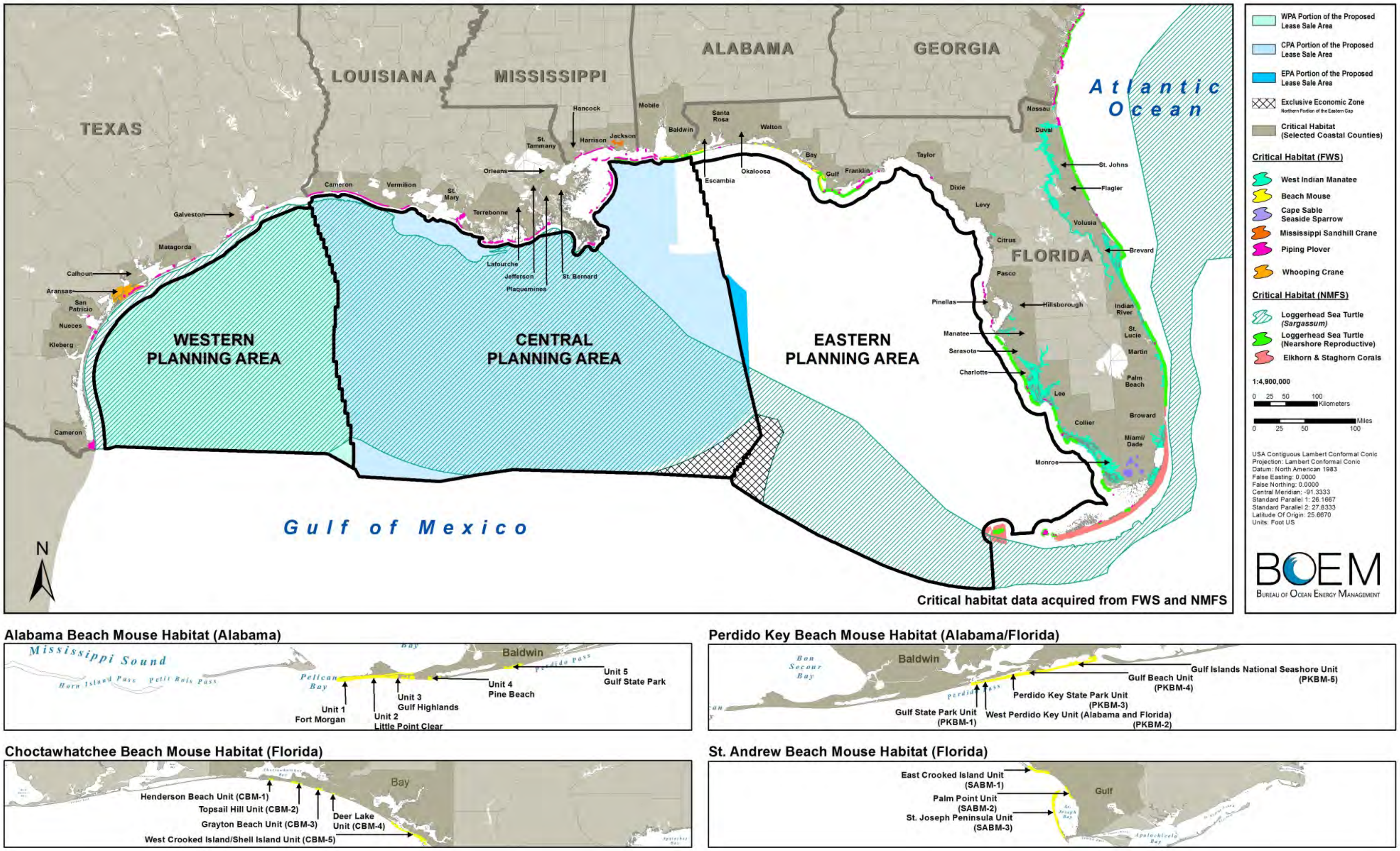


Figure 4-10. Gulf of Mexico Protected Species' Critical Habitats.

Impact-Level Definitions

As the routine activities, accidental events, and cumulative impacts are considered for specific listed species, each is given criteria per level of impact represented below.

- **Negligible** – An individual or group of animals would be subject to nominal to slight measurable impacts. No mortality or injury to any individual would occur, and no disruption of behavioral patterns would be expected. The disturbance would last only as long as the human-caused stimulus was perceptible to the individual or group.
- **Minor** – An individual or group of animals would be subject to a human-caused stimulus and be disturbed, resulting in an acute behavioral change. No mortality or injury to an individual or group would occur.
- **Moderate** – An individual or group of animals would be subject to a human-caused stimulus and be disturbed, resulting in a chronic behavioral change. Individuals may be impacted but at levels that do not affect the fitness of the population. Some impacts to individual animals may be irreversible.
- **Major** – An individual or group of animals would be subject to a human-caused stimulus, resulting in physical injury or mortality, and would include sufficient numbers that the continued viability of the population is diminished, including annual rates of recruitment or survival. Impacts would also include permanent disruption of behavioral patterns that would affect a species or stock.

The potential magnitude of impact for each of these impact-producing factors is provided in **Table 4-18** to help the reader quickly identify the level of potential impacts for each impact-producing factor.

Table 4-18. Protected Species Impact-Producing Factors That Are Reasonably Foreseeable.

Protected Species	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Marine Mammals	Sea Turtles	Beach Mice[2]	Protected Birds	Protected Corals[3]
Routine Impacts					
Geological and Geophysical Activities	Negligible to Moderate	Negligible to Moderate	N/A*	N/A	N/A
Transportation (vessel strikes)	Negligible	Negligible	N/A	N/A	N/A
Discharges (air and water quality degradation)	Negligible	Negligible	N/A	Negligible	N/A
Decommissioning (explosive severance)	Negligible to Minor	Negligible to Moderate	N/A	N/A	Negligible

Protected Species	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Marine Mammals	Sea Turtles	Beach Mice[2]	Protected Birds	Protected Corals[3]
Noise	Negligible to Minor	Negligible to Minor	N/A	Negligible	N/A
Drilling and Exploration (bottom-disturbing activities)	N/A	N/A	N/A	N/A	Negligible
Offshore Lighting/Platform Presence	N/A	N/A	N/A	Negligible	N/A
Vessel Operation (bottom-disturbing activities)	N/A	N/A	N/A	N/A	Negligible
Accidental Impacts					
Oil Spills[4]	Negligible to Moderate	Negligible to Moderate	Negligible	Negligible to Moderate	Negligible
Oil-Spill Response Activities	Negligible to Minor	Negligible to Minor	Negligible	Negligible to Minor	Negligible
Marine Trash and Debris	Negligible	Negligible	Negligible	Negligible	Negligible
Cumulative Impacts					
Incremental Contribution[5]	Negligible	Negligible	Negligible	Negligible	Negligible
OCS Oil and Gas [6]	Negligible to Moderate	Negligible to Moderate	Negligible	Negligible to Moderate	Negligible
Non-OCS Oil and Gas[7]	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major

* N/A represents those impact-producing factors that are not applicable to that protected species group.

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.9 of the 2017-2022 GOM Multisale EIS.

[2] Beach mice are not found in the WPA; therefore, they are not likely to be impacted by Alternative B.

[3] Ranges for the potential impacts to protected corals are based on whether or not protected stipulations are placed on leases.

[4] Accidental oil spills are those <10,000 bbl.

[5] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.

[6] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.

[7] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

For protected coral impact-producing factors, refer to **Table 4-13** in **Chapter 4.6.1** ("Topographic Features") since coral impact-producing factors are covered there and would apply to protected corals as well. For protected birds impact-producing factors, refer to **Table 4-16** in **Chapter 4.8** ("Birds") since the impact-producing factors that impact coastal, marine, and migratory birds (the listed birds are either found in coastal areas or are migratory and utilize coastal areas as part of their life history) are covered there. For beach mice, the most relevant impact-producing factors are those causing harm to the populations by affecting their habitat (i.e., beaches). **Table 4-10** in **Chapter 4.3.2** ("Coastal Barrier Beaches and Associated Dunes") covers the impact-producing factors that affect beaches and dunes, and information on impacts to beach mouse habitat that can be found there.

BOEM understands that mitigations greatly reduce the likelihood of an impact-producing factor, but mitigations do not guarantee that a protected species would not be impacted. There is a very low probability that a protected species may not be sighted despite all of the mitigative precautions taken to reduce impact. Unlikely scenarios such as these may cause major impacts to a protected species with a very low population because some impact-producing factors may negatively impact the reproductive success of an individual and, therefore, the continued viability of the population. However, based on credible scientific research and that within the GOM, there is a long-standing and well-developed OCS Program (more than 60 years); scenarios such as these are highly speculative. There are no data to suggest that activities from the previous OCS Programs are significantly impacting protected species populations. Therefore, for purposes of this analysis, BOEM has considered the potential affects of impact-producing factors that are reasonably foreseeable to occur.

Current baselines (including past and present events) are described for all protected species under their respective "Affected Environment" sections in the 2017-2022 GOM Multisale EIS. The altered baseline includes individual species directly affected by this unexpected unique catastrophic event. BOEM understands that each oil-spill event is unique and that its outcome depends on several factors, including time of year and location of the release relative to winds, currents, land, and sensitive resources, as well as specifics of the well and response effort. Specific to the *Deepwater Horizon*, the Trustees have completed the PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), which has the purpose and need of assessing and creating restoration plans to relieve injuries from the *Deepwater Horizon* explosion, oil spill, and response to natural resourses and services. The injuries assessed within the PDARP/PEIS do not necessarily equate the baseline as defined in NEPA. BOEM continues to analyze the *Deepwater Horizon* explosion, oil spill, and response as information becomes available, and it was evaluated as part of the baseline for resources in this Supplemental EIS.

BOEM analyzed a low-probability catastrophic event (USDOI, BOEM 2017b) in conjunction with its analysis of potential effects, as requested by the CEQ pursuant to its regulation at 40 CFR § 1502.22. The CEQ (2010) recommended that BOEM should "ensure that NEPA documents provide decision makers 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." A low-probability catastrophic spill is, by definition, *not* reasonably certain to occur. The return period of a catastrophic oil spill in OCS areas is estimated to be 165 years, with a 95-percent confidence interval between 41 years and more than 500 years (Ji et al., 2014). The use of other methods of analysis in this evaluation are significantly limited in their applicability and availability and they would not provide any meaningful or useful information to be used to assess risk of catastrophic spill occurrence at this programmatic level of OCS oil- and gas-related activities in the GOM.

4.9.1 Marine Mammals

Summary

BOEM has reexamined the analysis for marine mammals presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for marine mammals presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of marine mammals, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.9.1 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

The Gulf of Mexico marine mammal community is diverse and distributed throughout the GOM, including northern Gulf of Mexico U.S. waters. Twenty-one species of cetaceans and one species of sirenian (West Indian manatee) regularly occur in the GOM and are identified in NMFS' Gulf of Mexico Stock Assessment Reports (Jefferson et al., 1992; Davis et al., 2000; Waring et al., 2016). The GOM's Cetacea include the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), and the order Sirenia, which includes the West Indian manatee. Most marine mammal distributions vary widely across the northern GOM with very little known about their respective breeding and calving grounds, as well as any potential migratory routes.

Along with stock assessment reports, NMFS also calculates the Potential Biological Removal (PBR) for cetaceans, which is defined under the MMPA 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 (U.S. Marine Mammal Commission and USDOC, NMFS, 2007). The PBR can be used as a conservative tool, most often for commercial fisheries, to help with management of the different marine mammal stocks because a potential impact-producing factor may have a more serious impact on a marine mammal stock that has a lower PBR and a less serious impact to a marine mammal stock with a higher PBR. Here, the PBR is used as a conservative analysis tool.

While all marine mammals are protected under the MMPA, the sperm whale is listed as endangered and the West Indian manatee is listed as threatened under the ESA, as described in detail in the 2017-2022 GOM Multisale EIS. On December 8, 2016, NMFS announced a 12-month finding on a petition to list the GOM Bryde's whale (*Balaenoptera edeni)* and proposed that it be listed as endangered under the ESA (*Federal Register*, 2016b). If NOAA issues a final rule listing the Bryde's whale as endangered, the species will receive additional protections, and Federal agencies will be required to consult under Section 7 for Federal actions that may affect the species.

Refer to Chapter 4.9.1 of the of the 2017-2022 GOM Multisale EIS for the full analyses of marine mammals. For the Gulf of Mexico, NMFS is charged with protecting all cetaceans, while manatees are under the jurisdiction of FWS. Details on BOEM's consultations and coordination with NMFS and FWS are presented in **Chapter 5.2** ("Endangered Species Act"). BOEM's protective measures for marine mammals are described below.

Protective Measures for Marine Mammals

The NTL 2016-BOEM-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," provides guidance to protect marine mammals and sea turtles during seismic operations. This NTL clarifies how operators should implement seismic survey mitigating measures, including ramp-up procedures, the use of a minimum sound source, airgun testing, shutdowns, and protected species observation and reporting. The Protected Species Stipulation, if applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities. In addition, NMFS, BOEM, and BSEE collaborated to publish National Standards for a Protected Species Observer Program, which provides guidance on how to reduce impacts to protected species from G&G activities by standardizing the variation in and improving the management of the program (Baker et al., 2013).

More detailed information on Gulf of Mexico G&G activities can be found in the *Gulf of Mexico Geological and Geophysical Activities: Western, Central, and Eastern Planning Areas—Draft Programmatic Environmental Impact Statement* (USDOI, BOEM, 2016c), which BOEM prepared with BSEE and the National Oceanic and Atmospheric Administration's NMFS as cooperating agencies, to evaluate the potential environmental impacts of multiple G&G activities within Federal waters of the Gulf of Mexico's OCS and adjacent State waters. BOEM also prepared the *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas—Final Programmatic Environmental Impact Statement* (USDOI, BOEM, 2014), which can also be a source for more detailed information on the seismic surveying technology and techniques.

BOEM issued NTL 2016-BOEM-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which explains how operators must implement measures to minimize the risk of vessel strikes to protected species and to report observations of injured or dead protected species. The Protected Species Stipulation, when applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities. Adherence to the NTL protocols is expected to reduce but not eliminate the risk of potential vessel strikes with marine mammals.

To address the potential impacts of marine debris, BSEE issued NTL 2015-BSEE-G03, "Marine Trash and Debris Awareness and Elimination," which provides information on the marine trash and debris awareness training video and slide show, and both postal and email addresses for submitting annual training reports. The information provided is intended to greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel; however, these directives do not eliminate the accidental release of debris, which could impact an individual or group of individuals if they become entangled in or ingest accidentally released debris. The Protected Species Stipulation, if applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities.

BOEM (then the Bureau of Ocean Energy Management, Regulation and Enforcement) issued "Decommissioning Guidance for Wells and Platforms" (NTL 2010- BSEE-G05) to offshore operators; it provides clarification and interpretation of regulations regarding decommissioning, as well as guidance to operators proposing to use explosives to perform well/casing severance. These guidelines specify and reference mitigation, monitoring, and reporting requirements. As noted in Chapter 3.1.6 of the 2017-2022 GOM Multisale EIS and as summarized in **Chapter 3** of this Supplemental EIS, decommissioning for wells and platforms are site specific and are reviewed by BSEE and BOEM.

Analysis

The analyses of the reasonably foreseeable potential impacts of routine activities and accidental events associated with a proposed lease sale and a proposed lease sale's incremental contribution to the cumulative impacts to marine mammals are presented in this chapter. Potential impact-level criteria are defined in **Chapter 4.9** ("Protected Species") and apply to marine mammal species described in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, that are reasonably foreseeable and to define the impact levels for each impact-producing factor in relation to the best available population estimates (refer to **Table 4-18** in **Chapter 4.9** ["Protected Species"]). The potential magnitude of impact and impact-level definitions for each of these impact-producing factors is provided in **Table 4-18** to help the reader quickly identify the level of potential impacts for each impact-producing factor that is reasonably foreseeable. The analyses supporting these conclusions are discussed below. Some impact-producing factors may have different potential impact levels to different marine mammal species due to their various population sizes, as well as their wide-ranging behavior; thus, some potential impact-producing factors are described in a range. Where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts. Refer to the "Incomplete or Unavailable Information" section below for a more detailed discussion.

BOEM understands that mitigations greatly reduce the likelihood of an impact-producing factor, but mitigations do not guarantee that a protected species (e.g., marine mammal) would not be impacted. There is a very low probability where a protected species may not be detected despite all of the mitigative precautions taken to reduce impact. Unlikely scenarios such as these may cause major impacts to a marine mammal species with a very low population because some impact-producing factors may negatively impact the reproductive success of an individual and therefore the continued viability of the population. However, based on credible scientific research and that within the GOM, there is a long-standing and well-developed OCS Program (more than 60 years); scenarios such as these are highly speculative. There are no data to suggest that routine activities from the previous OCS Programs are significantly impacting marine mammal populations. Therefore, for purposes of this analysis, BOEM has considered the potential effects of impact-producing factors that are reasonably foreseeable.

This chapter provides a summary of the information detailed in the 2017-2022 GOM Multisale EIS regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from activities described in **Chapter 3** and their potential impacts that could result from a single proposed lease sale. BOEM has considered the potential affects of impact-producing factors that are reasonably foreseeable based on credible scientific research and past data for the following analysis. This analysis applies to all considered alternatives analyzed in **Chapter 4**.

As discussed in Chapter 4.9.1.1 of the 2017-2022 GOM Multisale EIS, the Potential Biological Removal (PBR) of a marine mammal species plays an important role in marine mammal management due to the fact that the same impact-producing factor may have a more serious impact on a marine mammal stock that has a lower PBR and a less serious impact to a marine mammal stock with a higher PBR. In other words, if an impact-producing factor were to negatively affect a number of individuals of a marine mammal stock that exceeds its respective PBR estimate, it could possibly diminish the continued viability of the stock, including the annual rates of recruitment or survival. BOEM understands that PBR is a very conservative estimate and that the abundance estimates used in estimating PBR may not accurately reflect the actual abundances of marine mammal stocks. The following evaluation considers how the impact-producing factors from routine activities, reasonably foreseeable accidental events, and cumulative impacts from activities described in **Chapter 3** may potentially impact a marine mammal species based on its respective PBR (refer to Table 4-14 of the 2017-2022 GOM Multisale EIS for list of marine mammal species and their respective PBR). BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts to marine mammals, including species that are poorly studied.

The major potential impact-producing factors affecting marine mammals in the GOM as a result of cumulative past, present, and reasonably foreseeable OCS energy-related activities are decommissioning activities, operational discharges, G&G activities, noise, transportation, marine debris, and accidental oil-spill and spill-response activities. Accidental events involving large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations inhabiting GOM waters. While accidental events cannot be predicted and have the potential to impact marine mammal species, the number of such events is expected to be very small based on OSRA (refer to Appendix E of the 2017-2022 GOM Multisale EIS).

Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative impacts experienced by marine mammal populations. At the regional, population-level scope of this analysis, impacts from reasonably foreseeable routine activities and accidental events could be **negligible** to **moderate** for any of the action alternatives. However, the incremental contribution of a proposed action to the cumulative impacts to marine mammal populations, depending upon the affected species and their respective population estimate, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response; non-OCS oil- or gas-related factors; and the minimization of the OCS oil- or gas-related impacts through lease stipulations and regulations, would be expected to be **negligible**. Under Alternative E, the cancellation of a proposed lease sale, the impacts on marine mammals within the Gulf of Mexico would be **none**. However, cumulative impacts from previous lease sales and non-OCS oil- and gas-related activities would remain. A full analysis of marine mammals can be found in Chapter 4.9.1 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The effects associated with selection of any of the alternatives would be equivalent because of the diversity and distribution of marine mammal species throughout the potential areas of interest. The analyses assumed a wide distribution of species and considered impacts to marine mammal species occurring in a wide range of habitats across all planning areas. While a proposed WPA lease sale (Alternative C) would be in a smaller area with less projected activity than a regionwide (Alternative A) or CPA/EPA lease sale (Alternative B) as described in **Chapter 3**, marine mammal species are widely distributed throughout the planning areas and may travel great distances across the GOM. As such, activities isolated to specific planning areas pose similar potential impacts to populations as do activities occurring in all planning areas. Therefore, a similar mix of species would be exposed to the analyzed impact-producing factors, regardless of the specific action alternative selected. For example, if a marine mammal species were to be accidentally struck by an OCS vessel, it would have the same impact to that individual and its respective population estimate in the WPA as it would in the CPA or EPA. Although it can be speculated that a smaller leased area resulting in less projected OCS oil- and gas-related activity would decrease the likelihood of OCS oil- and gas-related activities impacting marine mammal populations, there are not enough conclusive data on the density, distributions, and migratory behaviors of marine mammal populations in the GOM throughout the year to support that speculation. Therefore, because of the diversity and wide distribution of species in the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. Under Alternative E, there would be no new activities associated with a proposed lease sale; however, activities associated with past lease sales and non-OCS oil- and gas-related activities would continue.

Incomplete or Unavailable Information

Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it was essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether credible scientific information applied using generally accepted scientific methodologies can be used in its place (40 CFR § 1502.22). BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts.

BOEM has identified incomplete information regarding impacts of the *Deepwater Horizon* explosion, oil spill, and response on marine mammals in the GOM. This incomplete information may be relevant to the evaluation of adverse impacts because it could provide changes in the baseline environmental conditions for marine mammals in the affected environment from the *Deepwater Horizon* oil spill and response, exacerbating any impacts from a proposed action. In NEPA, the term "baseline" usually consists of the pre-project environmental conditions. For the purpose of this Supplemental EIS, the baseline is the condition of resources in the vicinity of the project as they exist at the time this environmental analysis began. The injuries assessed within the PDARP/PEIS do not necessarily equate to the current baseline as defined in NEPA. Quantification of a new baseline has several difficulties, including the lack of pre-spill data, the interpretation of post-spill data, and other potential parameters that may have contributed to the quantification of the new baseline. The difference between the state of the resources in an earlier injury assessment and in a current baseline assessment equals any recovery that may have occurred. In addition, the injury assessment reviews a worst-case impact scenario while a baseline assessment determines a reasonable understanding of the current state of the resource.

On December 13, 2010, NMFS declared an unusual mortality event (UME) for cetaceans (whales and dolphins) in the Gulf of Mexico; it was later closed in May 2016. Evidence of the UME was first noted by NMFS as early as February 2010, before the *Deepwater Horizon* explosion, oil spill, and response. During this UME, spatial and temporal boundaries of stranded cetaceans were defined as far as the Florida Panhandle and west to the Louisiana-Texas border (USDOC, NMFS, 2015a). However, these boundaries were redefined by NOAA, based upon analysis of stranding data, to include all cetaceans that stranded in Alabama, Mississippi, and Louisiana from March 2010 through July 2014 and all cetaceans other than bottlenose dolphins that stranded in the Florida Panhandle (Franklin County through Escambia County) from March 2010 through July 2014. The NOAA has claimed that these boundaries could be adjusted in the future based upon the availability of new results or analyses (USDOC, NMFS, 2016a). As of May 2016, a total of 1,141 cetaceans (5% stranded alive and 95% stranded dead) stranded during the UME between Franklin County, Florida, and the Louisiana/Texas border. 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 (USDOC, NMFS, 2016a).

The UME investigation and the Deepwater Horizon Natural Damage Resource Assessment (NRDA) determined that the *Deepwater Horizon* explosion, oil spill, and response resulted in the death of marine mammals and is the most likely explanation of the persistent, elevated stranding numbers in the northern Gulf of Mexico after the spill. Data have supported that the adrenal and lung disease observed in dolphins was most likely due to exposure to petroleum products from the spill. This has resulted in both dolphin mortalities, which peaked from March 2010 through July 2014, and fetal loss. Research, while ongoing, suggests that the effect on these populations has not ended, with evidence of failed pregnancies found in 2015 (USDOC, NMFS, 2016a).

Although data have suggested that exposure to petroleum products may result in reproductive failure, other factors have the potential to affect marine mammal reproduction and were also observed during the timeframe of this UME. In addition to investigating all other potential causes, scientists are still investigating what role *Brucella* plays in the northern Gulf of Mexico UME. *Brucella* is a gram-negative, intracellular bacterium that has been isolated from many marine mammal species globally (Nymo et al., 2011; Guzmán-Verri et al., 2012; Hernández-Mora et al., 2013) and that may cause placentitis and sporadic late-term abortion (Miller et al. 1999; Dagleish et al., 2008; Guzmán-Verri et al., 2012; Hernández-Mora et al., 2013). As of October 27, 2015, 68 out of 210 dolphins tested were positive or suspected positive for *Brucella*. More detail on *Brucella* and its role in the UME can be found on NMFS' website (USDOC, NMFS, 2016a). Future investigations on immune function in Gulf of Mexico dolphins are needed to determine whether exposure to hydrocarbons during the *Deepwater Horizon* oil spill or other environmental stressors may have caused an increased susceptibility to infectious agents that affect the fetal-placental unit or other conditions leading to late-term fetal loss (Colegrove et al., 2016). Furthermore, a study by Carmichael et al. (2012) suggested that natural stressors, combined with the *Deepwater Horizon* explosion, oil spill, and response, may have created a "perfect storm" for bottlenose dolphins in the northern Gulf of Mexico. Many coastal species in the northern Gulf of Mexico, including dolphins, experienced unusually harsh winter conditions in early 2010, which were followed by the *Deepwater Horizon* explosion, oil spill, and response. A third potential stressor was introduced in January 2011 when large volumes of cold freshwater, associated with melt water from an unusually large winter snowfall near the Mobile Bay watershed, entered the nearshore coastal systems very rapidly. This event happened days prior to the start of unusually high numbers of perinatal (near term to neonatal) bottlenose dolphin mortalities in the northern Gulf of Mexico from January to April 2011.

Various environmental stressors that are known to cause death to marine mammals were also present during the *Deepwater Horizon* explosion, oil spill, and response, but it is unclear at this time what level of impact these stressors contributed to the increase in strandings (Carmichael et al., 2012). According to NMFS' website referenced above, evidence of the UME was first documented by NMFS as early as March 2010, a month prior to the *Deepwater Horizon* explosion and oil spill. The NMFS has also documented an additional 12 UMEs that have been previously declared in the GOM for cetaceans (an additional 7 specific to manatees only) since 1991 (USDOC, NMFS, 2015b). However, studies published from the NRDA process evaluating the possible impacts of the *Deepwater Horizon* explosion, oil spill, and response on bottlenose dolphins exposed to oiling have shown overall poor health and prevalence of poor body condition, disease, and abnormalities as compared with bottlenose dolphins in the Gulf of Mexico that were not exposed to oiling (Schwacke et al., 2013; Venn-Watson et al., 2015). Bacterial pneumonia was also identified from dolphins before and during the UME, but it was detected more in the UME dolphins (Venn-Watson et al., 2015). While this information may ultimately be useful in expanding the available knowledge on baseline environmental conditions following the *Deepwater Horizon* explosion, oil spill, and response, it remains difficult to draw specific conclusions regarding the current overall bottlenose dolphin population in the GOM.

Even with recent publications, such as the Venn-Watson et al. (2015) marine mammal study, the best available information on impacts to GOM marine resources does not yet provide a complete understanding of the impacts of the oil spill and active response/cleanup activities from the *Deepwater Horizon* explosion and oil spill on marine resources as a whole in the GOM. Relevant data on the status of marine mammal populations after the UME and *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. For example, even 20 years after the *Exxon Valdez* spill, the long-term impacts to marine mammal populations are still being investigated (Matkin et al., 2008). Therefore, it is not possible for BOEM to obtain this information within the timeframe contemplated for the NEPA analysis in this Supplemental EIS, regardless of the cost or resources needed.

Unavailable information provides challenges in understanding the baseline conditions and changes within marine mammal populations. The impacts of tropical storms and hurricanes in the GOM have never been determined and the impacts remain very difficult to quantify. The impacts associated with the *Deepwater Horizon* explosion, oil spill, and response makes an understanding of the cumulative impacts less defined. The process, timeline, and determination of NMFS' proposal to list the Bryde's whale as endangered is unknown, but it is not essential to a reasoned choice among alternatives because, if listed, BOEM would need to consult under ESA Section 7 (refer to **Chapter 5.2**). BOEM used existing information and accepted scientific methodologies to extrapolate from publicly available information on marine mammals in completing the relevant analysis of marine mammal populations. There are existing leases in the GOM with ongoing or the potential for exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities would continue to occur in the GOM irrespective of a proposed action (e.g., fishing, military activities, and scientific research). Therefore, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to marine mammals because the full extent of impacts on marine mammals is not known. However, BOEM has determined that the information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action Alternatives) because none of the sources reveal reasonably foreseeable significant adverse impacts to marine mammals not otherwise considered in this Supplemental EIS.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including publications from Federal agencies and journal articles) were examined to assess recent information regarding marine mammals that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for marine mammals presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on marine mammals has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for marine mammals presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program. The incremental contribution of a proposed lease sale (i.e., Alternatives A, B, C, and D) to cumulative impacts to marine mammal populations, depending upon the affected species and their respective population estimate, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response; non-OCS oil- or gas-related factors; and the minimization of OCS oil- or gas-related impacts through lease stipulations and regulations, would be expected to be **negligible**.

4.9.2 Sea Turtles

Summary

BOEM has reexamined the analysis for sea turtles presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for sea turtles presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of sea turtles, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.9.2 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Five sea turtle species are known to inhabit the waters of the GOM (Pritchard, 1997): the loggerhead (*Caretta caretta*); Kemp's ridley (*Lepidochelys kempii*); green (*Chelonia mydas*); leatherback (*Dermochelys coriacea*); and hawksbill (*Eretmochelys imbricata*). All five species are highly migratory with individuals migrating into nearshore waters as well as other areas of the GOM, North Atlantic Ocean, and the Caribbean Sea, and they use beaches along these coasts during nesting season. These sea turtles are protected under the Endangered Species Act of 1973. The FWS and NMFS share Federal jurisdiction for sea turtles. The FWS has responsibility for monitoring and managing sea turtles (i.e., nesting turtles, eggs, and hatchlings) on the beaches; and NMFS has jurisdiction for sea turtles in the marine environment. Refer to Chapter 4.9.2 of the of the 2017-2022 GOM Multisale EIS for the full analyses of sea turtles. BOEM's protective measures for sea turtles are provided below.

Protective Measures for Sea Turtles

Seismic operations have the potential to harm sea turtles in close proximity to active airgun arrays. The Protected Species Stipulation and NTL 2016-BOEM-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimize the potential of harm from seismic operations to sea turtles that could be within the exclusion zone. These mitigations for sea turtles and marine mammals include, but are not limited to, onboard observers, ramp-up procedures, shutdowns, and the use of a minimum sound source. Noise impacts on turtles from seismic surveys are described in the "Noise" section in Chapter 4.9.2 of the 2017-2022 GOM Multisale EIS. More detailed information on the seismic surveying technology and techniques that could be used is provided in BOEM's *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas—Final Programmatic Environmental Impact Statement* (USDOI, BOEM, 2014) and as of the publication of this Supplemental EIS, BOEM, with BSEE and the National Oceanic and Atmospheric Administration's NMFS as cooperating agencies, prepared the *Gulf of Mexico Geological and Geophysical Activities: Western, Central, and Eastern Planning Areas—Draft Programmatic Environmental Impact Statement* to evaluate the potential environmental impacts of multiple G&G activities within Federal waters of the Gulf of Mexico's OCS and adjacent State waters (USDOI, BOEM, 2016c).

There have been no documented sea turtle strikes with drilling and service vessels in the GOM; however, collisions with small or submerged sea turtles may go undetected. Based on sea turtle density estimates in the GOM, the encounter rates between sea turtles and vessels would be expected to be greater in water depths <200 m (656 ft) (USDOC, NMFS, 2007b). To further minimize the potential for vessel strikes, NTL 2016-BOEM-G01, "Vessel Strike Avoidanceand Injured/Dead Protected Species Reporting," was issued; this NTL provides NMFS' guidelines for monitoring procedures related to vessel strike avoidance measures for sea turtles and other protected species. In the past, compliance with this NTL and other protective measures has been mandatory as a result of the Protected Species Stipulation, which has been applied at the lease sale stage. With the implementation of these measures and the avoidance of potential strikes from OCS vessels, the risk of collisions between oil- and gas-related vessels (including those for G&G, drilling, production, decommissioning, and transport) and sea turtles is appreciably reduced, but strikes may still occur. BOEM and BSEE monitor for any takes that have occurred as a result of vessel strikes and require that any operator immediately report the striking of any animal (NTL 2016-BOEM-G01).

Operators must comply with the guidelines provided in NTL 2015-BSEE-G03, "Marine Trash and Debris Awareness and Elimination." Should a proposed lease sale be held, the NTLs would become mandatory under the expected application of the Protected Species Stipulation. The BSEE prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR § 250.300).

The NTL, "Decommissioning Guidance for Wells and Platforms" (NTL 2010-G05), provides guidelines for offshore operators that specify and reference NMFS' biological opinion mitigation requirements currently in place for protected species, including sea turtles. In addition, terms and conditions, and reasonable and prudent measures identified during consultation for decommissioning would be required conditions of approval in any decommissioning authorizations. The regulations at 30 CFR part 550 outline the environmental, monitoring, and mitigation information that operators must submit with plans for exploration, development, and production. This regulation requires OCS energy-related activities to be conducted in a manner that is consistent with the provisions of the ESA. Additionally, NMFS has implemented a protected species observer program for structure decommissioning.

Analysis

The approach of this analysis is to focus on the potential impact-producing factors for sea turtles from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as reasonably foreseeable accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor under a proposed action (refer to **Table 4-18** in **Chapter 4.9** [“Protected Species”]). The potential magnitude of impact and impact-level definitions for each of those impact-producing factors is provided in **Table 4-18** to help the reader quickly identify the level of potential impacts for each impact-producing factor. The analyses supporting these conclusions are discussed below.

This chapter provides a summary of the information detailed in the 2017-2022 GOM Multisale EIS regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from activities described in **Chapter 3** and their potential impacts on sea turtles that would potentially result from a single proposed lease sale. This analysis applies to all considered alternatives.

Five ESA-listed sea turtle species are present throughout the northern GOM year-round; however, only Kemp’s ridley and loggerhead sea turtles commonly nest on beaches in the GOM during the nesting season. Due to the expected implementation of mitigations (e.g., BOEM and BSEE proposed compliance with NTLs under the proposed Protected Species Stipulation and conditions of approval on postlease activities), routine activities (e.g., noise or transportation) and accidental events (e.g., oil spills) related to a proposed action are not expected to have long-term adverse effects on the population size or productivity of any sea turtle species or populations in the northern GOM. Lethal effects could occur from chance collisions with OCS oil- and gas-related service vessels or ingestion of accidentally released plastic materials from OCS oil- and gas-related vessels and facilities. Most routine activities and accidental events as a result of a proposed action are therefore expected to have **negligible** to **moderate** impacts. For example, a minor impact might be a behavioral change in response to noise while a moderate impact might be a spill contacting an individual and causing injury or mortality.

Historically, intense harvesting of eggs, loss of suitable nesting beaches, and fisheries-related mortality led to the rapid decline of sea turtle populations. Anthropogenic actions continue to pose the greatest threat to sea turtles since their listing under the ESA, as well as natural threats including climate change, disease, and natural disasters. The incremental contribution of a proposed action to the cumulative impacts on sea turtles would be expected to be **negligible**. Population-level impacts are not anticipated. Under Alternative E, the cancellation of a proposed lease sale, impacts on sea turtles within the Gulf of Mexico would be **none**. However, cumulative impacts from previous lease sales and non-OCS oil- and gas-related activities would remain. A full analysis of sea turtles can be found in Chapter 4.9.2 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The effects associated with selection of any of the action alternatives would be equivalent because of the diversity and distribution of sea turtles throughout the potential Area of Interest. The analyses assumed a wide distribution of species and considered impacts to sea turtles occurring in a wide range of habitats across all planning areas. While a WPA lease sale (Alternative C) would be in a smaller area with less projected activity than a regionwide (Alternative A) or CPA/EPA lease sale (Alternative B) as described in **Chapter 3**, sea turtles are distributed throughout the planning areas. As such, activities isolated to specific planning areas pose similar potential impacts to populations as do activities occurring in all planning areas. Therefore, because of the free-swimming ability and wide distribution of species across the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. However, Alternative E, No Action, would avoid impacts from a proposed lease sale and the related postlease activities as the lease sale would not be held; only impacts from past lease sales and associated postlease activities or other G&G permits would continue.

Incomplete or Unavailable Information

Unavailable information provides challenges in understanding the baseline conditions and changes within sea turtle populations. The impacts associated with the *Deepwater Horizon* explosion, oil spill, and response makes an understanding of the cumulative impacts less defined but overall changes the baseline as in less numbers of individual species. Not all of the information collected during the NRDA process, which was used as a basis for their determinations, is yet publicly available. BOEM used existing information and reasonably accepted scientific methodologies to extrapolate from publicly available information on sea turtles in completing the relevant analysis of sea turtle populations. There are existing leases in the GOM with ongoing or the potential for exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities would continue to occur in the GOM irrespective of a proposed action (e.g., fishing, military activities, and scientific research). Also, little is known about the early life history of leatherbacks regarding the "lost years" (Carr, 1986). BOEM used available research and presented what is known in **Chapter 4.9.2.1**. Therefore, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to sea turtles because the full extent of impacts on sea turtles is not known; however, BOEM has determined that the information is not essential to a reasoned choice among alternatives for this Supplemental EIS (including the No Action and Action Alternatives).

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including NOAA/NMFS' Office of Protected Resources website and Sea Turtle Stranding and Salvage Network website, Gulf Spill Restoration site (PDARP/PEIS), FWS' Environmental Conservation Online System, National Park Service, JSTOR, and Google Scholar) were examined to assess recent information regarding sea turtles that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for sea turtles presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on sea turtles has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for sea turtles presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program. The incremental contribution of a proposed action to the cumulative impacts on sea turtles would be expected to be **negligible**.

4.9.3 Beach Mice (Alabama, Choctawhatchee, Perdido Key, and St. Andrew)

Summary

BOEM has reexamined the analysis for beach mice presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for beach mice presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of beach mice, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.9.3 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

The following four subspecies of beach mouse (*Peromyscus polionotus*) occupy restricted habitats in the mature coastal dunes of Florida and Alabama and are federally listed as endangered: Alabama (*P.p. ammobates*); Perdido Key (*P.p. trisyllepsis*); and Choctawhatchee (*P.p. allophrys*) (listed June 6, 1985; *Federal Register*, 2006b); and St. Andrew (*P.p. peninsularis*) (listed December 18, 1998; *Federal Register*, 1998). Current critical habitat is included in the critical habitat map (**Figure 4-10**). Populations of the listed subspecies have fallen to levels approaching extinction. These four subspecies of beach mice are similar in appearance but can be identified by pelage color and location (Bowen, 1968).

Protective Measures for Beach Mice

Impacts to beach mice may occur directly to the animal or its habitat. Marine trash and debris could affect beach mice due to the potential to ingest and/or become entangled. The BSEE has taken measures to reduce marine debris by imposing marine debris awareness and prevention measures on the oil and gas industry through NTL 2015-BSEE-G03, which provides guidance to industry operators regarding the reduction of trash and debris elimination into the marine environment and informing operators of regulations set by other regulatory agencies (i.e., USEPA and USCG). This mitigation is a binding part of leases through the Protected Species Stipulation. The OCS oil- and gas-related proposed activities may contribute minimal marine debris or disruption to beach mouse areas, but the impacts would be **negligible**. Due to the proximity of the beach mouse habitat to any OCS oil- and gas-related activity, any accidental loss of debris as a result of OCS oil- and gas-related activities would be minimal.

Analysis

The approach of this analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor (refer to **Table 4-18** in **Chapter 4.9** ["Protected Species"]). The potential magnitude of impact and impact-level definitions for each of these impact-producing factors is provided in **Table 4-18** to help the reader quickly identify the level of potential impacts for each impact-producing factor. The analyses supporting these conclusions are discussed below.

This chapter provides a summary of the information detailed in the 2017-2022 GOM Multisale EIS regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from the activities described in **Chapter 3** that are associated with non-OCS oil- and gas-related and OCS oil- and gas-related activities. This analysis applies to all considered alternatives.

Beach mice rely on dune systems as favorable habitat for foraging and maintaining burrows. Due to the distance between beach mouse habitat and OCS oil- and gas-related activities, routine activities are not likely to affect beach mouse habitat except under very limited situations. Pipeline emplacement or construction, for example, could cause temporary degradation of beach mouse habitat; however, these activities are not expected to occur in areas of designated critical habitat. Accidental oil spills and associated spill-response efforts are not likely to impact beach mice or their critical habitat because the species live above the intertidal zone where contact is less likely. Habitat loss from non-OCS oil- and gas-related activities (e.g., beachfront development) and predation have the greatest impacts to beach mice. Overall, the incremental contribution of impacts from reasonably foreseeable routine activities and accidental events to the overall cumulative impacts on beach mice is expected to be **negligible**. Under Alternative E, the cancellation of a proposed lease sale, impacts on beach mice would be **none**. However, cumulative impacts from previous lease sales and other non-OCS oil- and gas-related activities would remain. A full analysis of beach mice can be found in Chapter 4.9.3 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Because of the distribution of species in the Area of Interest, the level of impacts would be generally the same for Alternatives A, B, and D. Alternative C would have no impacts since no beach mice habitat exists near the WPA proposed lease sale area. The WPA is approximately 380 mi (612 km) from known beach mouse habitat; OSRA modeling calculated a <0.05 to 1 percent chance of oil from a catastrophic spill contacting beach mouse habitat 30 days post-spill. Alternative E, No Action, would only have impacts associated with ongoing activities from past lease sales and non-OCS oil- and gas-related activities.

Incomplete or Unavailable Information

BOEM has determined that there is no incomplete or unavailable information regarding the listed beach mice relevant to the potential impacts from a proposed action or alternatives, and no such information was essential to a reasoned choice among alternatives. BOEM used existing information and reasonably accepted scientific methodologies from available information on beach mice in completing the relevant analysis of impacts.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed journal articles and Internet sources were examined to assess recent information regarding beach mice that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for beach mice presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on beach mice has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for beach mice presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.9.4 Protected Birds

Summary

BOEM has reexamined the analysis for protected birds presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for protected birds presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of protected birds, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.9.4 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Protected birds are species or subspecies listed under the ESA by FWS as threatened or endangered due to the decrease in their population sizes or loss of habitat; therefore, a proposed action could have a greater impact. BOEM is undergoing consultation with FWS to minimize the potential impacts to ESA-listed species. The protected birds analyzed in this Supplemental EIS include those species that use the OCS or coastal counties/parishes along the Gulf of Mexico during any part of their lifecycle and that are listed under the Endangered Species Act as threatened or endangered. Other species that met these criteria were excluded if their habitats were more upland or away from the coast (Appendix F of the 2017-2022 GOM Multisale EIS). All of the following protected bird species are also protected under the Migratory Bird Treaty Act. The impact-producing factors that could affect protected birds are outlined in **Table 4-18** in **Chapter 4.9** ("Protected Species"). A review of a description of associated impact-producing factors for these species is discussed and can be referenced from **Chapter 4.8** ("Birds"). However, similar impact-producing factors that may affect protected species may have greater impacts to protected species and their associated critical habitat due to their small population size and ESA-listing status. Those impacts are considered in the following analysis.

The habitats of the protected bird species described in this Supplemental EIS vary from upland habitat, freshwater wetlands, estuarine, coastal beaches, and tidal flats to offshore migration and foraging; impacts to the physical aspects of the coastal habitats are identified in **Chapter 4.3** ("Coastal Habitats"). Critical habitat is presented in **Figure 4-10**.

Collectively, the bird species included in this analysis are distributed across the GOM region from southern Florida to eastern Texas as year-round residents or migratory with a strong seasonal component. Many of the migratory bird species are less abundant along the GOM during the season when they are on their breeding grounds and have higher densities and/or wider distributions during migration and non-breeding season.

Protective Measures for Protected Birds

Marine debris produced by OCS oil- and gas-related activities as a result of accidental disposal into the water may affect protected birds by entanglement or ingestion. Regulations prohibiting intentional disposal of items, beach-cleaning efforts to remove debris from certain locations, and the use of marine debris awareness and prevention measures on the oil and gas industry through NTL 2015-BSEE-G03 (formerly NTL 2012-BSEE-G01), which provides guidance to industry operators regarding the reduction of trash and debris elimination into the marine environment and which informs operators of regulations set by other regulatory agencies (i.e., the USEPA and USCG), help reduce impacts to protected birds. Implementation of BSEE's Marine

Trash and Debris NTL is required through ESA consultation with FWS and is expected to be applied by the oil and gas industry for associated OCS oil- and gas-related activity.

Analysis

The analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts to ESA-listed birds are presented in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor (refer to **Table 4-18** in **Chapter 4.9** ["Protected Species"]). The potential magnitude of impact and impact-level definitions for each of these impact-producing factors is provided in **Table 4-18** to help the reader quickly identify the level of potential impacts for each impact-producing factor. The analyses supporting these conclusions are discussed below.

This chapter provides a summary of the information detailed in the 2017-2022 GOM Multisale EIS regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from activities described in **Chapter 3** and their potential effects that could potentially result from a single proposed lease sale or the alternatives. This analysis applies to all considered alternatives. Because of the distribution of the different protected bird species in the Area of Interest, the level of impacts would vary from Alternatives A, B, C, and D. However, Alternative E, No Action, would only have impacts associated with continuing effects from past lease sales and non-OCS oil- and gas-related activities. This chapter will include a summary of the potential impacts as they relate to the action alternatives and the protected bird species. The analyses of applicable impact-producing factors are the same as those for birds in general (refer to **Chapter 4.8**, "Birds"); however, the resulting level of impact would differ, as defined under the protected species impact criteria.

Impacts from routine activities, which include discharges and wastes affecting air and water quality, noise, and possibly artificial lighting, would be **negligible** to protected birds. The listed bird species considered are typically coastal birds and would not be exposed to much of the OCS oil- and gas-related activities. Waste discharges to air or water produced as a result of routine activities are regulated by USEPA and BOEM and are subject to limits to reduce potential impacts; therefore, due to precautionary requirements and monitoring, the impacts to protected birds would be **negligible** for any of the action alternatives. The major impact-producing factors resulting from accidental events associated with a proposed action that may affect protected birds include accidental oil spills and response efforts. In the case of an accidental oil spill, impacts would be **negligible** to **moderate** depending on the magnitude and spatiotemporal proximity of such an event. Major impacts could occur if a large oil spill occurred with direct contact to a protected bird species or if the habitat became contaminated resulting in mortality of a listed species. Marine debris produced by OCS oil- and gas-related activities as a result of accidental disposal into the water may affect protected birds by entanglement or ingestion. Due to the regulations prohibiting the intentional disposal of items, impacts would be expected to be **negligible**; however, impacts may scale up to **moderate** if the accidental release of marine debris caused mortality of a listed bird.

Overall, BOEM would expect **negligible** to **moderate** impacts to protected birds considering routine activities, accidental events, and cumulative impacts for any of the action alternatives. Due to the precautionary requirements and monitoring discussed above, the incremental impacts to protected birds would be **negligible** for any of the action alternatives (i.e., Alternatives A-D). For Alternative E, the cancellation of a proposed lease sale, the additional incremental impacts to ESA-protected birds or their habitats would be **none**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of protected birds can be found in Chapter 4.9.4 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Due to the precautionary requirements and monitoring discussed above, the impacts to protected birds would be **negligible** for any of the action alternatives (i.e., Alternatives A-D). The impacts of Alternative B would be the same as Alternative A for all previously specified protected bird species, with the exception of the whooping crane with the listed population in Texas in the WPA and which is outside of the CPA or EPA. The Cape Sable seaside sparrow, roseate tern, and the Mississippi sandhill crane are not found off Texas; therefore, they would not be impacted by a proposed lease sale in the WPA. The impacts of Alternative D would be the same as Alternative A, B, or C because the areas of potential exclusion are specific to areas that do not have any impact on ESA-protected bird species or their habitats. The impacts of Alternative E would yield no additional incremental impacts to ESA-protected birds or their habitats.

Incomplete or Unavailable Information

Refer to **Chapter 4.8** ("Birds") for existing incomplete or unavailable Information related to protected birds. The conclusions remain unchanged.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed journal articles and Internet sources were examined to assess recent information regarding protected birds that may be pertinent to a proposed action. No new relevant information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for protected birds presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on protected birds has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for protected birds presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.9.5 Protected Corals

Summary

BOEM has reexamined the analysis for protected corals presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for protected corals presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of protected corals, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.9.5 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Corals in the GOM that are protected under the ESA include those listed in **Table 4-17**. Distribution of those listed species within the U.S. Exclusive Economic Zone ranges from the State of Florida to Flower Garden Banks National Marine Sanctuary and the U.S. territories of Puerto Rico, U.S. Virgin Islands, and Navassa Island. Critical habitat was designated for the elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) coral species by NMFS in 2008 and includes four counties in the State of Florida (i.e., Palm Beach, Broward, Miami-Dade, and Monroe Counties), as well as the U.S. territories of the U.S. Virgin Islands (St. John/St. Thomas and St. Croix) and Puerto Rico (*Federal Register*, 2008b). However, this designated critical habitat is located outside of the GOM and is not expected to be affected by a proposed action, as seen in **Figure 4-10**. Though the listed species are protected, they would experience the same types of potential impact-producing factors from a proposed action as other coral species inhabitating live bottom habitats. For a detailed description and impact analysis of live bottom habitats in the GOM, refer to **Chapter 4.6**.

Protective Measures for Protected Corals

Potential routine impact-producing factors on protected corals are the same as those analyzed and described in **Chapter 4.6.1**. Impacts resulting from both routine activities and accidental events are mitigated through the Topographic Features Stipulation. Protective measures are detailed in NTL 2009-G39. The site-specific survey information required for postlease reviews of permit applications would allow BOEM to identify and protect live bottom features (which protected corals may inhabit) from potential harm by proposed OCS oil- and gas-related activities by requiring that bottom-disturbing activity be distanced from live bottom features. Further, it is believed that most, if not all, of the protected corals occur either within the boundaries of the Flower Garden Banks National Marine Sanctuary, which is an area currently excluded from future leasing, or far from the area of proposed activities in shallow waters in and around the Florida Keys and Dry Tortugas in State or Federal waters of the EPA that are subject to the Congressional leasing moratorium that is in effect through 2022.

Analysis

This chapter provides information regarding the protected coral species. However, the types of impact-producing factors affecting these species are the same as those described in **Chapter 4.6.1** ("Topographic Features"); therefore, they are briefly summarized here in the context of the protected coral species. A wider impact analysis for live bottom habitats (which protected corals may inhabit) can be found in **Chapter 4.6** ("Live Bottom Habitats"). However, the level of impact from OCS oil- and gas-related and non-OCS oil- and gas-related activities does differ from those seen in **Chapter 4.6.1** because the protected coral species have smaller population sizes, and localized impacts could have a magnified effect. Therefore, the impact levels for protected coral species are described separately in **Table 4-18**. The potential magnitude of impact and impact-level definitions for each of the impact-producing factors is provided in **Table 4-18** to help the reader quickly identify the level of potential impacts for each impact-producing factor. The analyses supporting these conclusions are discussed below.

Some activities as a result of a proposed lease sale have the potential to directly impact protected coral habitat within the GOM. Because of the similarity and overlap of the effects of many activities that occur in the OCS, the relevant impact-producing factors can result from bottom-disturbing activities (i.e., routine activities and accidental events) and the potential accidental release of drilling muds and contaminants.

Elkhorn, staghorn, boulder star, lobed star, and mountainous star corals are listed by NMFS as threatened due to the decrease in their population sizes; therefore, the relative impacts from a proposed action on a particular group of coral colonies could have disproportionately higher population-level impacts than what might be realized by other, non-listed coral species. BOEM understands this and therefore performs a consultation with NMFS to minimize any potential impacts to these species. Though the listed species are protected (given ESA status), they could experience the same types of potential impact-producing factors from a proposed action as other coral species. Without effective mitigations, routine activities and accidental events resulting from a proposed action could directly impact coral habitats within the GOM. The site-specific survey information required for postlease reviews of permit applications would allow BOEM to identify and protect live bottom features (which protected corals may inhabit) from potential harm by proposed OCS oil- and gas-related activities by requiring that bottom-disturbing activity be distanced from live bottom features. Assuming adherence to the expected lease stipulations and other postlease protective restrictions and mitigations, the routine activities related to a proposed action could have short-term, localized and temporary effects on protected corals, if any. While accidental events have the potential to cause severe damage to specific coral communities, the number of such events is expected to be small, and any impacts would be reduced or prevented by the lease stipulations and postlease distancing requirements. Furthermore, the OCS lease blocks in the EPA that are closest to ESA-defined critical habitat areas for listed corals are not being offered in a proposed lease sale due to the current leasing moratorium and are, therefore, too distant to be reasonably affected by routine activities or accidental events. In addition, many of the protected corals occur within the Flower Garden Banks National Marine Sanctuary, which, under the current boundaries, is not proposed for future leasing under any of the alternatives in this Supplemental EIS or in the 2017-2022 GOM Multisale EIS. Therefore, the incremental contribution of activities resulting from a proposed action to the overall cumulative impacts to protected corals is expected to be **negligible** for any of the action alternatives. Proposed OCS oil- and gas-related activities would contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative impacts experienced by corals. The non-OCS oil- and gas-related cumulative impacts to protected corals are expected to be dramatically greater than any impacts related to OCS oil and gas activities. Under Alternative E, the cancellation of the proposed action, the impacts on protected corals would be **none**. However, cumulative impacts from previous lease sales and non-OCS oil- and gas-related activities would remain. A full analysis of protected corals can be found in **Chapter 4.9.5** of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

Under Alternatives A, B, and C, the proposed activities would have the same impact levels to protected corals whether they occur in the WPA, CPA, or EPA. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), many of the protected corals either occur in the Flower Garden Banks National Marine Sanctuary, which is not proposed for leasing under any alternative, or are far from the area of proposed activities. Additional protection is provided through lease stipulations and postlease activity reviews and associated site-specific information requirements and (when necessary) mitigations. Because of these protective measures and because protected corals occur far from areas of proposed activities, impacts from reasonably foreseeable routine activities and accidental events are both expected to be **negligible**. A negligible impact would be largely undetectable and may cause slight, localized changes to a protected coral species community in which recovery from the impact is expected. No mortality or injury to an individual or group would be expected to occur. Under Alternative B, a proposed lease sale would not occur in the WPA, which includes the Flower Garden Banks National Marine Sanctuary; therefore, impacts to protected corals as a result of a proposed lease sale would not be reasonably foreseeable to occur. There would, however, be ongoing cumulative impacts to the resources associated with ongoing OCS oil- and gas-related activities resulting from previous lease sales and from non-OCS oil- and gas-related activities and conditions. Development of oil and gas would, in all likelihood, be postponed to a future lease sale decision; in that case, the overall level of OCS oil- and gas-related activity would be delayed, not reduced, at least in the short term. It would take several cancelled lease sales before there would likely be a noticeable decrease in postlease activities from previous oil and gas lease sales. Under Alternative D, should the blocks subject to the Topographic Features Stipulation be excluded, protected corals would be further protected by distancing OCS oil- and gas-related activities farther from these habitats, thereby reducing the probability of potential impacts from routine activities or accidental events. Under Alternative E, there would be no new activities associated with a proposed lease sale; however, activities associated with past lease sales and non-OCS oil- and gas-related activities and conditions would continue.

Incomplete or Unavailable Information

Refer to **Chapter 4.6** ("Live Bottom Habitats") for incomplete or unavailable information related to protected corals.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources, including literature from relevant peer-reviewed journals and reports, were examined to assess recent information regarding protected corals that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for protected corals presented in the 2017-2022 GOM Multisale EIS based on the additional information presented above. No new information was discovered that would alter the impact conclusion for protected corals presented in the 2017-2022 GOM Multisale EIS, and the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.10 COMMERCIAL FISHERIES

Summary

BOEM has reexamined the analysis for commercial fisheries presented in the 2017-2022 GOM Multisale EIS. No new information was discovered that would alter the impact conclusion for commercial fisheries presented in the 2017-2022 GOM Multisale EIS. The analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of commercial fisheries, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.10 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

The Gulf of Mexico is home to a large and complex commercial fishing industry. There were $1.027 billion in finfish and shellfish landings in the Gulf of Mexico in 2014, which comprised 19 percent of total U.S. landings (USDOC, NMFS, 2016b). Some of the most economically important commercial fisheries in the Gulf of Mexico are white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), eastern oysters (*Crassostrea virginica*), Gulf menhaden

(*Brevoortia patronus*), blue crab (*Callinectes sapidus*), red grouper (*Epinephelus morio*), red snapper (*Lutjanus campechanus*), and tunas (*Thunnus* spp.). Fisheries are managed by NOAA Fisheries (NMFS), as advised by the regional fisheries management councils. Commercial fisheries are regulated by various mechanisms, including permitting, closures, quotas, and gear restrictions. Some of the most common gear types are trawls (for shrimp), purse seines (for menhaden), dredges (for oysters), traps (for blue crab), and longlines (for various finfish). Chapter 4.10.1 of the 2017-2022 GOM Multisale EIS presents data on landings revenues in each Gulf Coast State and data on the economic impacts of these revenues. The biological aspects for the targeted species are discussed in Chapter 4.7 ("Fish and Invertebrate Resources") and in greater detail in the same Chapter 4.7 of the 2017-2022 GOM Multisale EIS.

Analysis

The analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts to commercial fisheries are presented below. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor (**Table 4-19**). The potential magnitude of impact for each impact-producing factor is provided in **Table 4-19** to help the reader quickly identify the level of potential impacts for commercial fisheries. The impact-level definitions and the analyses supporting these conclusions are summarized in this chapter. The analysis in this chapter relies on the analysis and conclusions reached in **Chapter 4.7** ("Fish and Invertebrate Resources"). Therefore, in general, the impact-producing factors identified in **Chapter 4.7** would have the potential to impact commercial fisheries as well.

Impact-Level Definitions

In this chapter (and in the analyses of the alternatives), the impact levels are defined in terms of the duration, intensity, and geographical extent of the impacts to the human uses of commercial fisheries along the Gulf Coast. Long-term impacts are those lasting more than 1 year. Extensive impacts are those for which it is difficult to find substitute fishing sources nearby, while severe impacts mostly or completely prevent commercial fishing in an area. In particular, the impacts of each impact-producing factor are summarized in **Table 4-19**, using the impact-level definitions below.

- **Beneficial** – Impacts would be positive. The level of benefical impacts are specified in the analysis, which could be low, medium, or high.
- **Negligible** – Little or no detectable adverse impact.
- **Minor** – Adverse impacts are detectable but less than severe.
- **Moderate** – Adverse impacts are severe but are short term and/or not extensive.
- **Major** – Adverse impacts are long term, extensive, and severe.

Table 4-19. Commercial Fisheries Impact-Producing Factors That Are Reasonably Foreseeable.

Commercial Fisheries	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Activities					
Fish Population	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Space-Use Conflicts	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Production Structure Emplacement and Removal	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Accidental Events					
Oil Spills	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Cumulative Impacts					
Incremental Contribution[2]	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
OCS Oil and Gas[3]	Beneficial to Moderate				
Non-OCS Oil and Gas[4]	Beneficial to Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.10 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

A proposed action could affect commercial fisheries by affecting fish populations or the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine activities such as seismic surveys, drilling activities, and service-vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts, depending on the location and species. For example, structure emplacement prevents trawling in the associated area and, thus, could impact the shrimp fishery. On the other hand, production platforms can facilitate fishing for reef fish such as red snapper and groupers. The eventual removal of production platforms would reverse these positive and negative impacts. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. A proposed action would be relatively small when compared with the overall OCS Oil and Gas Program, State oil and gas activities, overall vessel traffic, tropical storms/hurricanes, economic factors, Federal and State fisheries management strategies, and other non-OCS oil- and gas-related factors. Therefore, the incremental contribution of a proposed action to the cumulative impacts to commercial fisheries would range from **beneficial (low)** to **minor** for any of the action alternatives. A full analysis of commercial fisheries can be found in Chapter 4.10 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The level of impacts to commercial fisheries would range from **beneficial (low)** to **minor** for Alternatives A, B, C, and D. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar because the types of activities that occur are similar and the differences are not large enough to change the range of impact conclusions. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access. Alternative E would prevent these impacts from occurring, except for potential **negligible** impacts arising from adjustments to incomes in the economy. Under Alternative E, fisheries would still be subject to the impacts from the OCS Oil and Gas Program, as well as the impacts from non-OCS oil- and gas-related activities.

Incomplete or Unavailable Information

BOEM has determined that there is incomplete or unavailable information related to commercial fisheries. Some of this incomplete or unavailable information relates to fish populations that support commercial fishing, which is discussed in **Chapter 4.7**. For example, there is incomplete or unavailable information regarding the long-term impacts of acute and chronic exposure to oil on fish and invertrebrates that support commercial fishing. This information is unavailable because these impacts would only become evident through time. In lieu of the incomplete or unavailable information, BOEM used various data sources and studies, including the most recent NMFS landings data, as well as the information in Carroll et al. (2016), to estimate the affected environment and impacts of OCS oil- and gas-related and non-OCS oil- and gas-related activities for commercial fishing. BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives because existing data sources are sufficient for BOEM to reasonably estimate impacts.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various sources (such as NMFS and Internet searches) were examined to assess recent information regarding commercial fisheries that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for commercial fisheries presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on commercial fisheries has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for commercial fisheries presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.11 RECREATIONAL FISHING

Summary

BOEM has reexamined the analysis for recreational fishing presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for recreational fishing presented in the 2017-2022 GOM Multisale EIS. The analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of recreational fishing, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.11 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Recreational fishing is a popular pastime in many parts of the Gulf of Mexico. The GOM's extensive estuarine habitats (**Chapter 4.3**), live bottom habitats (**Chapter 4.6**), and artificial substrates (including artificial reefs, shipwrecks, and oil and gas platforms) support several valuable recreational fisheries. Fisheries are managed by NOAA Fisheries (NMFS), as advised by the regional fisheries management councils. Recreational landings and effort data for Louisiana, Mississippi, Alabama, and Florida are provided by NMFS; recreational fishing data for Texas is provided by the Texas Parks and Wildlife Department. These data, along with data on the economic impacts of recreational fishing, are presented in the 2017-2022 GOM Multisale EIS. The biological aspects of the affected environment are discussed in **Chapter 4.7** ("Fishes and Invertebrate Resources") of this Supplemental EIS and Chapter 4.7 of the 2017-2022 GOM Multisale EIS.

Analysis

The analyses of the potential impacts of routine activities and accidental events associated with a proposed lease sale and a proposed lease sale's incremental contribution to the cumulative impacts to recreational fishing are presented below. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as the accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor. The analysis in this chapter relies on the analysis and conclusions reached in **Chapter 4.7** ("Fish and Invertebrate Resources"). Therefore, in general, the impact-producing factors identified in **Chapter 4.7** would have the potential to impact recreational fishing as well.

Impact-Level Definitions

In this chapter (and in the analyses of the alternatives), the impact levels are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of recreational fisheries along the Gulf Coast. Long-term impacts are those lasting more than 1 year. Extensive impacts are those for which it is difficult to find substitute fishing sources nearby, while severe impacts mostly or completely prevent recreational fishing in an area. The impacts of each impact-producing factor are summarized in **Table 4-20** using the impact-level definitions below to help the reader quickly identify the level of potential impacts for recreational fishing. The analyses supporting these conclusions are summarized below.

- **Beneficial** – Impacts would be positive. The level of benefical impacts are specified in the analysis, which could be low, medium, or high.
- **Negligible** – Little or no detectable adverse impact.
- **Minor** – Adverse impacts are detectable but less than severe.
- **Moderate** – Adverse impacts are severe but are short term and/or not extensive.
- **Major** – Adverse impacts are long term, extensive, and severe.

Table 4-20. Recreational Fishing Impact-Producing Factors That Are Reasonably Foreseeable.

Recreational Fishing	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Activities					
Anthropogenic Sound	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Bottom-Disturbing Activities	Negligible	Negligible	Negligible	Negligible	Negligible
Space-Use Conflicts	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Production Structure Emplacement and Removal	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Accidental Events					
Oil Spills	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Cumulative Impacts					
Incremental Contribution[2]	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
OCS Oil and Gas[3]	Beneficial to Moderate				
Non-OCS Oil and Gas[4]	Beneficial to Major				

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.11 of the 2017-2022 GOM Multisale EIS.
[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.
[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.
[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

Alternatives A-D can affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternatives A-D on fish populations are presented in **Chapter 4.7** ("Fishes and Invertebrate Resources"). Vessel traffic associated with a proposed action can cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect will be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, can cause fishing closures and can affect the aesthetics of fishing in an area. However, accidental events that could arise would likely be small and localized. Alternatives A-D should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, tropical storms/hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternatives A-D on recreational fisheries are expected to be **beneficial (low)** (due to fish attraction at platforms and the potential use of decommissioned platforms as rigs-to-reefs) to **minor** adverse incremental impacts (due to impacts to fish populations, space-use conflicts, and oil spills) on recreational fishing activities because of the limited amount of activity and because the positive and negative impacts would partially offset each other. Alternative E would cause some economic adjustments (refer to **Chapter 4.14.2**), which could cause **negligible** impacts to recreational fishing activities. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of recreational fishing can be found in Chapter 4.11 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The level of impacts to recreational fishing would range from **beneficial (low)** to **minor** for Alternatives A, B, C, and D. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar because the types of activities that occur are similar and the differences are not large enough to change the range of impact conclusions. Alternative E would prevent these impacts from occurring, except for **negligible** changes to recreational fishing due to changes in income patterns in the economy.

Incomplete or Unavailable Information

BOEM has identified incomplete or unavailable information regarding the extent to which recreational fishing is dependent upon OCS platforms, as well as on the site-specific determinants of this dependency. In lieu of this incomplete or unavailable information, BOEM used existing information and reasonably accepted scientific methodologies. For example, BOEM used data on recreational fishing activity provided by the Texas Parks and Wildlife Department and NMFS to examine trends in recreational fishing in various areas. BOEM has also used information from Heitt and Milon (2002) and Ajemian et al. (2015), which provide some information on the scale and location of platform-dependent recreational fishing. BOEM does not expect the incomplete or unavailable information to significantly change its estimates of the impacts of the OCS Oil and Gas Program on recreational fishing activity because BOEM still has enough baseline data to reasonably estimate impacts. Therefore, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various sources (including NMFS, the Texas Parks and Wildlife Department, and Internet searches) were examined to assess recent information regarding recreational fishing that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for recreational fishing presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on recreational fishing has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for recreational fishing presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.12 RECREATIONAL RESOURCES

Summary

BOEM has reexamined the analysis for recreational resources presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for recreational resources presented in the 2017-2022 GOM Multisale EIS. The analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of recreational resources, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.12 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Recreational resources are natural or manmade things that are used as part of activities that are primarily for human enjoyment. The GOM is home to various resources that support recreational activities. These include ocean-based resources as well as resources in the counties and parishes along the Gulf of Mexico. Chapter 4.12.1 of the 2017-2022 GOM Multisale EIS provides information regarding the affected environment for recreational resources, including data on the scales of recreation and tourism in onshore areas, as well as information regarding beaches, wildlife viewing, artificial reefs, and marine protected areas in the Gulf of Mexico region.

Analysis

This chapter analyzes the potential impacts of routine activities and accidental events associated with a proposed action on recreational resources, as well as a proposed action's incremental contribution to the cumulative impacts to recreational resources. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), accidental events, and cumulative impacts, and to define the impact levels for each impact-producing factor.

Impact-Level Definitions

In this chapter (and in the analyses of the alternatives) the impact levels are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of recreational resources along the Gulf Coast. Long-term impacts are those lasting more than 1 year. Extensive impacts are those for which it is difficult to find substitute recreational activities nearby, while severe impacts mostly or completely diminish the recreational value of a resource. In particular, the impacts of each impact-producing factor are summarized in **Table 4-21** using the impact-level definitions below to help the reader quickly understand the potential impacts of a proposed lease sale on recreational resources. The analyses supporting these conclusions are discussed below.

- **Beneficial** – Impacts would be positive. The level of benefical impacts are specified in the analysis, which could be low, medium, or high.
- **Negligible** – Little or no detectable adverse impact.
- **Minor** – Adverse impacts are detectable but less than severe.
- **Moderate** – Adverse impacts are severe but are short term and/or not extensive.
- **Major** – Adverse impacts are long term, extensive, and severe.

For Alternatives A-D, space-use conflicts (from vessel traffic) and visual impacts (from the visibility of OCS structures) that arise due to the broader OCS Program would be **negligible** to **minor**. Structure emplacements can have **beneficial (low)** impacts on recreational fishing and diving because platforms often act as artificial reefs, but the eventual removal of these structures would lead to **negligible** to **minor** negative impacts. Oil spills can have a **negligible** to **minor** negative effect on beaches and other coastal recreational resources. Alternatives A-D should also be viewed in light of the overall OCS Program, as well as various non-OCS oil- and gas-related factors such as beach/wetlands erosion, beach disruptions, economic factors, and activities that can cause space-use conflicts and aesthetic impacts, such as commercial and military activities.

Table 4-21. Recreational Resources Impact-Producing Factors That Are Reasonably Foreseeable.

Recreational Resources	Magnitude of Potential Impact[1]				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Activities					
Space-Use Conflicts	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Structure Emplacement and Removal	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Visual Impacts	Negligible to Minor	Negligible to Minor	Negligible	Negligible to Minor	Negligible
Indirect Econoic Impacts	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Accidental Events					
Oil Spills	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Marine Debris	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Cumulative Impacts					
Incremental Contribution[2]	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
OCS Oil and Gas[3]	Beneficial to Moderate				
Non-OCS Oil and Gas[4]	Beneficial to Major				

[1] The analysis supporting these conclusions is discussed in detail in the “Environmental Consequences” section in Chapter 4.12 of the 2017-2022 GOM Multisale EIS.

[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.

[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.

[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

Comparison of Alternatives

Because of the relatively small contribution of any given lease sale under any of the action alternatives (i.e., Alternatives A-D) to the overall OCS Program, in addition to other non-OCS oil- and gas-related activities, the incremental impacts are expected to be **beneficial (low)** to **minor** adverse effects. However, the visual impacts of production structures arising from Alternative C would be **negligible** because of the distances of these structures from shore. There could be **negligible** impacts to recreational resources due to the small economic adjustments that would occur in light of

Alternative E. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of recreational resources can be found in Chapter 4.12 of the 2017-2022 GOM Multisale EIS.

Incomplete or Unavailable Information

There is some incomplete or unavailable information regarding the visual impacts from a proposed action. In particular, the attitudes of people towards the visibility of structures that could arise in certain areas are not fully known. BOEM has determined that such information is not essential to a reasoned choice among alternatives because much of this uncertainty relates to the inherent uncertainty regarding where (and what types) of structures would arise from a proposed action. In addition, existing information allows for sufficient estimates of the overall dependence of visual impacts to factors such as distance, height, brightness, and general location. BOEM used generally accepted scientific principles to estimate the visual impacts of a proposed action, including literature sources, data sources, and photographic evidence. This evidence suggests that the incremental visual impacts of a proposed action would be **negligible** to **minor**. In addition, BOEM has issued an Information to Lessees and Operators to ensure that visual impacts near the Gulf Islands National Seashore are considered at BOEM's site-specific review stage.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various sources (including Internet searches related to the Gulf Islands National Seashore, economic conditions, and oil-spill impacts) were examined to assess recent information regarding recreational resources that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for recreational resources presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new relevant information on recreational resources has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for recreational resources presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.13 ARCHAEOLOGICAL RESOURCES

Summary

BOEM has reexamined the analysis for archaeological resources presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for archaeological resources presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of archaeological resources, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.13 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation (30 CFR § 550.105).

Available evidence suggests that sea level in the northern GOM was at least 90 m (295 ft), and possibly as much as 130 m (427 ft), lower than present sea level during the period 20,000-17,000 years Before Present (B.P.) (Nelson and Bray, 1970). Sea level in the northern GOM reached its present stand around 3,500 years B.P. (Pearson et al., 1986). During periods that the continental shelf was exposed above sea level, the area was open to habitation by prehistoric peoples.

Historic archaeological resources on the OCS consist of historic shipwrecks and a single historic lighthouse, the Ship Shoal Light. A historic shipwreck is defined as a submerged or buried vessel or its associated components, at least 50 years old, that has foundered, stranded, or wrecked, and that is currently lying on or embedded in the seafloor. Europeans are known to have traversed the waters of the western Gulf of Mexico as early as Captain Alonso Alvarez de Piñeda's expedition in 1519. Alvar Nuñez Cabeza de Vaca is likely the first European to be shipwrecked along the Texas coast as early as 1528 (Francaviglia, 1998).

Protective Measures for Archaeological Resources

To mitigate potential adverse impacts to archaeological resources, BOEM requires an archaeological reconnaissance survey of areas impacted by bottom-disturbing activities and avoidance or other actions, up to and including full Phase III excavation, of all potential archaeological resources within the identified area of potential effect of the undertaking. Based on shallow hazard survey data and shipwreck discoveries since 2008, an archaeological survey may be required as a result of site-specific NEPA analysis conducted for new bottom-disturbing activity associated with plans (USDOI, BOEM, 2011). Archaeological surveys, where required prior to an operator beginning OCS oil- and gas-related activities, are expected to identify possible archaeological sites so that they may be avoided. BOEM requires operators to submit an archaeological report with their EP, DOCD, DPP, or other permit application for certain OCS lease blocks. These requirements are posted on BOEM's website under NTL 2005-G07 and NTL 2011-JOINT-G01. **Table 4-22** illustrates the results of the surveys and archaeological reviews between 2009 and 2014. The number of shipwrecks and potential archaeological sites, identified each year through archaeological reviews and surveys, are listed in **Table 4-22**.

Table 4-22. Archaeological Surveys and Resources Identified, 2009-2014.

Year	Blocks Surveyed	Identified Shipwreck Sites	Potential Archaeological Sites Mitigated by Avoidance (identified through requisite industry surveys)
2009	118	11	479 magnetic anomalies and 103 sonar targets
2010	74	8	274 magnetic anomalies and 100 sonar targets
2011	120	15	577 magnetic anomalies and 171 sonar targets
2012	115	15	341 magnetic anomalies and 112 sonar targets
2013	166	6	374 magnetic anomalies and 163 sonar targets
2014	144	13	417 magnetic anomalies and 146 sonar targets

As per NTL 2010-G05 ("Decommissioning Guidance for Wells and Platforms") (idle iron initiative), idle and toppled oil and gas industry-related structures embedded in the seafloor, including single-leg caissons, multi-legged jacketed fixed platforms, floating platforms secured by suction pilings, and subsea well-head and manifold systems, must be decommissioned and removed. Depending on water depth, seafloor characteristics, and vessel availability, an anchored barge, moored barge, or liftboat may be used. Additionally, the site must be cleared of debris to a radius of 600 or 1,320 ft (183 or 402 m) depending on the structure type and use. Clearance may be carried out by trawling or by sonar and diving operations. As of 2013, BOEM may require, as a condition of approval for a decommissioning permit, an archaeological survey in advance of structure-removal activities when no preexisting survey of the area of potential effect exists.

Under 30 CFR § 550.194(c) lessees are required to immediately notify BOEM's Regional Director of the discovery of any potential archaeological resources. Under 30 CFR § 250.194(c) and 30 CFR § 250.1010(c), lessees are also required to immediately notify BOEM's and BSEE's Regional Directors of the discovery of any potential archaeological resources.

Analysis

Impacts to archeological sites occur when proposed activities result in complete or partial destruction of the resource and are equivalent to a loss of integrity as defined in the National Historic Preservation Act (54 U.S.C. §§ 300101 *et seq.*). In determining the appropriate impact threshold, both the extent to which the proposed activity results in a loss of integrity and the degree to which losses can be compensated by mitigating activities, including preservation or data recovery, are considered. For the purposes of this analysis, all alternatives may be assumed to have effectively similar potential impacts to archaeological resources. Only those resources determined eligible or potentially eligible for listing in the National Register of Historic Places are considered under the National Historic Preservation Act. Resources are eligible for listing in the National Register of Historic Places if they meet one or more eligibility criteria (for archeological sites, generally

Criterion D, having the potential to provide information important to history or prehistory) and if they possess integrity. For purposes of archaeological mitigation, BOEM/BSEE considers all uninspected shipwrecks, sonar targets, and magnetic anomalies to be potentially eligible for the National Register of Historic Places.

For the analysis of impacts to archeological resources, the determination of the intensity of an impact is based on the foreseeable loss of integrity to known or potential resources. The analysis considers only the direct impacts of seafloor disturbance associated with the below-listed, impact-producing factors as there would be no additional impacts upon archeological resources under any of the alternatives under consideration upon completion of said activities. As each archaeological resource is unique and exists at a specific location on the seafloor, there is a high level of variability in how a site may be impacted by any potential impact-producing factor. Therefore, it is impossible to evaluate the potential impact to an archaeological site from a proposed action at the programmatic level. During postlease activities, each permitted action would be assessed for site-specific potential impacts during the permit application process, and avoidance buffers would be placed around identified resources in order to mitigate potential impacts.

The analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts are presented below. The approach of the analysis is to focus on the potential impact-producing factors from routine OCS oil- and gas-related activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts. Archaeological resources are primarily impacted by any activity that directly disturbs or has the potential to disturb the seafloor. For the OCS Program, this includes the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement and installation; the use of seismic receiver nodes and cables; the dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; post-decommissioning activities including trawling clearance; and the masking of archaeological resources from industry-related infrastructure and debris. Visual impacts to coastal archaeological and historic sites are not considered, as offshore oil and gas infrastructure has existed on the OCS since the 1940s and constitutes a seaward historic viewshed in its own right. Additionally, offshore oil and gas infrastructure predates the National Historic Preservation Act, and therefore, any coastal historic property currently on the National Register of Historic Places would not derive its eligibility from an unobstructed view of the GOM.

Impact-Level Definitions

The definition of impact thresholds used in this analysis are listed below.

- **Beneficial** – An archeological site is stabilized in its current condition to maintain its existing level of integrity or an archeological site is preserved in accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties.

- **Negligible** – The lowest level of detection that would have neither adverse nor beneficial impacts.
- **Minor** – Disturbance of archaeological resources would result in little, if any, loss of site integrity.
- **Moderate** – Site disturbance would result in a loss of integrity and a partial loss of the character-defining features and information potential that form the basis of the site's National Register of Historic Places' eligibility. Mitigation is accomplished by a combination of archeological data recovery and in-place preservation.
- **Major** – The disturbances result in a loss of site integrity to the extent that the resource is no longer eligible for listing in the National Register of Historic Places. The site's character-defining features and information potential are lost to the extent that archeological data recovery is the primary form of mitigation.

Duration: Short-term impacts last for the duration of construction-related activities while long-term impacts last beyond the proposed construction activities and are permanent. Generally, impacts to archeological sites are considered long-term impacts.

The impact of coastal and marine environmental degradation from OCS oil- and gas-related activities is expected to minimally affect cultural resources in comparison to other sources of coastal erosion and subsidence. Impacts of routine discharges are localized in time and space, are regulated by USEPA permits, and would have minimal impact. Accidental events that could impact archaeological resources include blowouts and oil or chemical spills and the associated cleanup response activities, and also the loss of debris from an MODU, platform, lay barge, etc. during offshore operations. A noncatastrophic oil spill (even one reasonably foreseeable as a result of a proposed lease sale) occurring and contacting a submerged archaeological resource is unlikely, given that oil released tends to rise quickly to the surface and that the average size of a spill is <1 bbl (refer to **Chapter 3.2.2** of this Supplemental EIS and Chapter 3.2.1 of the 2017-2022 GOM Multisale EIS).

Offshore oil and gas activities resulting from a proposed action could adversely impact an archaeological resource because of incomplete knowledge on the location of these sites in the GOM. The risk of contact to archaeological resources is greater in instances where archaeological survey data are unavailable. Such an event could result in the disturbance or destruction of important archaeological information. Archaeological surveys provide the necessary information to develop avoidance strategies that would reduce the potential for adverse impacts on archaeological resources. As part of the environmental reviews conducted for postlease activities, available information would be evaluated regarding the potential presence of archaeological resources within the proposed action area to determine if additional archaeological resource surveys and mitigation is warranted.

Regardless of which planning area a proposed lease sale is held, the greatest potential impact to an archaeological resource as a result of a proposed action under any of the action alternatives is site-specific and would result from direct contact between an offshore activity or accidental event and a site. A proposed action's postlease activities, including the drilling of wells and installation of platforms, installation of pipelines, anchoring, and removal of platforms and other structures installed on the seafloor and site clearance activities, as well as accidental events such as loss of debris, may result in **negligible** to **major** impacts to archaeological sites.

Major impacts could potentially occur if the mitigations described above were not applied to postlease activities. With identification, evaluation, and avoidance or mitigation of archeological resources, the incremental contribution of a proposed action is expected to result in **negligible**, long-term cumulative impacts to archeological resources; however, if an archaeological site were to be impacted, impacts may range from **negligible** to **major**. Under Alternative E, the impact-producing factors mentioned above would not take place for that proposed lease sale; therefore, the impacts would be **none**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. A full analysis of archaeological resources can be found in Chapter 4.13 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

For the purposes of this analysis, all alternatives may be assumed to have effectively similar potential impacts to archaeological resources. Therefore, the level of impacts would be the same for Alternatives A, B, C, and D. Under Alternative E, there would be no new activities associated with a proposed lease sale; however, activities associated with past lease sales and non-OCS oil- and gas-related activities would continue.

Incomplete or Unavailable Information

There is incomplete or unavailable information regarding the long-term impacts of oil, dispersant, and/or dispersed oil contamination on, and the location of, archaeological resources in the GOM. There are currently no published studies on the long-term impacts to archaeological resources exposed to oil, dispersant, or dispersed oil contamination. However, considering the low probability of an accidental oil spill contacting an archaeological site as a result of a proposed action, BOEM has determined that the information is not essential to a reasoned choice among alternatives.

Additionally, the locations of all archaeological resources in the GOM cannot be determined because the overall costs of obtaining that information through survey of the entire GOM are exorbitant. This incomplete information may be relevant to adverse impacts because the locations and integrity of many archaeological resources remain unknown. Nevertheless, this incomplete information is not likely to be available within the timeline contemplated in the NEPA analysis of this Supplemental EIS. It would take several years before data confirming the presence (or lack thereof) of archaeological resources, and the status of each, could be investigated, analyzed, and compiled. Archaeological sites within the GOM have the potential to be buried, embedded in, or laying on the seafloor. The seafloor is comprised of highly variable bathymetric and geophysical regimes, which differentially affect the ease and ability to identify, ground truth, and evaluate archaeological sites. This fact, combined with the scope of the acreage within the GOM, results in the aforementioned exorbitant costs and time factors.

BOEM used existing information and reasonably accepted scientific theories on archaeological site potential in the Gulf of Mexico to extrapolate from available information in completing the relevant analysis. In addition, future site-specific, remote-sensing surveys of the seafloor, where required, establish the presence of potential resources (NTL 2005-G07, "Archaeological Resource Surveys and Reports"). The results of these surveys are reviewed in tandem with credible scientific evidence from previously identified sites, regional sedimentology, and physical oceanography that is relevant to evaluating the adverse impacts on resources that are a part of the human environment. The survey data are analyzed by industry and BOEM's archaeologists prior to the authorization of any new or significant bottom-disturbing impacts and, if necessary, avoidance of potential archaeological resources is prescribed. Archaeological surveys are expected to be effective in identifying resources to allow for mitigation application and protection of the resource during OCS oil- and gas-related activities. A proposed action is not expected to have a reasonably foreseeable significant impact because BOEM's evaluation of such impacts is based upon pre-disturbance and site-specific surveys, the results of which BOEM uses to require substantial avoidance of any potential resource that could be affected by the proposed activity. Therefore, BOEM has determined that the gaps in information on the presence of or status of archaeological resources is not essential to a reasoned choice among alternatives at the lease sale stage.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including JSTOR, the National Technical Information Service's National Technical Reports Library, and ScienceDirect) were examined to assess recent information regarding archaeological resources that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for archaeological resources presented in the 2017-2022 GOM Multisale EIS based on the information presented above. No new information was discovered that would alter the impact conclusion for archaeological resources presented in the 2017-2022 GOM Multisale EIS, and the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.14 HUMAN RESOURCES AND LAND USE

4.14.1 Land Use and Coastal Infrastructure

Summary

BOEM has reexamined the analysis for land use and coastal infrastructure presented in the 2017-2022 GOM Multisale EIS. No new information was discovered that would alter the impact conclusion for land use and coastal infrastructure presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of land use and coastal infrastructure, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Along the Gulf Coast, from the southern tip of Cameron County, Texas, to the Florida Keys, 23 BOEM-defined Economic Impact Areas (EIAs) are identified for the Gulf of Mexico region. The counties and parishes that form the EIAs are listed and the EIAs are visually illustrated in **Figure 4-11**. The EIAs geographically link together not only counties and parishes immediately adjacent to the GOM but also those tied to coastal counties and parishes as parts of functional economic areas. An analysis that encompasses where people live, as well as where they work, permits a more meaningful assessment of the impact of offshore oil and gas activities. The OCS oil- and gas-related activities draw on existing infrastructural, economic, and labor capacity from across the GOM region. BOEM's analysis considers the potential impacts in all 23 EIAs regardless of where a proposed action may take place.

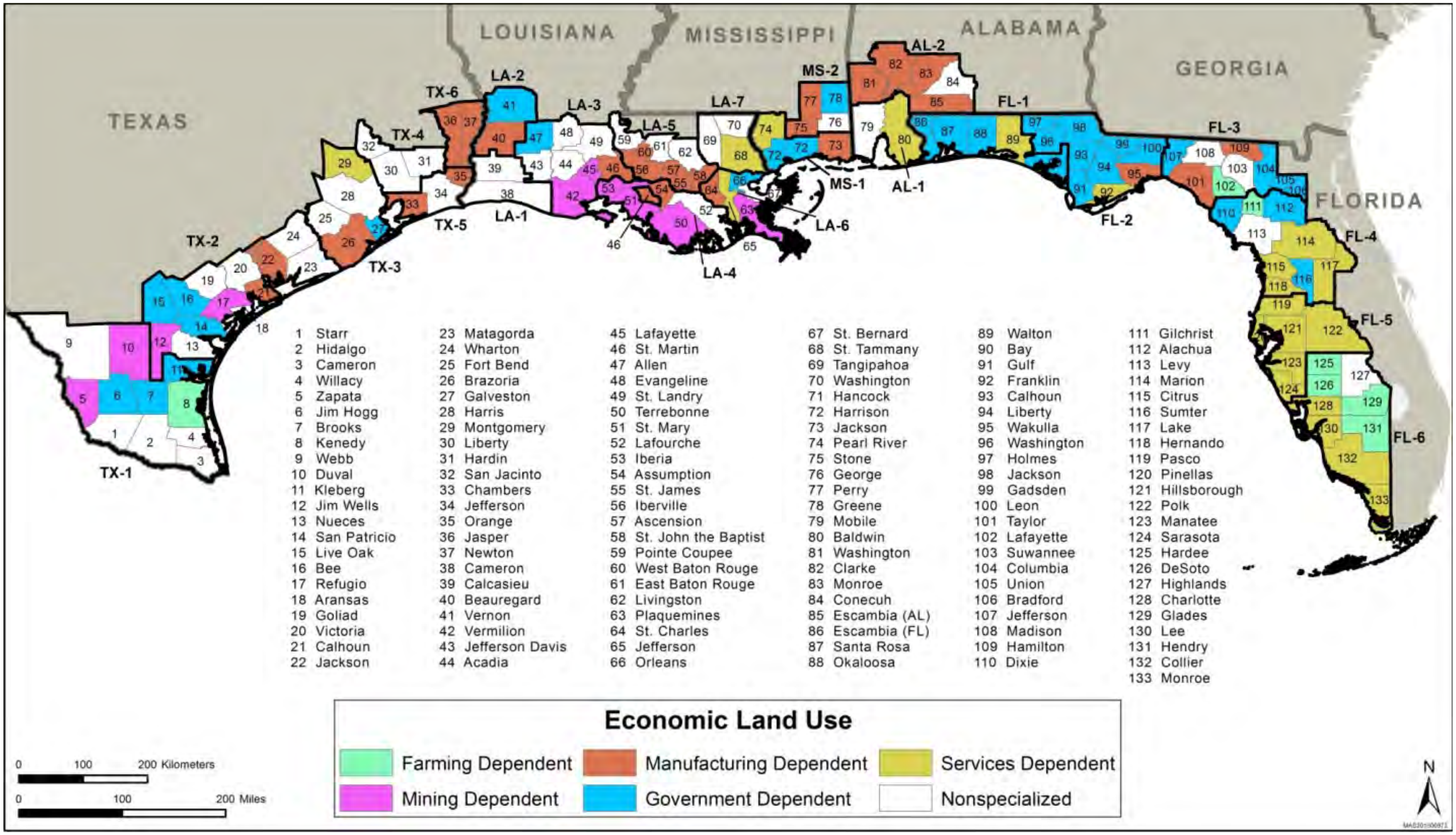


Figure 4-11. Economic Land Use Patterns.

Analysis

For land use and coastal infrastructure, a proposed action would involve all of the Gulf Coast States: Texas; Louisiana; Mississippi; Alabama; and Florida. Particular emphasis is placed on the 133 counties and parishes that constitute the 23 BOEM-identified EIAs and are located in the coastal areas of all five states. This geographic area is broadly diverse in types of land use and distribution of coastal infrastructure related to OCS oil- and gas-related activities. Some counties and parishes are more closely connected to the offshore oil and gas industry than others, such as Harris County, Texas, and Lafourche Parish, Louisiana. Figures 3-9, 3-11, and 3-12 of the 2017-2022 GOM Multisale EIS illustrate the analysis area's key infrastructure.

Impacts to land use and coastal infrastructure may be positive as well as negative. For example, increased economic demand for services provided by infrastructure facilities would lead to more hiring, and this additional employment would further the positive economic trend as new workers spend their wages in the community. The affected environment and analyses supporting these conclusions are discussed below. BOEM has concluded that the selection of Alternative E would result in negligible impacts. Cumulative impacts of current and past activities, however, would continue to occur under Alternative E.

Impact-Level Definitions

- **Beneficial** – Positive impacts in the form of maintaining current employment levels, creating new employment, indirect and induced positive impacts through increased spending, and stimulating local and regional economies.
- **Negligible** – Little or no measureable adverse impact.
- **Minor** – Small-scale measurable adverse impact, temporary in duration and geographically small area (less than county/parish level).
- **Moderate** – Medium-scale measurable adverse impact and may last from a few weeks to 1 year and geographically may affect multiple counties/parishes.
- **Major** – Large-scale measurable or potentially unmeasurable adverse impact, long-lasting (1 year to many years), and may occur over a geographically large regional area.

The impacts of each impact-producing factor for Alternatives A through D are summarized in **Table 4-23** to help the reader quickly identify the level of potential impacts for each impact-producing factor using the impact-level definitions below.

Table 4-23. Land Use and Coastal Infrastructure Impact-Producing Factors That Are Reasonably Foreseeable.

Land Use and Coastal Infrastructure	Magnitude of Potential Impact[1]			
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D
Routine Activities				
Changes in the Level of OCS Exploration, Development, and Production Activities	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Expansions of Existing Infrastructure	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate
New Infrastructure Facility Construction	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate
Onshore Waste Disposal	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Navigation Channel Maintenance Dredging	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Accidental Events				
Oil Spills (coastal and offshore)	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Chemical/Drilling-Fluid Spills	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Spill Response	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Vessel Collisions	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Cumulative Impacts				
Incremental Contribution[2]	Minor	Minor	Minor	Minor
OCS Oil and Gas[3]	Beneficial to Moderate			
Non-OCS Oil and Gas[4]	Beneficial to Major			

[1] The analysis supporting these conclusions is discussed in detail in the "Environmental Consequences" section in Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS.

[2] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) as a result of a single proposed lease sale in the 2017-2022 Five-Year Program.

[3] This includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales.

[4] This includes other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as a proposed action, but they are not related to the OCS Oil and Gas Program.

A current snapshot of land use and coastal infrastructure in the GOM reveals a diverse social and economic landscape, with the oil and gas industry playing a substantially larger role in some states (i.e., Texas and Louisiana) than in the rest of the GOM. The oil and gas industry has developed across the region over many decades and is intimately intertwined with its socioeconomic structure. This complex structure involves both offshore (i.e., Federal OCS and State waters) and onshore (i.e., private land, and State and Federal onshore lands) exploration, development, and production activities, complicating the environmental impact analysis because it is very difficult, if not impossible, to separate the impacts of Federal OCS oil- and gas-related activities from those of oil and gas activities in State waters and onshore, or foreign imports.

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore network of coastal infrastructure that includes large and small companies providing a wealth of services from construction facilities, service bases, and waste disposal facilities to crew, supply, and product transportation, as well as processing facilities. **Chapter 3.1.2.2** summarizes coastal infrastructure scenario projections, and Chapter 3.1.5.3 of the 2017-2022 GOM Multisale EIS describes onshore waste disposal. More detail on coastal infrastructure can be found in Chapter 3.1.7 of the 2017-2022 GOM Multisale EIS. A description of the affected environment covers land use in the area and different infrastructure categories that support thousands of jobs. These jobs represent direct, indirect, and induced economic impacts that ripple through the Gulf Coast economy. As a long-standing part of the regional economy that developed over the past several decades, the coastal infrastructure network is quite mature in the Gulf of Mexico region.

Because OCS oil- and gas-related activities are supported by a long-lived, expansive onshore network of coastal infrastructure that includes hundreds of large and small companies, routine operations associated with a proposed action are not expected to produce any major impacts to land use and coastal infrastructure. Potential impacts from routine operations could range from **negligible** to **moderate**, depending on the location, scale, and type of activity. The impacts of reasonably foreseeable accidental events such as oil spills, chemical and drilling fluid spills, and vessel collisions are not likely to last long enough to adversely affect overall land use or coastal infrastructure in the analysis area and would therefore be **negligible** to **moderate**. For a detailed analysis of a high-impact, low-probability catastrophic oil spill, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b).

The cumulative analysis includes impacts that could result from a proposed lease sale combined with baseline conditions, all past, present, and future Federal OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions that are external to Federal OCS oil- and gas-related activities. Activities relating to all past, present, and future OCS oil- and gas-related activities are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks. Non-OCS oil- and gas-related factors contribute substantially to the cumulative impacts on land use and coastal infrastructure, while only a **minor** incremental contribution is expected for a proposed action.

Comparison of Alternatives

For any of the action alternatives (i.e., Alternatives A, B, C, and D), the cumulative impacts on land use and coastal infrastructure could range from **beneficial** to **moderate** for OCS oil- and gas-related activities and **beneficial** to **major** for non-OCS oil- and gas-related activities, depending on the specifics of each situation, whether the impacts are measurable, how long the impacts would last, and the size of the affected geographic area as defined in Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS. Alternative E would result in no lease sale and, thus, the direct impacts as a result of a proposed lease sale woud be **none**, and there would be no incremental contribution of impacts to land use and coastal infrastructure beyond a temporary negative economic impact for the oil and gas industry and coastal states, such as Louisiana, that are more dependent on oil and gas revenues. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative.

Incomplete or Unavailable Information

BOEM has identified incomplete information regarding the potential impacts of coastal land loss on land use and coastal infrastructure. This incomplete information may be relevant to adverse impacts because it is not completely known how current subsidence and erosion is affecting industry or what plans industry is making to mitigate current or future impacts. Because there are hundreds of large and small property-owning businesses spread across the coastal zone, which directly and indirectly support the offshore petroleum industry, the identity of these properties and the possibilities of losses due to subsidence, sea-level rise, and erosion cannot be quantified at this time.

BOEM has employed reasonably accepted scientific methodologies to extrapolate from existing information on dredged material and other approaches used to mitigate for land loss in completing its analysis and formulating the conclusions presented here. For a more detailed discussion on deltaic land loss, refer to **Chapter 4.3.2** ("Coastal Barrier Beaches and Associated Dunes"). In the case of coastal ports, for example, dredged material from navigation slips are used to fill in property and mitigation habitat areas for wildlife and to act as a barrier to protect ports from storm surges (Volz, 2013). This example shows that, although BOEM does not possess a complete understanding of what industrial infrastructure improvements may occur, such as mitigation for land loss, industry would most likely mitigate as necessary to protect existing and growing infrastructure. With each passing year, the pressure increases to take action and protect critical oil and gas infrastructure (Traywick, 2016). Like any industrial infrastructure improvements, future adaptations would occur on an as-needed basis or as new technologies become available. Given that coastal infrastructure will continue to be subject to the impacts of coastal land loss and routine tropical storm activity, there will also continue to be considerable motivation to protect existing infrastructure. Therefore, BOEM has determined that the information is not essential to a reasoned choice among alternatives. BOEM continues to monitor the industry and its infrastructure footprint over time to document short- and long-term impacts of continued land loss.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including USDHS, Federal Emergency Management Agency; USDOC, Bureau of the Census; USDOC, NOAA; USDOE, Energy Information Administration; USDOT, Maritime Administration; USDOI, FWS; RestoreTheGulf.gov website; USEPA; Louisiana Department of Environmental Quality; Louisiana Recovery Authority; Louisiana Office of Community Development; Mississippi Department of Environmental Quality; Alabama Department of Environmental Management; State of Florida Department of Environmental Protection; recently published journal articles, and trade publications such as The Greater Lafourche Port Commission, LA1 Coalition, The Oil Drum, Rigzone, *Oil and Gas Journal*, *Offshore* Magazine, Reuters, TOLLROADS News, and *The Energy Journal*) were examined to assess recent information regarding land use and coastal infrastructure that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for land use and coastal infrastructure presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on land use and coastal infrastructure has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for land use and coastal infrastructure presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.14.2 Economic Factors

Summary

BOEM has reexamined the analysis for economic factors presented in the 2017-2022 GOM Multisale EIS based on the additional information presented below. No new information was discovered that would alter the impact conclusion for economic factors presented in the 2017-2022 GOM Multisale EIS. The analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of economic factors, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.14.2 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS.

Introduction

Economic factors are factors that explain and quantify the human behaviors that determine the positive and negative impacts from the alternatives. Chapter 4.14.2.1 of the 2012-2022 GOM

Multisale EIS provides detailed economic and demographic data for Gulf of Mexico EIAs, provides background research regarding the offshore oil and gas industry, and presents data from the Office of Natural Resources' revenue regarding sales volumes, sales values, and revenues received from offshore oil and gas activities.

Analysis

This chapter discusses the routine activities, accidental events, and cumulative impacts to economic factors that would arise from the alternatives. Many of the economic impacts of the alternatives would be beneficial, and these impacts are stated in terms of standard measures of economic activity. The negative impacts are measured in terms of the severity, duration, and geographical extent of impacts. Long-term impacts are those lasting more than 1 year. Extensive impacts are those that affect numerous economic impact areas. Severe impacts cause sizeable impacts to economic activity in levels or relative to the size of an economic impact area.

Impact-Level Definitions

In this chapter the impact levels are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of economic factors along the Gulf Coast.

- **Beneficial** – Positive impacts stated in levels and percentages of employment (number of jobs), labor income (wages, benefits, and sole-proprietor income), and/or value-added (contribution to gross regional product).
- **Negligible** – Little or no detectable adverse impact.
- **Minor** – Adverse impacts are detectable but less than severe.
- **Moderate** – Adverse impacts are severe but are short-term and/or not extensive.
- **Major** – Adverse impacts are long-term (more than 1 year), extensive, and severe.

A proposed action would lead to **beneficial (low)** impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. A proposed action could also lead to negative economic impacts (**negligible** to **minor**) arising from accidental events and disruptions to other industries. There would be some differences in economic impacts among the alternatives, corresponding to the differences in the scales and distributions of likely activities. Chapter 4.14.2 of the 2017-2022 GOM Multisale EIS presents detailed estimates of the economic impacts of the alternatives. A full analysis of economic factors can be found in Chapter 4.14.2 of the 2017-2022 GOM Multisale EIS.

Comparison of Alternatives

The alternatives should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the incremental economic impacts of a proposed action are forecast to be **beneficial (low)**, although there would be some **minor** adverse impacts that may occur as a result of accidental events. The exact impacts will be roughly proportional to the amount of resulting oil and gas industry activity that occurs as a result of a proposed action. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar because the types of activities that occur are similar and the differences are not large enough to change the range of impact conclusions. Alternative E, the cancellation of a proposed lease sale, would negatively impact firms and employees that depend on recurring leases; therefore, the impacts of Alternative E would be **negligible** to **minor**, with some partially offsetting **beneficial** impacts. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative.

Incomplete or Unavailable Information

Even after evaluating the information above, there is still incomplete or unavailable information. This information primarily relates to the onshore geographic distributions of economic impacts arising from the OCS Program, which would allow BOEM to better estimate the impacts from routine activities, accidental events, and cumulative impacts. This information is difficult to obtain since most data sources do not adequately differentiate between onshore and offshore oil and gas activities. In addition, standard data sources do not trace revenue and corporate profit streams to ultimate expenditures. BOEM used reasonably accepted scientific methodologies to extrapolate from existing information in completing the relevant analysis and formulating the conclusions presented here. For example, BOEM used the model MAG-PLAN to estimate the impacts of the alternatives and OCS Program. In addition, the economic impacts arising from the OCS Program are generally positive, not adverse. Therefore, BOEM has determined that the incomplete or unavailable information, while relevant, is not essential to a reasoned choice among alternatives.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various sources (including Internet searches regarding economic developments) were examined to assess recent information regarding economic factors that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for economic factors presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on economic factors has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for economic factors presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.14.3 Social Factors (Including Environmental Justice)

Summary

BOEM has reexamined the analysis for social factors presented in the 2017-2022 GOM Multisale EIS. No new information was discovered that would alter the impact conclusion for social factors presented in the 2017-2022 GOM Multisale EIS. Further, the analysis and potential impacts detailed in that document still apply for the remaining proposed GOM lease sales in the Five-Year Program.

A detailed description of social factors, along with the full analyses of the potential impacts of routine activities, accidental events, and cumulative impacts associated with a proposed action are presented in Chapter 4.14.3 of the 2017-2022 GOM Multisale EIS. The following information is a summary of the resource description and impact analysis incorporated from the 2017-2022 GOM Multisale EIS. An environmental justice determination follows in **Chapter 4.14.3.1**.

Introduction

The affected environment that comprises the baseline for the social factors' environmental impact analysis is geographically distributed across 23 BOEM-identified EIAs in all five Gulf Coast States. **Figure 4-12** shows the aggregation of 133 counties and parishes that comprise the EIAs. **Chapter 4.14.2** ("Economic Factors") discusses the methodology behind the development of the EIAs and employment in the analysis area.

Analysis

The petroleum industry as a whole in the Gulf of Mexico region has matured over several decades and is well-developed, expansive, extensive, and deeply intertwined in the regional communities and economies of the five coastal states, i.e., Texas, Louisiana, Mississippi, Alabama, and Florida. An inherent complication in conducting an impact analysis of OCS oil- and gas-related activities lies in the fact that the industry involves exploration, development, and production located on private and public lands onshore, State waters offshore, and on the Federal OCS. This long-lived, well-developed, and extensive industry functions within a much larger context, a socioeconomic framework that weaves through the region in a complex, inter-connected grid-like manner. Nothing occurs as an isolated event, but rather results from and simultaneously triggers other events, all of which are experienced at varying degrees of negative or positive impact. For example, when oil prices drop and then gasoline prices drop, this positively impacts individuals and businesses who buy fuel. When oil prices remain low for many months, negative impacts begin to appear. Oil and gas companies start reducing the number of employees to cut operational costs. Laid-off employees no longer have income to make purchases and the businesses where workers would normally spend their money began to suffer and, when necessary, people began moving out of the area to find other work, leading to a negative impact on the housing market, depressing real estate prices as the number of units available for rent or sale outgrows the demand. A negative impact for some (i.e., sellers and landlords) becomes a positive impact for others (i.e., buyers and renters). This is just one example of an event leading to dual ripple impacts (negative and positive) through communities and illustrates the complexity of the socioeconomic framework.

Within this context, and in the cumulative analysis, a single proposed lease sale is like a blip on a radar screen, one tiny piece of a vastly complex social and economic structure. A single proposed lease sale's main impact on communities would be to contribute to the maintenance of current employment levels; not to create new jobs; not to cause a notable increase of people to move into the region; not to cause new roads, schools, or hospitals to be built; and not to cause large public works improvements. A single proposed lease sale would help to maintain what decades of economic development have built, the complex Gulf of Mexico region that exists today.

While this chapter is titled "social factors," the resource discussed here is essentially human beings. The list of potential impact-producing factors is, in a sense, nearly limitless because the industry involves people at all levels; it simultaneously affects and is affected by people, their communities, and their daily lives. Most of the impacts to people are positive, e.g., in the form of direct employment in the industry, indirect employment in the extensive support sectors, and employees' spent wages and tax revenues that support community businesses and local governments.

Impact-Level Definitions

Impacts to people and communities may be positive as well as negative. For example, increased economic demand would lead to more hiring, and this additional employment would further the positive economic trend as new workers spend their wages in the community. The definitions below define the impact levels for this analysis.

- **Beneficial** – Positive impacts such as any of the following: measurable beneficial effects such as maintaining current employment levels; creating new employment; and indirect and induced positive impacts through increased spending that stimules local and regional economies.
- **Negligible** – Little or no measureable adverse impact.
- **Minor** – Small-scale measurable adverse impact, temporary in duration, and geographically small area (less than county/parish level).
- **Moderate** – Medium-scale measurable adverse impact, may last from a few weeks to 1 year, and geographically may affect multiple counties/parishes.
- **Major** – Large-scale measurable or potentially unmeasurable adverse impact, long lasting (1 year to many years), and may occur over a geographically large regional area.

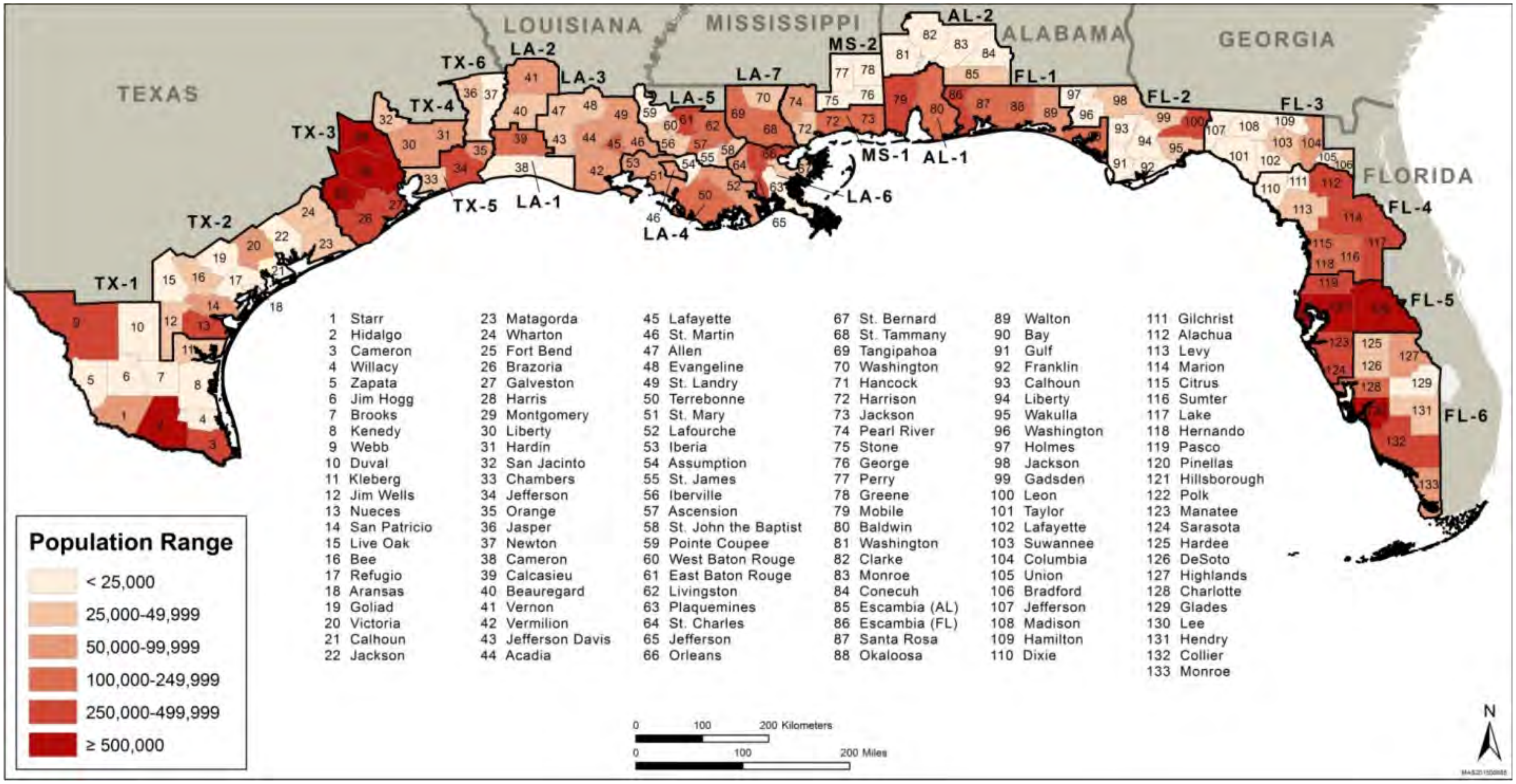


Figure 4-12. Population of BOEM's Economic Impact Areas in the Gulf of Mexico.

A regionwide proposed lease sale is the preferred alternative and, just like planning area specific lease sales, involves all of the Gulf Coast States, i.e., Texas, Louisiana, Mississippi, Alabama, and Florida because the onshore effects operate independently of the boundaries of offshore planning areas. Particular emphasis is placed on the 133 counties and parishes that constitute the 23 BOEM-identified EIAs and that are located in the coastal areas of all five states. **Figure 4-11** shows the aggregation of counties and parishes into the EIAs used for BOEM's socioeconomic analysis. This geographic area possesses a culturally and racially diverse population. Some counties and parishes are more closely connected to the offshore oil and gas industry than others, particularly Harris County, Texas, and Lafourche Parish, Louisiana.

Analysis of the various alternatives considers impact-producing factors within a distinct framework that includes frequency, duration, and geographic extent. Frequency (i.e., rare, intermittent, and continuous) refers to how often the impact-producing factor occurs over the entire analysis period of 50 years for routine activities and accidental events and for an analysis period of 70 years for cumulative impacts. Duration (i.e., low, medium, and high) refers to how long the impact-producing factor lasts (i.e., from less than a year to many years). Geographic extent refers to which areas are affected and, depending on the impact-producing factor, the size of an affected area.

Potential social impacts resulting from a proposed action would occur within the larger socioeconomic context of the GOM region. The affected environment of the analysis area is quite large geographically and in terms of population (133 counties and parishes with over 22.7 million residents). The impacts from routine activities related to a proposed action are expected to be **negligible** to **moderate**, widely distributed, and to have little impact because of the existing extensive and widespread support system for the petroleum industry and its associated labor force. Outside of a low-probability catastrophic oil spill, which is not reasonably foreseeable and not part of a proposed action, any potential accidental events are not likely to be of sufficient scale or duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area and would therefore range from **negligible** to **moderate**. In the cumulative analysis, impacts from OCS oil- and gas-related activities would range from **beneficial** to **moderate**. Non-OCS oil- and gas-related factors, which include all human activities, natural events, and processes, actually contribute more to cumulative impacts than do factors related to OCS oil- and gas-related activities alone and result in **beneficial** to **major** impacts. The incremental contribution of a proposed action to cumulative impacts would be **minor**. Alternative E would result in no lease sale and, thus, the overall incremental impacts as a result of Alternative E would be **none**. Cumulative impacts of current and past activities (i.e., OCS oil- and gas-related and non-OCS oil- and gas-related), however, would continue to occur under this alternative. For a detailed analysis of a high-impact, low-probability catastrophic oil spill, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2017b).

Coastal populations experience cumulative impacts that include all human activities and natural processes and events. The cumulative analysis includes impacts that could result from a proposed lease sale combined with baseline conditions, all past, present, and future Federal OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions that are external to Federal OCS oil- and gas-related activities. Within this divided analytical framework of OCS oil- and gas-related and non-OCS oil- and gas-related impacts, the largest quantity of impact-producing factors for coastal populations occur as non-OCS oil- and gas-related impacts because OCS oil- and gas-related activities form a very small part of the greater, complex socioeconomic structure in the GOM. The incremental contribution to cumulative impacts of a proposed action, i.e., a single regionwide lease sale, would be **minor** for communities and people in the Gulf Coast region.

Comparison of Alternatives

The impacts for social factors would be similar for Alternatives A, B, C, and D; however, the level of impacts would be directly related to the level of OCS oil- and gas-related activity in the Gulf of Mexico. Alternative B would produce proportionately smaller OCS oil- and gas-related activity than Alternative A, and Alternative C would result in less OCS oil- and gas-related activity than Alternative A or B. The impacts of Alternative D could be less than Alternative A, B, or C, but this difference would likely be indiscernible. Under Alternative E, there would be no new activities associated with a proposed lease sale; however, activities associated with past lease sales and non-OCS oil- and gas-related activities would continue.

Incomplete or Unavailable Information

BOEM has identified unavailable information that is relevant to people and communities regarding the impacts of the *Deepwater Horizon* explosion, oil spill, and response. This information cannot be obtained because long-term health impact studies, subsistence studies, and the NRDA process are ongoing, and data from these efforts would be unavailable and unobtainable for some time. In order to fill this data gap, BOEM has used existing information and reasonably accepted scientific methodologies to extrapolate from available information in completing the relevant analysis, including information that has been released after the *Deepwater Horizon* explosion, oil spill, and response and studies of past oil spills, which indicate that a low-probability, catastrophic oil spill, which is not part of a proposed lease sale and not likely expected to occur, may have adverse impacts on residents in GOM coastal communities. Research into possible long-term health impacts of the *Deepwater Horizon* explosion, oil spill, and response continues (National Institute of Environmental Health Science, 2014; National Center for Disease Preparedness, 2013 and 2014; Substance Abuse and Mental Health Services Administration and Centers for Disease Control and Prevention, 2013). Because long-term health impacts to coastal populations are unknown, this information may be relevant to the evaluation of impacts from the *Deepwater Horizon* explosion, oil spill, and response; therefore, BOEM would continue to seek additional information as it becomes available and bases the previous analysis on the best information currently available. Although long-term health impacts to people and communities may be relevant to this analysis, BOEM has determined that the unavailable information is not essential to a reasoned choice among alternatives based on the information discussed above.

New Information Available Since Publication of the 2017-2022 GOM Multisale EIS

Various printed and Internet sources (including peer-reviewed research publications, U.S. Department of Health and Human Services, National Institutes of Health; USEPA; USDOC, Bureau of the Census and Bureau of Labor Statistics; USDHS, Federal Emergency Management Agency; USDOE, Energy Information Administration; RestoreTheGulf.gov website; *Deepwater Horizon* Oil Spill Portal; Louisiana Department of Environmental Quality; Mississippi Department of Environmental Quality; Alabama Department of Environmental Management; State of Florida Department of Environmental Protection; Louisiana Recovery Authority; Louisiana Office of Community Development; The Greater Lafourche Port Commission; LA1 Coalition; Reuters; Rigzone; and *Oil and Gas Journal*) were examined to assess recent information regarding social factors that may be pertinent to a proposed action. No new information that would add to the analyses or change the conclusions was discovered since publication of the 2017-2022 GOM Multisale EIS.

Conclusion

BOEM has reexamined the analysis for social factors presented in the 2017-2022 GOM Multisale EIS, with the understanding that no new information on social factors has been published since the publication of the 2017-2022 GOM Multisale EIS. Therefore, no new information was discovered that would alter the impact conclusion for social factors presented in that document, and the analysis and potential impacts detailed in the 2017-2022 GOM Multisale EIS still apply for the remaining proposed GOM lease sales in the Five-Year Program.

4.14.3.1 Environmental Justice Determination

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," directs Federal agencies to make a determination as to whether their actions have disproportionate environmental impacts on minority or low-income people. These environmental impacts encompass human health, and social and economic consequences. In 1997, President Clinton issued Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," directing Federal agencies to identify and assess environmental health risks and safety risks of its policies, programs, and activities that may disproportionately affect children. In accordance with NEPA and the Executive Orders, BOEM provides opportunities for community input during the NEPA process.

One example of BOEM's efforts to foster an inclusive and transparent public process are the meetings that BOEM has held with the Vietnamese fisherfolk community in Mississippi at the Vietnamese fisherfolk community's request. BOEM provided Vietnamese translations of relevant portions of the 2017-2022 GOM Multisale EIS to maximize participation. Additional avenues of public outreach employed by BOEM include specific types of notices that are (1) mailed to public libraries; interest groups; industry; ports and docks; local, State, and Federal agencies; and federally recognized Indian Tribes; (2) published in local newspapers; (3) posted on the Internet; and (4) published in the *Federal Register*. The formal scoping process is initiated by the publication of a

Notice of Intent, and public scoping meetings are held in several geographically separate cities to allow the public to submit comments and to identify all stakeholders' concerns. All public comments and responses to comments are published in the Draft and Final Supplemental EISs. A detailed discussion of the complete scoping process can be found in **Chapter 5.3**. A summary of the scoping comments for this Supplemental EIS can be found in **Chapter 5.3.1**.

In accordance with 40 CFR §§ 1508.7 and 1508.8, BOEM has considered potential cumulative, direct, and indirect impacts to minority and low-income populations in the analysis area. Furthermore, in reaching this considered environmental justice determination, BOEM utilized guidance from the Council on Environmental Quality (CEQ, 1997), the U.S. Environmental Protection Agency (USEPA, 1998) and the Federal Interagency Working Group on Environmental Justice & NEPA Committee (2016). The OCS lease sales occur in Federal waters 3 nmi (3.5 mi; 5.6 km) or 9 nmi (10.4 mi; 16.7 km) from shore. Thus, the permitted activities of petroleum exploration, extraction, and production that occur on these leaseholds are distant from human habitation, and these activities would not have any direct impacts on low-income and minority populations. State offshore oil and gas leasing occurs in waters closer to land were petroleum-related activities are generally viewed as having a greater potential for directly impacting coastal communities. Indirect impacts to minority and low-income populations could occur onshore, and would result from the operations of the extensive infrastructure system that supports all onshore and offshore oil and gas activities. This downstream infrastructure moves hydrocarbon product to market and includes gas processing facilities, petrochemical plants, transportation corridors, petroleum bulk storage facilities, and gas and petroleum pipelines. These facilities comprise a mature, widespread and concentrated infrastructure system (refer to **Chapter 4.14.1**). Much infrastructure is located in coastal Louisiana and Texas, and to a lesser extent in Mississippi's Jackson County and Alabama's Mobile County. While many fabrication and supply facilities are concentrated around coastal ports, downstream processing is concentrated in industrial corridors farther inland (Dismukes, 2011b; Kaplan et al., 2011). The onshore downstream infrastructure exists to support all oil- and gas-related activities (i.e., onshore, offshore, and imported product), and the proportion of Federal OCS contribution to downstream infrastructure use has not yet and, most likely, may never be possible to determine as it is dependent on highly unpredictable market demands and prices.

Potential environmental justice impacts that may arise from downstream support activities cannot be influenced by BOEM's decisionmaking because BOEM has no regulatory authority over any onshore activities, including their location. Many other Federal and State agencies regulate onshore oil and gas infrastructure. Therefore, BOEM has determined that a proposed lease sale would not adversely affect minority and low-income populations.

4.15 Unavoidable Adverse Impacts of a Proposed Action

Unavoidable adverse impacts associated with a proposed action are expected to be primarily short term and localized in nature and are summarized below. Adverse impacts from low-probability catastrophic events, which are not part of a proposed action and not likely expected to occur, could be of longer duration and extend beyond the local area. All OCS oil- and gas-related activities involve temporary and exclusive use of relatively small areas of the OCS over the lifetimes of specific projects. Lifetimes for these activities can be days, as in the case of seismic surveys, or decades, as in the case of a production structure or platform. No activities in the OCS Program involve the permanent or temporary use or "taking" of large areas of the OCS. Cumulatively, however, a multitude of individual projects results in a major use of OCS space.

Air Quality: Unavoidable short-term impacts on air quality could occur after large oil spills because of evaporation and volatilization of the lighter components of crude oil, combustion from surface burning, and aerial spraying of dispersant chemicals. Mitigation of long-term impacts from offshore engine combustion during routine operations would be accomplished through existing regulations and the development of new control emission technology. Short-term impacts from spill events could occur and are likely to be aggravated or mitigated by the time of year the spills take place.

Water Quality: Routine offshore operations would cause some unavoidable adverse impacts to varying degrees on the quality of the surrounding water. Drilling, construction, overboard discharges of drilling mud and cuttings, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. This, however, would only affect water in the immediate vicinity of the construction activity or in the vicinity of offshore structures, rigs, and platforms. Impacts from these activities would be reduced through existing NPDES regulations. Accidental spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms. Spilled oil from a tanker collision would affect the water surface in combination with dispersant chemicals used during spill response. A subsurface spill would subject the surface, water column, and near-bottom environment to spilled oil and gas released from solution, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals.

Unavoidable impacts to onshore water quality would occur as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of lease sale activities. Vessel traffic contributes to the degradation of water quality by chronic low-quantity oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in ship paints. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to point-source discharges from support facilities such as refineries and marine terminals.

Coastal Habitats: If an oil spill contacts beaches or barrier islands, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced, and a beach could experience several years of small surface residue balls (also called tarballs) washing ashore over time, causing an aesthetic impact. Sand borrowing on the OCS for coastal restorations involves the taking of a quantity of sand from the OCS and depositing it onshore, essentially moving small products of the deltaic system to another location. If sand is left where it is, it would eventually be lost to the deltaic system by redeposition or burial by younger sediments; if transported onshore, it would be lost to burial and submergence caused by subsidence and sea-level rise.

If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In more heavily oiled areas, wetland vegetation could experience suppressed productivity for several years; in more lightly oiled areas, wetland vegetation could experience die-back for one season. Epibionts (organisms growing) on wetland vegetation and grasses in the tidal zone could be killed, and the productivity of tidal marshes for the vertebrates and invertebrates that use them to spawn and develop could be impaired. Much of the wetland vegetation would recover over time, but some wetland areas could be converted to open water. Some unavoidable impacts could occur during pipeline and other related coastal construction, but regulations are in place to avoid and minimize these impacts to the maximum extent practicable. Unavoidable impacts resulting from dredging, wake erosion, and other secondary impacts related to channel use and maintenance would occur as a result of a proposed action.

Offshore Biological Habitats: Unavoidable adverse impacts would take place if an oil spill occurred and contacted offshore biological habitats, such as *Sargassum* at the surface; fish, turtles, and marine mammals in the water column; or benthic habitats on the bottom. There could be some adverse impacts on organisms contacted by oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals that, at this time, are not completely understood, particularly in subsurface environments.

Fish and Invertebrate Resources: Unavoidable adverse impacts from routine operations would take place from discharges from vessels and platforms. These would be minor given the available area for fish habitat. If a large oil spill occurs, the oil, dispersant chemicals, or emulsions of oil droplets and dispersant chemicals could temporarily displace mobile fish species on a population or local scale. There could also be impacts on prey and sublethal impacts on fish.

Birds: Unavoidable adverse impacts from routine operations on birds could result from noise, helicopter and OCS service-vessel traffic, coastal facility and platform lighting, and floating trash and debris. Trans-Gulf migrating species could be affected by lighted platforms, helicopter and vessel traffic, and floating trash and debris. If a large oil spill occurs and contacts bird habitats, some birds could experience lethal and sublethal impacts from oiling, and birds feeding or resting in the water could be oiled and die. Birds coming into contact with oil may migrate more deeply into marsh habitats, out of reach from spill responders seeking to count them or collect them for rehabilitation. Oil spills and oil-spill cleanup activities could also affect the food species for bird species. Depending on the time of year, large oil spills could decrease the nesting success of species that concentrate nests in coastal environments due to direct impacts of the spill and also disruption from oil-spill cleanup activities.

Threatened and Endangered Species: Because a proposed lease sale does not in and of itself make any irreversible or irretrievable commitment of resources that would foreclose the development or implementation of any reasonable and prudent measures to comply with the

Endangered Species Act, BOEM may proceed with publication of this Supplemental EIS and finalize a decision among these alternatives even if consultation is not complete, as described in Section 7(d) of the ESA (also refer to **Chapter 5.7**). Irreversible loss of individuals that are ESA-listed species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

Marine Mammals: Unavoidable adverse impacts to marine mammals would be those that also affect endangered and threatened marine mammal species. Routine operation impacts (such as seismic surveys, water quality and habitat degradation, helicopter disturbance, vessel collision, and discarded trash and debris) would be negligible or minor to a population, but they could be lethal to individuals as in the case of a vessel collision. A large oil spill would temporarily degrade habitat if spilled oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals contact free-ranging pods or calving grounds.

Commercial Fisheries and Recreational Fishing: Unavoidable adverse impacts from routine operations are loss of open ocean or bottom areas desired for fishing by the presence or construction of OCS oil- and gas-related facilities and pipelines. Loss of gear could occur from bottom obstructions around platforms and subsea production systems. If a large oil spill occurs, it is unlikely that fishermen would want, or be permitted, to harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species, rendering them unmarketable.

Recreational Resources: Unavoidable adverse impacts from routine operations may result in the accidental loss overboard of some floatable debris that may eventually come ashore on frequented recreational beaches. A large oil spill could make landfall on recreational resources, leading to local or regional economic losses and stigma effects, causing potential users to avoid the area after acute impacts have been removed. Some recreational resources become temporarily soiled by weathered crude oil, and small surface residue balls (also called tarballs) may come ashore long after stranded oil has been cleaned from shoreline areas. Impacts on recreational resources from a large oil spill may, at the time, seem irreversible, but the impacts are generally temporary. Beaches fouled by a large oil spill would be temporarily unavailable to the people who would otherwise frequent them, but only during the period between landfall and cleanup of the oil, followed by an indefinite lag period during which stigma effects recede from public consciousness.

Archaeological Resources: Unavoidable adverse impacts from routine operations could lead to the loss of unique or significant archaeological information if unrecognized at the time an area is disturbed. It is BOEM's policy to not approve any EP or DOCD plan with known or potential archaeological resources within 500 ft (152 m) of the planned activity or a pipeline application with known or potential archaeological resources within the pipeline corridor or right-of-way (the 200-ft [61-m] corridor in which the pipeline is to be constructed). For decommissioning activities, all known or potential (i.e., side-scan sonar targets) archaeological resources must be investigated before site clearance activities take place and, if the presence of archaeological resources is confirmed, exceptions to the site clearance requirements at that location would be granted. Complete archaeological data recovery (excavation) would be required if BOEM decided that a permitted activity must take place that would cause an adverse impact to an archaeological resource.

Economic and Social Factors: Net economic, political, and social benefits to the U.S. accrue from the production of hydrocarbon resources. Once these benefits become routine, unavoidable adverse impacts from routine operations follow trends in supply and demand based on the commodity prices for oil, gas, and refined hydrocarbon products. Declines in oil and gas prices can lead to activity ramp downs by operators until prices rise. A large oil spill would cause temporary increases in economic activity associated with spill-response activity. An increase in economic activity from the response to a large spill could be offset by temporary work stoppages that are associated with spill-cause investigations and would involve a transfer or displacement of demand to different skill sets. Routine operations affected by new regulations that are incremental would not have much effect on the baseline of economic activity; however, temporary work stoppages or the introduction of several new requirements at one time, which are costly to implement, could cause a drop-off of activity as operators adjust to new expectations or use the opportunity to move resources to other basins where they have interests.

4.16 Irreversible and Irretrievable Commitment of Resources

Irreversible or irretrievable commitment of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples are when a species becomes extinct or when wetlands are permanently converted to open water. In either case, the loss is permanent.

4.16.1 Coastal Habitats

An irreversible or irretrievable loss of wetlands and associated biological resources could occur if wetlands 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. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to these activities to mitigate these impacts. Ongoing natural and anthropogenic processes in the coastal zone, only one of which is an OCS oil- and gas-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 the absence of new sediment added to the delta plain appear to be much more dominant processes impacting coastal wetlands.

4.16.2 Biological Resources

An irreversible loss or degradation of ecological habitat caused by cumulative activity tends to be incremental over the short term. Irretrievable loss may not occur unless or until a critical threshold is reached. It can be difficult or impossible to identify when that threshold is, or would be, reached. Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

4.16.2.1 Threatened and Endangered Species

Irreversible loss of individuals that are protected species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

4.16.2.2 Fish and Invertebrate Resources, Deepwater Benthic Communities, Commercial Fisheries, and Recreational Fishing

Irreversible loss of fish and invertebrate resources, including commercial and recreational species, may be caused by structure removals 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. Removing structures 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, the Rigs-to-Reef Program would help offset these impacts.

4.16.3 Archaeological Resources

Any loss of undiscovered archaeological resources on or below the seafloor of the OCS in developed areas would be an irreversible and irretrievable commitment of resources. A resource can be completely destroyed, severely damaged, or the scientific context badly impaired by well drilling, subsea completions, and platform and pipeline installation, or sand borrowing. An archaeological survey, avoidance through development design, documentation, and/or other mitigation would be accomplished prior to development, so as to minimize impacts.

4.16.4 Oil and Gas Development

Leasing and subsequent development and extraction of hydrocarbons as a result of a proposed action represents an irreversible and irretrievable commitment by the removal and consumption of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of a proposed action is presented in **Chapter 3.1.2**.

4.16.5 Loss of Human and Animal Life

The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public and work place safety and environmental protection. Nevertheless, some loss of human and animal life may be inevitable from unpredictable and unexpected acts of man and nature (i.e., unavoidable accidents, accidents caused by human negligence or misinterpretation, human error, and adverse weather conditions). Some normal and required operations, such as structure removal, can kill sea life in proximity to explosive charges or by removal of the structure that served as the framework for invertebrates living on it and the fish that lived with it.

4.17 RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The short-term impacts on various components of the environment in the vicinity of the proposed action are related to long-term impacts and the maintenance and enhancement of long-term productivity.

4.17.1 Short-Term Use

Short-term refers to the total duration of oil and gas exploration and production activities. Extraction and consumption of offshore oil and natural gas is a short-term benefit. Discovering and producing domestic oil and gas now reduces the Nation's dependency on foreign imports. Depleting a nonrenewable resource now removes these domestic resources from being available for future use. The production of offshore oil and natural gas as a result of a proposed action would provide short-term energy, and as it delays the increase in the Nation's dependency on foreign imports, it can also allow additional time for ramp-up and development of long-term renewable energy sources or substitutes for nonrenewable oil and gas. Economic, political, and social benefits would accrue from the availability of these natural resources.

The principle short-term use of the leased areas in the Gulf of Mexico would be for the production of up to 0.211-1.118 BBO and 0.547-4.424 Tcf of gas from a proposed action. The impact scenario in this Supplemental EIS extends approximately from 2017 to 2066. The 50-year time period is used because it is the approximate longest life span of activities conducted on an individual lease. The 50 years following a proposed lease sale is the period of time during which the activities and impacting factors that follow as a consequence of a proposed lease sale would be influencing the environment.

The cumulative impact scenario in this Supplemental EIS extends from approximately 2017 to 2086. The 70-year timeframe includes projected activity from (1) past lease sales for which exploration or development has either not yet begun or is continuing, (2) lease sales that would be held in the Five-Year Program, and (3) future lease sales that would be held as a result of future Five-Year Programs (four additional programs are included in this cumulative analysis). Activities that take place as a result of Five-Year Programs beyond the next four programs are not included in this analysis. The 70-year time period following a proposed lease sale is the period of time during which the activities and impacting factors that follow as a consequence of the cumulative impact scenario would be influencing the environment.

The specific impacts of a proposed action vary in kind, intensity, and duration according to the activities occurring at any given time (**Chapter 3**). Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of a proposed action but also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (over 25 years), potentially punctuated by more severe impacts as a result of accidental events or a spill. Platform removal is also a short-term activity with localized impacts, including removal of the habitat for encrusting invertebrates and fish living among them. Many of the impacts on physical, biological, and socioeconomic resources discussed in **Chapter 4** are considered to be short term (being greatest during the construction, exploration, and early production phases). These impacts would be further reduced by the mitigating measures discussed in **Chapter 2.2.4**.

The OCS development off Texas and Louisiana has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and specialized recreational fishing equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. A proposed action could increase these incidental benefits of offshore development. Offshore fishing and diving have gradually increased in the past three decades, with offshore structures and platforms becoming the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities, but this could be offset by the Rigs-to-Reef program.

The short-term exploitation of hydrocarbons for the OCS Program in the Gulf of Mexico may lead to long-term impacts on biologically sensitive resources and areas if a large oil spill occurs. A spill and spill-response activity could temporarily interfere with commercial and recreational fishing, beach use, and tourism in the area where the spill makes landfall and in a wider area based on stigma effects. The proposed leasing may also result in onshore development and population increases that could cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure (refer to **Chapter 4.14**).

4.17.2 Relationship to Long-Term Productivity

Long-term refers to an indefinite period beyond the termination of oil and gas production. Over a period of time after peak oil production has occurred in the Gulf of Mexico, a gradual easing of the specific impacts caused by oil and gas exploration and production would occur as the productive reservoirs in the Gulf have been discovered and produced, and have become depleted. The BSEE estimates that oil production in the GOM peaked at 1.6 MMbbl/day in 2002, declined for a few years and then peaked again in 2009 and 2010 at 1.6 MMbbl/day before declining again. Production rates in 2015 indicate it was another high year (1.5 MMbbl/day), and gas production in the GOM peaked at 14.4 Bcf/day in 1997 and has declined since then to 3.6 Bcf/day in 2015 (USDOI, BSEE, 2016b). Production has shifted from many smaller reserves on the continental shelf to fewer larger reserves in deep water. Large deepwater oil discoveries have the potential to alter the oil production rate, but the exact effect any one discovery would have or when that discovery would be made is difficult to project due to the difficulties that may be encountered producing these prospects because of their geologic age; burial depth and high-temperature, high-pressure *in-situ* conditions; lateral continuity of reservoirs; and the challenges of producing from ultra-deepwater water depths.

The Gulf of Mexico's large marine ecosystem is considered a Class II, moderately productive ecosystem (mean phytoplankton primary production 150-300 gChlorophyll *a*/m^2-yr [The Encyclopedia of Earth, 2008]) based on Sea-viewing Wide Field-of-view Sensor (SeaWiFS) global primary productivity estimates (USDOC, NASA, 2003). After the completion of oil and gas production, a gradual ramp-down to economic conditions without OCS oil- and gas-related activity would be experienced, while the marine environment is generally expected to remain at or return to its normal long-term productivity levels that, in recent years, has been described as stressed (The Encyclopedia of Earth, 2008). The Gulf of Mexico's large marine ecosystem shows signs of ecosystem stress in bays, estuaries, and coastal regions (Birkett and Rapport, 1999). There is shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading. The overall condition for the U.S. section of this large marine ecosystem, according to the USEPA's seven primary indicators (Jackson et al., 2000), is good dissolved oxygen, fair water quality, poor coastal wetlands, poor eutrophic condition, and poor sediment, benthos, and fish tissue (The Encyclopedia of Earth, 2008).

To help sustain the long-term productivity of the Gulf of Mexico ecosystem, the OCS Program provides structures to be used as site-specific artificial reefs and fish-attracting devices for the benefit of commercial and recreational fishermen and for sport divers and spear fishers. Approximately 10 percent of the oil and gas structures removed from the OCS are eventually used for State artificial reef programs. Additionally, the OCS Program continues to improve the knowledge and mitigation practices used in offshore development to enhance the safe and environmentally responsible development of OCS oil and gas resources.

CHAPTER 5

CONSULTATION AND COORDINATION

What's in This Chapter?

- BOEM is conducting consultation and other activities to comply with laws and Executive Orders.
- BOEM coordinated the prelease process with key agencies and organizations.
- The prelease and NEPA process has included publication of the Notice of Intent to Prepare an EIS (NOI).
- BOEM conducted internal and public scoping to determine the content of this Supplemental EIS.
  - 441 comments were received during the scoping process.
- The National Park Service is a cooperating agency on this Supplemental EIS.

5 CONSULTATION AND COORDINATION

5.0 INTRODUCTION

BOEM is conducting consultation and other activities to comply with the following laws, including but not limited to, the following: the development of consistency determinations (CDs) under the Coastal Zone Management Act (CZMA); consultation under the Endangered Species Act (ESA) for potential impacts to listed species or designated critical habitat; completion of an Essential Fish Habitat assessment pursuant to the Magnuson-Stevens Fishery Conservation and Management Act; and a request for comments and consultation with federally recognized Indian Tribes pursuant to the National Historic Preservation Act and Executive Order 13175. Pursuant to NEPA, BOEM has conducted public involvement activities during scoping for the Draft Supplemental EIS. This chapter describes the processes with which BOEM worked with other Federal and State agencies, Tribal governments, and the public during the development of this Supplemental EIS.

5.1 COASTAL ZONE MANAGEMENT ACT

The Federal agency performs a consistency review pursuant to the CZMA, and CDs are prepared for each coastal State along the Gulf of Mexico with a federally approved Coastal Management Program (CMP) prior to each of the proposed lease sales. To prepare the CDs, BOEM reviews each State's approved Coastal Management Plan and analyzes the potential impacts as outlined in the 2017-2022 GOM Multisale EIS and this Supplemental EIS, new information, and applicable studies as they pertain to the enforceable policies of each CMP. The CZMA requires that Federal actions that have reasonably foreseeable coastal effects (i.e., effects to any coastal use or resource of the coastal zone) be "consistent to the maximum extent practicable" with relevant enforceable policies or guidelines of the State's federally approved coastal management program (15 CFR part 930 subpart C).

Based on these and other analyses, BOEM's Gulf of Mexico OCS Region's Regional Director makes an assessment of consistency, which is then sent to the States of Texas, Louisiana, Mississippi, Alabama, and Florida for proposed regionwide lease sales; to Texas and Louisiana for proposed WPA lease sales; or Louisiana, Mississippi, Alabama, and Florida for proposed CPA and/or EPA lease sales. If the State concurs, BOEM proceeds with the proposed lease sale. A State's concurrence may be presumed when a State does not provide a response within the 60-day review period. A State may request an extension of time to review the CD within the 60-day period, which the Federal agency shall approve for an extension of 15 days or less. If a State objects, it must do the following under the CZMA:

(1) indicate how BOEM's prelease proposal is inconsistent with the State's federally approved CMP and suggest alternative measures to bring BOEM's proposal into consistency with the State's CMP; or

(2) describe the need for additional information that would allow a determination of consistency. In the event of an objection, the Federal and State agencies should use the remaining portion of the 90-day review period to attempt to resolve their differences (15 CFR § 930.43(b)).

At the end of the 90-day review period, the Federal agency shall not proceed with the activity over a State agency's objection unless the Federal agency concludes that, under the "consistent to the maximum extent practicable" standard described in 15 CFR § 930.32, consistency with the enforceable policies of the CMP is prohibited by existing law applicable to the Federal agency and the Federal agency has clearly described, in writing, to the CZMA State agency the legal impediments to full consistency; or, the Federal agency has concluded that its proposed action is fully consistent with the enforceable policies of the CMP, though the State agency objects. Unlike the consistency process for specific OCS plans and permits, there is no procedure for administrative appeal to the Secretary of Commerce for a Federal CD for prelease activities. In the event that there is a serious disagreement between BOEM and a State, either agency may request mediation. Mediation is voluntary, and the Secretary of Commerce would serve as the mediator. Whether there is mediation or not, the final CD is made by DOI, and it is the final administrative action for the prelease consistency process. Each Gulf State's CMP is described in Appendix J of the 2017-2022 GOM Multisale EIS.

5.2 ENDANGERED SPECIES ACT

The Endangered Species Act of 1973 (16 U.S.C. §§ 1531 *et seq.*) establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. BOEM and BSEE are currently in consultation with NMFS and FWS regarding the OCS oil and gas program in the Gulf of Mexico. BOEM is acting as the lead agency in the ongoing consultation, with BSEE's assistance and involvement. The programmatic consultation, which was reinitiated in 2010, was expanded in scope after the reinitiation of consultation by BOEM following the *Deepwater Horizon* explosion and oil spill, and it will include both existing and future OCS oil and gas leases in the Gulf of Mexico over a 10-year period. This consultation also considers any changes in baseline environmental conditions following the *Deepwater Horizon* explosion, oil spill, and response. The programmatic consultation will also include postlease activities associated with OCS oil- and gas-related activities in the Gulf of Mexico, including G&G and decommissioning activities. While the programmatic Biological Opinion is in development, BOEM and NMFS have agreed to interim consultations on postlease approvals.

With consultation ongoing, BOEM and BSEE will continue to comply with all reasonable and prudent measures and the terms and conditions under the existing consultations, along with implementing the current BOEM- and BSEE-required mitigation, monitoring, and reporting requirements. Based on the most recent and best available information at the time, BOEM and BSEE will also continue to closely evaluate and assess risks to listed species and designated critical habitat in upcoming environmental compliance documentation under NEPA and other statutes. Refer to Appendix K of the 2017-2011 GOM Multisale EIS for copies of the consultation letters.

5.3 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

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 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 oil- and gas-related activities authorized by BOEM may result in adverse effects to EFH and therefore require EFH consultation.

BOEM prepared an EFH Assessment white paper that describes the OCS proposed activities, analyzes the effects of the proposed activities on EFH, and identifies proposed mitigating measures (USDOI, BOEM, 2016d). The EFH Assessment was sent to NMFS on June 8, 2016, with a letter requesting formal consultation. This regional programmatic EFH consultation will cover proposed GOM lease sales analyzed in the 2017-2022 Five-Year Program and related activities (i.e., decommissioning and geological and geophysical). The EFH Assessment, the formalized conservation recommendations put forth by NMFS and accepted by BOEM/BSEE or NMFS' concurrence will complete the EFH consultation. However, all agencies will continue to communicate for the duration of the EFH consultation (2017-2022).

5.4 NATIONAL HISTORIC PRESERVATION ACT

In accordance with the National Historic Preservation Act (54 U.S.C. §§ 300101 *et seq.*), Federal agencies are required to consider the effects of their undertakings on historic properties. The implementing regulations for Section 106 of the National Historic Preservation Act, issued by the Advisory Council on Historic Preservation (36 CFR part 800), specify the required review process. In accordance with 36 CFR § 800.8(c), BOEM intends to use the NEPA substitution process and documentation for preparing a prelease EIS and Record of Decision or a postlease environmental assessment and Finding of No Significant Impact to comply with Section 106 of the National Historic Preservation Act in lieu of 36 CFR §§ 800.3-800.6. Because of the extensive geographic area analyzed in this Supplemental EIS and because identification of historic properties will take place after leases are issued, BOEM will complete its Section 106 review process once BOEM has performed the necessary site-specific analysis of postlease activities prior to issuing a permit or approving these activities. Additional consultations with the Advisory Council on Historic Places, State Historic Preservation Offices, federally recognized Indian Tribes, and other consulting parties may take place at that time, if appropriate. Refer to **Chapter 4.13** for more information on this review process and Appendix K of the 2017-2022 GOM Multisale EIS for copies of the State Historic Preservation Offices' concurrence letters.

As an early planning effort, BOEM initiated a request for comment on the NOI for the 2017-2022 GOM Multisale EIS via a formal letter to each of the affected Gulf Coast States on April 3, 2015. A 30-day comment period was provided. The State Historic Preservation Officers for Alabama, Florida, and Louisiana responded via formal letters, all concurring that no historic properties will be affected. The Florida State Historic Preservation Officer further requested to be notified and given the opportunity to comment should any cultural resources be identified off the Florida coast. No additional responses were received.

BOEM also solicited Tribal comment on the *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Draft Proposed Program* via a formal letter on March 4, 2015, and on the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Draft Environmental Impact Statement* via a formal letter on May 19, 2016. Those letters were addressed to each of the Gulf Coast State-affiliated federally recognized Indian Tribes, including the Alabama-Coushatta Tribe of Texas, Caddo Nation of Oklahoma, Chitimacha Tribe of Louisiana, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Jena Band of Choctaw Indians, Miccosukee Tribe of Indians of Florida, Mississippi Band of Choctaw Indians, Poarch Band of Creek Indians, Seminole Tribe of Florida, Seminole Nation of Oklahoma, and Tunica-Biloxi Indian Tribe of Louisiana. The May 2016 letter was also sent to the Muscogee (Creek) Nation. No comments or requests to consult have yet been received; however, BOEM continues to invite Tribal consultation on all of its activities and will be responsive to any Tribal concerns that may arise.

Historic Preservation Fund

In 1977 the Historic Preservation Fund (54 U.S.C. §§ 303101-303103) was established to assist State and Tribal Historic Preservation Officers in their efforts to protect and preserve historic properties as set forth in the requirements of the National Historic Preservation Act. The Historic Preservation Fund is authorized at $150 million per year and is fully funded from OCS oil and gas revenues payable to the United States under Section 9 of the OCSLA (43 U.S.C. § 1338). However, these funds are available for expenditure only when appropriated by Congress, which has never fully appropriated the available funds. Since its inception, approximately $3.3 billion of the Historic Preservation Fund remains unappropriated (National Conference of State Historic Preservation Officers, 2015).

The Historic Preservation Fund's monies may be used directly by State Historic Preservation Officers/Tribal Historic Preservation Officers or passed on as subgrants and contracts to public and private agencies, nonprofit organizations, educational institutions, and individuals. Eligible preservation projects include historic properties' survey and inventory, National Register of Historic Places' nominations, preservation education, architectural planning, historic structure reports, community preservation planning, and brick and mortar repairs to buildings (USDOI, NPS, 2014).

These historic preservation programs can further catalyze community and neighborhood revitalization, job creation, and economic development, primarily through heritage tourism and the rehabilitation of historic properties through the Historic Tax Credit, which is administered by State Historic Preservation Officers. Since the Historic Preservation Fund was implemented in 1977, the Historic Tax Credit program nationwide has rehabilitated nearly 39,000 buildings, created 2.4 million jobs, created 140,000 low- and moderate-income housing units, and leveraged $109 billion in non-Federal investment (National Conference of State Historic Preservation Officers, 2014; USDOI, NPS, 2014). In Fiscal Year 2015, Congress allocated a total of $56.41 million from the Historic Preservation Fund, of which $46.925 million was awarded to State Historic Preservation Officers and $8.985 million was awarded to Tribal Historical Preservation Officers. An additional $500,000 was awarded for projects that will increase diversity in the National Register of Historic Places and the National Historic Landmarks Programs (National Conference of State Historic Preservation Officers, 2015).

5.5 GOVERNMENT-TO-GOVERNMENT TRIBAL CONSULTATION

In accordance with Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," Federal agencies are required to establish regular and meaningful consultation and collaboration with Tribal officials in the development of Federal policies that have Tribal implications to strengthen the United States' government-to-government relationships with Indian Tribes, and to reduce the imposition of unfunded mandates upon Indian Tribes. On March 4, 2015, BOEM sent a formal letter to federally recognized Indian Tribes notifying them of the development of the *2017-2022 Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program* and the *Gulf of Mexico Proposed Geological and Geophysical Activities: Western, Central, and Eastern Planning Areas—Programmatic Environmental Impact Statement*. That letter was addressed to each of the Gulf Coast State-affiliated Indian Tribes, including the Alabama-Coushatta Tribe of Texas, Caddo Nation of Oklahoma, Chitimacha Tribe of Louisiana, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Jena Band of Choctaw Indians, Miccosukee Tribe of Indians of Florida, Mississippi Band of Choctaw Indians, Poarch Band of Creek Indians, Seminole Tribe of Florida, Seminole Nation of Oklahoma, and Tunica-Biloxi Indian Tribe of Louisiana. The letter was intended to be the first step of a long-term and broad consultation effort between BOEM and the Gulf-area Tribes, inclusive of all BOEM activities that may occur under the Draft Proposed Program, as well as ongoing activities. On May 19, 2016, another formal letter was sent announcing and soliciting consultation on the release of the 2017-2022 Proposed Program, Draft Five-Year Program EIS, and Draft 2017-2022 GOM Multisale EIS. That letter was sent to each of the above-listed Tribes, as well as to the Muscogee (Creek) Nation. As of this writing, no formal responses have been received in response to either the March 2015 or May 2016 letters; however, informal discussions with designated Tribal representatives are ongoing to determine if any of the individual Tribes desire continued consultation on these issues.

The Poarch Band of Creek Indians has indicated that they do not have any specific concerns with BOEM's activities on the OCS, but they would like to continue to receive notifications on BOEM's activities (McCullers, official communication, 2015). Additionally, the Jena Band of

Choctaw has indicated a general concern over adverse effects to documented or undocumented prehistoric and historic sites in the CPA and requests to be notified should such effects occur, as well as to continue being notified on BOEM's activities (Shively, official communication, 2015a and 2015b).

BOEM has also analyzed environmental justice issues for minority and low-income populations, which is broadly applicable to federally recognized Indian Tribes. Further information on that analysis can be found in **Chapter 4.14.3.1**.

5.6 NATIONAL ENVIRONMENTAL POLICY ACT

5.6.1 Development of the Proposed Action

This Supplemental EIS addresses a proposed regionwide Federal OCS oil and gas lease sale, as tentatively scheduled in the Five-Year Program. This Supplemental EIS is expected to be used to inform decisions for each of the two proposed lease sales scheduled in 2018 and to be used and supplemented as necessary for decisions for each of the remaining proposed regionwide lease sales scheduled in the Five-Year Program. BOEM 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 Supplemental EIS. Key agencies and organizations included FWS, NOAA, NOAA's National Marine Fisheries Service, National Park Service, U.S. Coast Guard, U.S. Department of Defense, USEPA, State governors' offices, federally recognized Indian Tribes, industry, and nongovernmental organizations.

5.6.1.1 Call for Information and Area ID Memorandum

Pursuant to the Outer Continental Shelf Lands Act of 1953, as amended (OCSLA), BOEM published a Call for Information (Call) to request and gather information to determine the Area Identification (Area ID) for each proposed lease sale. The Call was published in the *Federal Register* (2015) on September 4, 2015. The comment period for the Call closed on October 5, 2015. BOEM received one comment letter in response to the Call from the Louisiana Department of Natural Resources, which is summarized below:

- the Louisiana Office of Coastal Management requests that BOEM consider secondary and cumulative impacts of OCS lease sales on coastal environments;
- BOEM should identify, quantify, and mitigate (e.g., compensatory mitigation) secondary and cumulative harm that occurs to Louisiana's coastal wetlands;
- BOEM should implement plans for validating predictions of social and environmental effects on coastal resources; and
- offshore exploration and development of hydrocarbon resources has been and continues to be of significant value to Louisiana and coastal communities.

Using information provided in response to the Call and from scoping comments received for the 2017-2022 GOM Multisale EIS, BOEM developed an Area ID recommendation memorandum. The Area ID is an administrative prelease step that describes the geographic area for environmental analysis and consideration for leasing. All of this information was used to develop a proposed action and a reasonable range of alternatives for the 2017-2022 GOM Multisale EIS, and subsequently, this Supplemental EIS. On November 20, 2015, the Area ID decision was made. One Area ID was prepared for all proposed lease sales. The Area ID memo recommended keeping the entire regionwide area of the GOM included in the Proposed Final Program for consideration in the 2017-2022 GOM Multisale EIS. The area identified for lease includes all of the available unleased blocks in the GOM not subject to Congressional moratorium pursuant to the Gulf of Mexico Energy Security Act of 2006.

5.6.1.2 Notice of Intent to Prepare a Supplemental EIS

On August 19, 2016, the NOI to prepare a Supplemental EIS for the proposed regionwide lease sales was published in the *Federal Register* (2016c). Additional public notices, including individual consultation invitations to federally recognized Indian Tribes, were distributed via the U.S. Postal Service, local newspapers, and the Internet. A 30-day comment period was provided; it closed on September 19, 2016. Federal, State, and local governments, federally recognized Indian Tribes, nongovernmental organizations, other interested parties, and the public at large were invited to send written comments on the scope of this Supplement EIS. BOEM received 433 comments in response to the NOI. These comments are summarized in **Chapter 5.6.2.2**.

5.6.2 Development of the Draft Supplemental EIS

5.6.2.1 Scoping

Scoping for the Draft Supplemental EIS was conducted in accordance with CEQ regulations for implementing NEPA. Public scoping provides those with an interest in the OCS Program an opportunity to provide comments on the proposed action. Public scoping meetings were held in Mississippi, Alabama, Texas, and Louisiana on the following dates and at the times and locations indicated below:

Tuesday, September 6, 2016
4:00 p.m. until 7:00 p.m. CDT
Courtyard by Marriott
Gulfport Beachfront MS Hotel
1600 East Beach Boulevard
Gulfport, Mississippi 39501
1 registered attendee
0 verbal comments received
1 written comment received

Wednesday September 7, 2016
4:00 p.m. until 7:00 p.m. CDT
Renaissance Mobile Riverview
Plaza Hotel
64 South Water Street
Mobile, Alabama 36602
6 registered attendees
2 verbal comments received
1 written comment received

Tuesday, September 13, 2016
4:00 p.m. until 7:00 p.m. CDT
Houston Marriott North
255 North Sam Houston Pkwy East
Houston, Texas 77060
4 registered attendees
2 verbal comments received
0 written comments received

Thursday, September 15, 2016
4:00 p.m. until 7 p.m. CDT
Wyndham Garden New Orleans Airport
6401 Veterans Memorial Blvd.
Metairie, Louisiana 70003
14 registered attendees
0 verbal comments received
2 written comments received

5.6.2.2 Summary of Scoping Comments

In addition to accepting oral and written comments at each public meeting, BOEM accepted written comments by mail and through the regulations.gov web portal (http://www.regulations.gov). BOEM received 433 comments in response to the NOI and 8 comments from the scoping meetings, totaling 441 comments. Of the comments received, 1 was a mailed letter; 3 were emails; 73 were received through the regulations.gov web portal; and 356 were form letters received in a bulk package. Comments came from Federal and State agencies, interest groups, industry, and the general public on the scope of this Supplemental EIS, significant issues that should be addressed, alternatives that should be considered, and mitigating measures. Each comment was read and categorized according to its source and the nature of the information included. All scoping comments received that were relevant for a lease sale NEPA document were considered in the preparation of the Draft Supplemental EIS. The scope and content of this Supplemental EIS was formulated to ensure that the relevant issues and concerns expressed by stakeholders during the scoping process were fully addressed. Summaries of comments received follow.

Louisiana Department of Natural Resources, Office of Coastal Management

- The Louisiana Office of Coastal Management continues to support the expansion of exploration and development of energy resources throughout the OCS waters and views these efforts as crucial to our Nation's economic and energy security.
- The State of Louisiana expressed that indirect and cumulative impacts to Louisiana's coastal resources are not adequately addressed in previous EISs.
- The State of Louisiana is also concerned that Louisiana's coastal wetlands are disproportionately bearing the impacts from OCS oil- and gas-related activities and requests compensatory mitigation.
- The Louisiana Office of Coastal Management acknowledges the progress that BOEM has continued to make in improving the procedures and techniques used in the environmental review process. However, BOEM must better revisit the predictions made for previous lease sales and compare these predictions with existing environmental conditions and adjust its impact evaluation process accordingly.

Consumer Energy Alliance

- In recent years, the domestic energy revolution has provided a major boost to the American economy and consumer pocketbooks, while fundamentally transforming the global geopolitical landscape to the benefit of U.S. national security. At the same time, thanks to continuing improvements in technology, practices, and oversight, the United States has demonstrated that offshore energy development and environmental stewardship can and do exist.
- The Consumer Energy Alliance understands that, to meet our long-term energy needs, we will need to access all of our resources, including oil and natural gas, nuclear, solar, wind, and beyond. We also understand that oil and natural gas will continue to be a critical and dominant part of that mix for decades to come.
- Industry and regulators alike have taken a number of actions in recent years that have further strengthened the safety of offshore operations in U.S. waters.
- An "all of the above" approach to energy policy is the only sensible solution, and that must include the Gulf of Mexico.
- The Consumer Energy Alliance urges the Department of the Interior to include valuable offshore opportunities in the Gulf of Mexico and to reject any demands to take actions that would in any way delay, restrict, or prohibit proposed Lease Sales 250 and 251.

Louisiana Mid-Continent Oil and Gas Association

- The Louisiana Mid-Continent Oil and Gas Association fully supports a continued robust OCS leasing program in the Gulf of Mexico.
- Louisiana's offshore oil and gas industry has a $44 billion economic impact on the State of Louisiana. Combining the offshore sector with related pipeline and refining activities, the oil and gas industry has $70 billion total annual impact to Louisiana. Federal revenue from offshore energy production in the past 10 years totaled $80 billion in lease sales and royalties – a major source of revenue for our country.
- Louisiana has demonstrated how to balance the development of our Nation's oil and gas resources off its coast and still maintain a robust hunting, fishing, and wildlife industry. In Louisiana, commercial fishing provides one-fourth of the fisheries catch in the lower 48 states, and our wetlands provide habitat for about 1.8 million migratory waterfowl. Wildlife recreation has amounted to a $2.2 billion industry.
- Since 2010, the oil and gas industry has demonstrated its commitment to ensure that people and the environment are protected during all phases of energy exploration, development, and production. A robust collaborative effort among

industry has resulted in the development of new technology and standards for prevention, intervention, and response. Industry has formed the Marine Well Containment Company and has developed cutting-edge technology to minimize the risk of a catastrophic oil spill. They have also formed the Center for Offshore Safety to continuously improve the safety performance of offshore operations.

- As a result of Gulf of Mexico Energy Security Act of 2006, Louisiana, Texas, Mississippi, and Alabama will receive 37.5 percent of royalties received from new oil and gas developments in Federal waters, and in 2017 that will expand to include a portion of all lease sale receipts since December 2006. Beginning in 2017, Louisiana will receive nearly $200 million per year through OCS revenue sharing that is dedicated to the Louisiana coast and projects designed to protect it.

Senator Sharon Hewitt, 2016 Regular Session, Louisiana Senate Resolution No. 116

- The Louisiana oil and gas industry and its workers, suppliers, and the entire business community have expressed their strong support for offshore energy exploration.
- The American economy is truly dependent on and stimulated by the oil and gas production of the Gulf of Mexico.
- The Gulf of Mexico provides nearly 20 percent of the Nation's crude oil supply.
- In Fiscal Year 2014 alone, the Gulf of Mexico energy development supported over 650,000 jobs, contributed over $64 billion in gross domestic product, and provided over $7 billion in revenue to the Federal Government.
- Offshore energy development and production in the Gulf of Mexico is vital to the economic well-being of the Gulf Coast States, coastal communities, and the entire Nation.
- Louisiana has been consistently ranked number two in the Nation in natural gas production, ranked in the top five in oil production, and our refining capability is second only to Texas.
- Our Nation's energy policy is dependent on a thriving oil and natural gas industry in the Gulf of Mexico and requires continued and expanded access to all areas of the Gulf of Mexico to increase and improve the economic well-being of residents, workers, and businesses in the Gulf Coast States' regions.
- Our Nation's energy policy directly affects our trade policy with other countries, our workforce, our economy, and our position as a global super-power to protect our interests at home.

American Petroleum Institute

- The American Petroleum Institute recommends that the Supplemental EIS focus on new information that is readily available and limit the Supplemental EIS to an analysis of this new information and not speculate on future results from ongoing studies.
- BOEM should consider the extensive safety improvements implemented by industry and the new requirements imposed on offshore operations since the *Deepwater Horizon* explosion, oil spill, and response, particularly the formation of many well containment companies and their ability to assist in any potential future incidents.
- This Supplemental EIS should be designed to serve as a document for future environmental reviews.
- Data from the best available peer-reviewed scientific literature, and not speculation, should be used.

Center for Biological Diversity; 350 Louisiana; Bold Louisiana; Earth Action, Inc.; Friends of the Earth; Greenpeace, USA; Gulf Restoration Network; and Louisiana Bucket Brigade

- BOEM's proposal will deepen the climate crisis and reverse course on President Obama's commitment to combat climate change. The proposal also threatens frontline communities and GOM wildlife with more toxic air and water pollution, coastal erosion, extreme weather events, and oil spills. We urge BOEM to halt all new oil and gas leases.
- BOEM's proposal fails to comply with the clear requirements of the OCSLA and NEPA to precisely define areas available for leasing and to conduct an analysis on a finer geographic scale. BOEM must remedy the numerous faults with its Draft Multisale EIS from which this document will tier to; consider new information regarding climate impact of offshore oil and gas; and harmful impacts of offshore fracking in the Gulf. It is entirely improper for BOEM to be moving forward with these 2018 lease sales before the 2017-2022 OCS Oil and Gas Leasing Program ("Program") is finalized. BOEM's proposal implements an inappropriate change to its NEPA procedures that will lead to less environmental analysis. BOEM is abandoning its prior approach of conducting a supplemental NEPA analysis for each lease sale held in the Gulf of Mexico. Such an approach also violates BOEM's duties under OCSLA to comply with NEPA at every stage of the offshore oil and gas authorization process; and ensure offshore development is balanced with environmental safeguards and protection of the human, marine, and coastal environments. BOEM would offer the entire Gulf of Mexico OCS planning area not under moratorium to oil companies. But Section 18(a) expressly requires BOEM to prepare a leasing program that consists "of a schedule of proposed lease sales indicating, as precisely as possible, the size,

timing, and location of leasing activity." Instead of "precisely" defining the location of lease sales, BOEM's proposal takes an areawide approach that designates the entire Gulf of Mexico as the area eligible for lease sales. This areawide lease sale approach is incompatible with the OCSLA. Indeed, under this approach, BOEM is allowing the oil industry to determine which areas are explored and developed, thereby abdicating the agency's responsibility under the OCSLA to direct oil activities and assure that they do not cause environmental harm. The designation lacks the precision required by law and is therefore unlawful.

- BOEM's Supplemental Analysis Must Remedy Numerous Deficiencies and Address New Information. In addition, NEPA regulations recognize that "tiering" from one environmental analysis to another may sometimes be appropriate where a broad environmental analysis has been conducted and the agency wishes to refer back to that assessment at a subsequent stage to avoid repetition. BOEM cannot continue to use tiering to avoid the requisite in-depth analysis required by NEPA.
- Finally, the Supplemental EIS must address new information revealed since the close of the public comment period on the Draft Multisale EIS. This new information includes unprecedented flooding in Louisiana; a report indicating the potential greenhouse gas emissions from offshore oil and gas drilling in the GOM; guidance from the Council on Environmental Quality ("CEQ") on analyzing the lifecycle greenhouse gas emissions from proposed projects; and the scope of offshore fracking being permitted in the Gulf of Mexico.
- BOEM's analysis must consider the final CEQ Guidance on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA issued on August 5, 2016. BOEM's Supplemental EIS must properly account for the downstream and lifecycle greenhouse gas emissions as the result of proposed Lease Sales 250 and 251.
- BOEM must also consider new information revealing the scope of inherently dangerous offshore fracking permitted in the Gulf of Mexico. New information reveals that the Obama administration permitted oil companies to frack offshore wells in the Gulf and Mexico more than 1,200 times between 2010 and 2014 alone. The fracks occurred in at least 630 different wells off the coasts of Texas, Louisiana, Mississippi, and Alabama; and many took place in critical habitat for imperiled loggerhead sea turtles. New information also reveals that at least one of the wells, which was connected to the flow line involved in a nearly 90,000-gallon oil spill in the Gulf of Mexico discovered on May 12, 2016, was fracked.
- Offshore fracking has several significant harmful impacts beyond that of conventional offshore oil and gas development. For example, oil companies are

allowed to dump their wastewater — including fracking chemicals — into the Gulf of Mexico, which may harm the Gulf of Mexico's sensitive wildlife. Many fracking chemicals are known to be toxic to people and marine animals. Forty percent of the chemicals added to fracking fluids have ecological effects, meaning they can harm aquatic and other wildlife. An analysis of the chemicals used during offshore fracking events in California found that many of the chemicals could kill or harm a broad variety of marine organisms, including sea otters, fish, and invertebrates. Indeed, scientists list some of the chemicals frequently used in offshore fracking as among the most toxic in the world with respect to aquatic life. Numerous scientists and reports have also linked fracking to water contamination, air contamination, spills, earthquakes and birth defects. BOEM's Supplemental EIS must properly account for the added harms and risks caused by offshore fracking in the Gulf of Mexico.

Terrebonne Port Commission

- Ending energy exploration in the Gulf of Mexico would start the elimination of billions of dollars in royalties to the Federal and State governments, and eliminate thousands of direct oil field jobs and several thousand spin off jobs. The State of Louisiana's economy would eventually be cut in half. It would force the U.S. to depend on importing more oil and gas, where this county needs energy independence.

Grow the Gulf

- Grow the Gulf supports the proposed action and continued safe energy exploration in the Gulf of Mexico.

Jean Public

- Jean Public opposes the proposed action due to the lack of safety changes since the *Deepwater Horizon* explosion, oil spill, and response.

Public Comments Supporting the Proposed Action

Almost 380 individual comments were received that were in support of the proposed lease sales, 356 of which were form letters. Commenters stated that future leases are vital to the national economy and security, and integral to the State of Louisiana and local economies and jobs. Several noted that oil and gas companies and employees must be good stewards of the environment and continue to provide more emphasis on safety. Several commenters stated that the recent downturn in oil and gas prices is hurting small towns and southern states in general.

Public Comments Supporting Alternative E, the No Action Alternative

Twenty-three individual comments were received that opposed future lease sales. Commenters stated that renewable energy should be pursued instead of oil and gas, fossil fuels should be left in the ground, and new lease sales are not compatible with the Paris Treaty. Issues of concern included the impacts of oil and gas on greenhouse gas emission and global climate change, the impacts of climate change on the GOM's environmental resources, warmer oceans, increased storms and flooding events, and land loss. Several were also concerned about continuing oil and chemical spill risks, continuing effects of past oil and chemical spills, leaking wells and pipelines, and a lack of reasonable alternatives. Environmental resources of concern included protected species (i.e., marine mammals, sea turtles, beach mice, protected birds, and corals), wetlands, fish nurseries, coral reefs, safety of seafood, and environmental justice. There were also comments on environmental justice concerns related to those living nearby petrochemical processing facilities.

5.6.2.3 Additional Public Input Opportunities

Although the scoping process is formally initiated by the publication of the NOI, scoping efforts and other coordination meetings have proceeded and will continue to proceed throughout the NEPA processes for the Five-Year Program. Scoping and coordination opportunities were also available during BOEM's requests for information, comments, input, and review of its other NEPA documents, including the following:

- request for information and comments on the 2017-2022 Five-Year Program,
- scoping and comments on the 2017-2022 Five-Year Program EIS, and
- scoping and comments on the 2017-2022 GOM Multisale EIS.

5.6.2.4 Cooperating Agencies

According to Part 516 of the DOI Departmental Manual, BOEM must invite eligible government entities to participate as cooperating agencies when developing an EIS in accordance with the requirements of NEPA and CEQ regulations. BOEM must also consider any requests by eligible government entities to participate as a cooperating agency with respect to a particular EIS, and must either accept or deny such requests.

The NOI, which was published on August 19, 2016, included an invitation to other Federal agencies and State, Tribal, and local governments to consider becoming cooperating agencies in the preparation of this Supplemental EIS. In a letter dated October 28, 2016, NPS requested cooperating agency status for this Supplemental EIS. On December 29, 2016, a Memorandum of Agreement between BOEM and NPS was initiated, which defines the roles and responsibilities for each agency (**Appendix A**).

5.6.2.5 Distribution of the Draft Supplemental EIS for Review and Comment

BOEM will send copies of the Draft Supplemental EIS to the government, public, and private agencies and groups listed below. Local libraries along the Gulf Coast will be provided copies of this document; a list of these libraries is available on BOEM's website at http://www.boem.gov/nepaprocess/.

Federal Agencies

Congress
- Congressional Budget Office
- House Resources Subcommittee on Energy and Mineral Resources
- Senate Committee on Energy and Natural Resources

Department of Commerce
- National Oceanic and Atmospheric Administration
  - National Marine Fisheries Service

Department of Defense
- Department of the Air Force
- Department of the Army
  - Corps of Engineers
- Department of the Navy
  - Naval Mine and Anti-Submarine Warfare Command

Department of Energy
- Strategic Petroleum Reserve PMD

Department of Homeland Security
- U.S. Coast Guard

Department of State
- Bureau of Oceans and International Environmental and Scientific Affairs

Department of the Interior
- Bureau of Ocean Energy Management
- Bureau of Safety and Environmental Enforcement
- Fish and Wildlife Service
- Geological Survey
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of Transportation
- Pipeline and Hazardous Materials Safety Administration
  - Office of Pipeline Safety

Environmental Protection Agency
- Region 4
- Region 6

Marine Mammal Commission

State and Local Agencies

Alabama
- Governor's Office
- Alabama Highway Department
- Alabama Historical Commission and State Historic Preservation Officer
- Alabama Public Library Service
- Alabama Public Service Commission
- City of Mobile
- City of Montgomery
- Department of Conservation and Natural Resources
- Department of Environmental Management
- Geological Survey of Alabama
- South Alabama Regional Planning Commission
- State Legislature Natural Resources Committee
- Town of Dauphin Island

Florida
- Governor's Office
- Bay County
- Citrus County
- City of Destin
- City of Fort Walton Beach
- City of Gulf Breeze
- City of Panama City
- City of Pensacola
- Department of Agriculture and Consumer Services
- Department of Environmental Protection
- Department of State Archives, History and Records Management
- Escambia County
- Florida Emergency Response Commission
- Florida Fish and Wildlife Conservation Commission
- Franklin County
- Gulf County
- Hernando County

- Hillsborough City-County Planning Commission
- Lee County
- Monroe County
- North Central Florida Regional Planning Council
- Okaloosa County
- Pasco County
- Santa Rosa County
- Sarasota County
- Southwest Florida Regional Planning Council
- State Legislature Agriculture and Natural Resources Committee
- Tampa Bay Regional Planning Council
- Walton County
- West Florida Regional Planning Council
- Withlacoochee Regional Planning Council

Louisiana

- Governor's Office
- Calcasieu Parish
- Cameron Parish
- City of Grand Isle
- City of Lake Charles
- City of Morgan City
- City of New Orleans
- Department of Culture, Recreation, and Tourism
- Department of Economic Development
- Department of Environmental Quality
- Department of Natural Resources
- Department of Transportation and Development
- Department of Wildlife and Fisheries
- Houma-Terrebonne Chamber of Commerce
- Jefferson Parish Director
- Jefferson Parish President
- Lafourche Parish Coastal Zone Management
- Lafourche Parish Water District #1
- Louisiana Geological Survey
- South Lafourche Levee District
- St. Bernard Planning Commission
- State House of Representatives, Natural Resources Committee
- State Legislature, Natural Resources Committee
- State of Louisiana Library
- Terrebonne Parish

Mississippi

- Governor's Office
- City of Bay St. Louis
- City of Gulfport
- City of Pascagoula
- Department of Archives and History
- Department of Environmental Quality
- Department of Marine Resources
- Department of Wildlife, Fisheries, and Parks
- Jackson-George Regional Library System
- Mississippi Development Authority
- State Legislature Oil, Gas, and Other Minerals Committee

Texas

- Governor's Office
- Aransas Pass Public Library
- Attorney General of Texas
- Chambers County Library System
- City of Lake Jackson
- General Land Office
- Southeast Texas Regional Planning Commission
- State Legislature Natural Resources Committee
- State Senate Natural Resources Committee
- Texas Historical Commission
- Texas Legislation Council
- Texas Parks and Wildlife Department
- Texas Sea Grant
- Texas State Library and Archives
- Texas Water Development Board

Federally Recognized Indian Tribes

- Alabama-Coushatta Tribe of Texas
- Caddo Nation of Oklahoma
- Chitimacha Tribe of Louisiana
- Choctaw Nation of Oklahoma
- Coushatta Tribe of Louisiana
- Jena Band of Choctaw Indians
- Miccosukee Tribe of Indians of Florida
- Mississippi Band of Choctaw Indians
- Poarch Band of Creek Indians
- Seminole Tribe of Florida
- Seminole Nation of Oklahoma
- Tunica-Biloxi Indian Tribe of Louisiana

Industry

Adams and Reese, LLP
Alabama Petroleum Council
American Petroleum Institute
Applied Technology Research Corporation
Area Energy LLC
Associated Gas Distributors of Florida
Baker Atlas
Baker Energy
Bepco, Inc.
C.H. Fenstermaker & Associates, Inc.
Century Exploration N.O., Inc.
Chet Morrison Contractors
Chevron U.S.A. Inc.
C-K Associates, LLC
Coastal Conservation Association
Coastal Environments, Inc.
Columbia Gulf Transmission
Continental Shelf Associates, Inc.
De Leon & Associates
Ecological Associates, Inc.
Ecology and Environment
Ecosystem Management, Inc.
Energy Partners, Ltd.
EOG Resources, Inc.
Exxon Mobil Production Company
Florida Natural Gas Association
Florida Petroleum Council
Florida Power and Light
Florida Propane Gas Association
Freeport-McMoRan, Inc.
General Insulation, Inc.
Global Industries, Ltd.
Gulf of Mexico Newsletter
Halliburton Corporation
Han & Associates, Inc.
Horizon Marine, Inc.
Industrial Vehicles International, Inc.
J. Connor Consultants
John Chance Land Surveys, Inc.
L&M Botruc Rental, Inc.
Lampl Herbert Consultants
Larose Intercoastal Lands, Inc.
Linder Oil Company
Louisiana Oil and Gas Association
Magnum Steel Services Corp.
Marine Safety Office
Mid-Continent Oil and Gas Association
Nature's Way Marine, LLC
Newfield Exploration Company
Offshore Process Services, Inc.
Oil and Gas Property Management, Inc.
Phoenix International Holdings, Inc.
Project Consulting Services
R.B. Falcon Drilling
Raintree Resources, Inc.
Science Applications International Corporation
Seneca Resources Corporation
SEOT, Inc.
Shell Exploration & Production Company
Shell Offshore, Inc.
Stone Energy Corporation
Strategic Management Services-USA
T. Baker Smith, Inc.
Texas Geophysical Company, Inc.
The SJI, LLC
The Times-Picayune
The Washington Post
URS Corporation
W & T Offshore, Inc.
Waring & Associates
WEAR-TV

Special Interest Groups

1000 Friends of Florida
Alabama Oil & Gas Board
Alabama Nature Conservancy
Alabama Wildlife Federation
American Cetacean Society
Apalachee Regional Planning Council
Apalachicola Riverkeeper
Audubon Louisiana Nature Center
Audubon of Florida
Barataria-Terrebonne National Estuary Program
Bay County Chamber of Commerce
Bay Defense Alliance
Capital Region Planning Commission
Center for Marine Conservation
Citizens Association of Bonita Beach
Clean Gulf Associates
Coalition to Restore Coastal Louisiana
Coastal Conservation Association
Concerned Shrimpers of America
Conservancy of Southwest Florida
Earthjustice
Florida Chamber of Commerce
Florida Natural Area Inventory
Florida Wildlife Federation
Gulf and South Atlantic Fisheries Foundation, Inc.
Gulf Coast Environmental Defense

Gulf Coast Fisherman's Coalition
Gulf Restoration Network
Houma-Terrebonne Chamber of Commerce
LA 1 Coalition, Inc.
League of Women Voters of the Pensacola Bay Area
Louisiana Wildlife Federation
Manasota-88
Marine Mammal Commission
Mobile Bay National Estuary Program
Natural Resources Defense Council
Nature Conservancy
Offshore Operators Committee
Organized Fishermen of Florida
Panama City Beach Convention and Visitors Bureau
Pensacola Archaeological Society
Perdido Key Association
Perdido Key Chamber of Commerce
Perdido Watershed Alliance
Restore or Retreat
Roffers Ocean Fishing Forecast Service
Save the Manatee Club
Sierra Club
South Central Industrial Association
Surfrider Foundation
The Nature Conservancy
The Ocean Conservancy

Ports/Docks

Alabama
Alabama State Port Authority
Port of Mobile

Florida
Manatee County Port Authority
Panama City Port Authority
Port of Pensacola
Port St. Joe Port Authority
Tampa Port Authority

Louisiana
Abbeville Harbor and Terminal District
Grand Isle Port Commission
Greater Baton Rouge Port Commission
Greater Lafourche Port Commission
Lake Charles Harbor and Terminal District
Plaquemines Port, Harbor and Terminal District
Port of Baton Rouge
Port of Iberia District
Port of New Orleans
Twin Parish Port Commission
St. Bernard Port, Harbor and Terminal District
West Cameron Port Commission

Mississippi
Mississippi State Port Authority

Texas
Brownsville Navigation District—Port of Brownsville
Port Freeport
Port Mansfield/Willacy County Navigation District
Port of Beaumont
Port of Corpus Christi Authority
Port of Galveston
Port of Houston Authority
Port of Isabel—San Benito Navigation District
Port of Port Arthur Navigation District

Educational Institutions/Research Laboratories

Abilene Christian University
Dauphin Island Sea Laboratory
Florida A&M University
Florida Institute of Oceanography
Florida Institute of Technology
Florida Sea Grant College
Florida State University
Foley Elementary School
Gulf Coast Research Laboratory
Gulf Coast State College
Harbor Branch Oceanography
Louisiana Sea Grant College Program
Louisiana State University
Louisiana Tech University
Louisiana Universities Marine Consortium
Loyola University
McNeese State University
Mississippi State University
Mississippi-Alabama Sea Grant Consortium
Mote Marine Laboratory
Nicholls State University
Pensacola Junior College
Tulane University
University of Alabama

University of Florida
University of Louisiana at Lafayette
University of Miami
University of Mississippi
University of New Orleans
University of South Alabama
University of South Florida
University of Southern Mississippi
University of Texas at Arlington
University of Texas at Austin
University of Texas Law School
University of Texas Libraries
University of West Florida

CHAPTER 6

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6 REFERENCES CITED

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CHAPTER 7

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7 PREPARERS

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CHAPTER 8

GLOSSARY

8 GLOSSARY

Acute—Sudden, short term, severe, critical, crucial, intense, but usually of short duration, as opposed to chronic. Effects associated with acute can vary depending on the context of its use (e.g., acute [short-term] exposure could be more or less problematic than chronic [long-term] exposure).

Anaerobic—Capable of growing in the absence of molecular oxygen.

Annular preventer—A component of the pressure control system in the BOP that forms a seal in the annular space around any object in the wellbore or upon itself, enabling well control operations to commence.

Anthropogenic—Coming from human sources, relating to the effect of humankind on nature.

Antipatharian Transitional Zone—The area located between 50 and 90 m (164 and 295 ft), where available light is reduced and there is a gradual ecosystem change from tropical shallow-water corals that are dependent on light to deeper water species, such as antipatharian black corals that are not.

API gravity—A standard adopted by the American Petroleum Institute for expressing the specific weight of oil.

Aromatic—Class of organic compounds containing benzene rings or benzenoid structures.

Attainment area—An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by USEPA.

Barrel (bbl)—A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic—On or in the bottom of the sea.

Biological Opinion—The FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 of the Endangered Species Act.

Block—A geographical area portrayed on official BOEM protraction diagrams or leasing maps that contains approximately 5,760 ac (2,331 ha; 9 mi^2).

Blowout—An uncontrolled flow of fluids below the mudline from appurtenances on a wellhead or from a wellbore.

Blowout preventer (BOP)—One of several valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and drill pipe or in open hole (i.e., hole with no drill pipe) during drilling completion operations. Blowout preventers on jackup or platform rigs are located at the water's surface; on floating offshore rigs, BOPs are located on the seafloor.

Cetacean—Aquatic mammal of the order Cetacea, such as whales, dolphins, and porpoises.

Chemosynthetic—Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthetic).

Coastal waters—Waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands—forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone—The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches, and it extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents (also refer to State coastal zone boundaries).

Completion—Conversion of a development well or an exploration well into a production well.

Condensate—Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensates generally have an API gravity of 50°-120°.

Continental margin—The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf—General term used by geologists to refer to the continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs in the Gulf of Mexico at about the 200-m (656-ft) water depth. The continental shelf is characterized by a gentle slope (about 0.1°). This is different from the juridical term used in Article 76 of the United Nations Convention on the Law of the Sea Royalty Payment (refer to the definition of Outer Continental Shelf).

Continental slope—The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (about 3°-6°).

Critical habitat—Specific areas essential to the conservation of a protected species and that may require special management considerations or protection.

Crude oil—Petroleum in its natural state as it emerges from a well or after it passes through a gas-oil separator, but before refining or distillation. An oily, flammable, bituminous liquid that is essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Delineation well—A well that is drilled for the purpose of determining the size and/or volume of an oil or gas reservoir.

Demersal—Living at or near the bottom of the sea.

Development—Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development and Production Plan (DPP)—A document that must be prepared by the operator and submitted to BOEM for approval before any development and production activities are conducted on a lease or unit in any OCS area other than the western Gulf of Mexico.

Development Operations Coordination Document (DOCD)—A document that must be prepared by the operator and submitted to BOEM for approval before any development or production activities are conducted on a lease in the western Gulf of Mexico.

Development well—A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploration well and from an offset well.

Direct employment—Consists of those workers involved in the primary industries of oil and gas exploration, development, and production operations (Standard Industrial Classification Code 13—Oil and Gas Extraction).

Discharge—Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersant—A suite of chemicals and solvents used to break up an oil slick into small droplets, which increases the surface area of the oil and hastens the processes of weathering and microbial degradation.

Dispersion—A suspension of finely divided particles in a medium.

Drilling mud—A mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up the annulus between the pipe and the walls of the borehole to a surface pit or tank. The mud lubricates and cools the drill bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to downhole pressures; also called drilling fluid.

Economically recoverable resources—An assessment of hydrocarbon potential that takes into account the physical and technological constraints on production and the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Effluent—The liquid waste of sewage and industrial processing.

Effluent limitations—Any restriction established by a State or USEPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Epifaunal—Animals living on the surface of hard substrate.

Essential habitat—Specific areas crucial to the conservation of a species and that may necessitate special considerations.

Estuary—Coastal semienclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication—Enrichment of nutrients in the water column by natural or artificial methods accompanied by an increase of respiration, which may create an oxygen deficiency.

Exclusive Economic Zone (EEZ)—The maritime region extending 200 nmi (230 mi; 370 km) from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration Plan (EP)—A plan that must be prepared by the operator and submitted to BOEM for approval before any exploration or delineation drilling is conducted on a lease.

Exploration well—A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present.

False crawls—Refers to when a female sea turtle crawls up on the beach to nest (perhaps) but does not and returns to the sea without laying eggs.

Field—An accumulation, pool, or group of pools of hydrocarbons in the subsurface. A hydrocarbon field consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.

Floating production, storage, and offloading (FPSO) system—A tank vessel used as a production and storage base; produced oil is stored in the hull and periodically offloaded to a shuttle tanker for transport to shore.

Gathering lines—A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical—Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geophysical survey—A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Habitat—A specific type of environment that is occupied by an organism, a population, or a community.

Hermatypic coral—Reef-building corals that produce hard, calcium carbonate skeletons and that possess symbiotic, unicellular algae within their tissues.

Harassment—An intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, feeding or sheltering.

Hermatypic—Corals in the order Scleractinia that build reefs by depositing hard calcareous material for their skeletons, forming the stony framework of the reef. Corals that do not contribute to coral reef development are referred to as ahermatypic (non-reef-building) species.

Hydrocarbons—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hypoxia—Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take—Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (refer to Taking).

Infrastructure—The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Jack-up rig—A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Kick—A deviation or imbalance, typically sudden or unexpected, between the downward pressure exerted by the drilling fluid and the upward pressure of *in-situ* formation fluids or gases.

Landfall—The site where a marine pipeline comes to shore.

Lease—Authorization that is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and that authorizes exploration for, and development and production of, minerals.

Lease sale—The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term—The initial period for oil and gas leases, usually a period of 5, 8, or 10 years depending on water depth or potentially adverse conditions.

Lessee—A party authorized by a lease, or an approved assignment thereof, to explore for and develop and produce the leased deposits in accordance with regulations at 30 CFR part 250 and 30 CFR part 550.

Littoral zone—Marine ecological realm that experiences the effects of tidal and longshore currents and breaking waves to a depth of 5-10 m (16-33 ft) below the low-tide level, depending on the intensity of storm waves.

Longshore sediment transport—The cumulative movement of beach sediment along the shore (and nearshore) by waves arriving at an angle to the coastline and by currents generated by such waves.

Macondo—Prospect name given by BP to the Mississippi Canyon Block 252 exploration well that the *Deepwater Horizon* rig was drilling when a blowout occurred on April 20, 2010.

***Macondo* spill**—The name given to the oil spill that resulted from the explosion and sinking of the *Deepwater Horizon* rig from the period between April 24, 2010, when search and recovery vessels on site reported oil at the sea surface, and September 19, 2010, when the uncontrolled flow from the *Macondo* well was capped.

Marshes—Persistent, emergent, nonforested wetlands characterized by predominantly cordgrasses, rushes, and cattails.

Military warning area—An area established by the U.S. Department of Defense within which military activities take place.

Minerals—As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Naturally occurring radioactive materials (NORM)—naturally occurring material that emits low levels of radioactivity, originating from processes not associated with the recovery of radioactive material. The radionuclides of concern in NORM are Radium-226, Radium-228, and other isotopes in the radioactive decay chains of uranium and thorium.

Nepheloid—A layer of water near the bottom that contains significant amounts of suspended sediment.

Nonattainment area—An area that is shown by monitoring data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by USEPA.

Nonhazardous oil-field wastes (NOW)—Wastes generated by exploration, development, or production of crude oil or natural gas that are exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (*Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes,* dated June 29, 1988, 53 FR 25446; July 6, 1988). These wastes may contain hazardous substances.

Oceanic zone—Offshore water >200 m (656 ft) deep. It is the region of open sea beyond the edge of the continental shelf and includes 65 percent of the ocean's completely open water.

Offloading—Unloading liquid cargo, crude oil, or refined petroleum products.

Operational discharge—Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator—An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter—Material derived from living plants or animals.

Outer Continental Shelf (OCS)—All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

Passerines—Perching birds (members of the Order Passeriformes) and songbirds.

Potential Biological Removal (PBR)—Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Pelagic—Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Plankton—Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Platform—A steel or concrete structure from which offshore development wells are drilled.

Play—A prospective subsurface area for hydrocarbon accumulation that is characterized by a particular structural style or depositional relationship.

Primary production—Organic material produced by photosynthetic or chemosynthetic organisms.

Produced water—Total water discharged from the oil and gas extraction process; production water or production brine.

Production—Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Province—A spatial entity with common geologic attributes. A province may include a single dominant structural element such as a basin or a fold belt, or a number of contiguous related elements.

Ram—The main component of a blowout preventer designed to shear casing and tools in a wellbore or to seal an empty wellbore. A blind shear ram accomplishes the former and a blind ram the latter.

Recoverable reserves—The portion of the identified hydrocarbon or mineral resource that can be economically extracted under current technological constraints.

Recoverable resource estimate—An assessment of hydrocarbon or mineral resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources can be brought to the surface.

Recreational beaches—Frequently visited, sandy areas along the Gulf of Mexico shorefront that support multiple recreational activities at the land-water interface. Included are National Seashores, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resorts.

Refining—Fractional distillation of petroleum, usually followed by other processing (e.g., cracking).

Relief—The difference in elevation between the high and low points of a surface.

Reserves—Proved oil or gas resources.

Rig—A structure used for drilling an oil or gas well.

Riser insertion tube tool—A "straw" and gasket assembly improvised during the *Macondo* spill response that was designed to siphon oil and gas from the broken riser of the *Deepwater Horizon* rig lying on the sea bottom (an early recovery strategy for the *Macondo* spill in May 2010).

Royalty—A share of the minerals produced from a lease paid in either money or "in-kind" to the landowner by the lessee.

Saltwater intrusion—Saltwater invading a body of freshwater.

Sciaenids—Fishes belonging to the croaker family (Sciaenidae).

Seagrass beds—More or less continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

Sediment—Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon)—Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Sensitive area—An area containing species, populations, communities, or assemblages of living resources, that is susceptible to damage from normal OCS oil- and gas-related activities. Damage includes interference with established ecological relationships.

Shear ram—The component in a BOP that cuts, or shears, through the drill pipe and forms a seal against well pressure. Shear rams are used in floating offshore drilling operations to provide a quick method of moving the rig away from the hole when there is no time to trip the drill stem out of the hole.

Site fidelity or philopatry—The tendency to return to a previously occupied location.

Spill of National Significance—Designation by the USEPA Administrator under 40 CFR § 300.323 for discharges occurring in the inland zone and the Commandant of the U.S. Coast Guard for discharges occurring in the coastal zone, authorizing the appointment of a National Incident Commander for spill-response activity.

State coastal zone boundary—The State coastal zone boundaries for each CZMA-affected State are defined at https://coast.noaa.gov/czm/media/StateCZBoundaries.pdf.

Structure—Any OCS facility that extends from the seafloor to above the waterline; in petroleum geology, any arrangement of rocks that may hold an accumulation of oil or gas.

Subarea—A discrete analysis area.

Subsea isolation device—An emergency disconnection and reconnection assembly for the riser at the seafloor.

Supply vessel—A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Taking—To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered or threatened species, or to attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts). Harassments are the most common form of taking associated with OCS Program activities.

Tension-leg platform (TLP)—A production structure that consists of a buoyant platform tethered to concrete pilings on the seafloor with flexible cable.

Tidal prism—The volume of water in an estuary or inlet between mean high tide and mean low tide, or the volume of water leaving an estuary at ebb tide.

Trunkline—A large-diameter pipeline receiving oil or gas from many smaller tributary gathering lines that serve a large area; common-carrier line; main line.

Turbidity—Reduced water clarity due to the presence of suspended matter.

Volatile organic compound (VOC)—Any organic compound that is emitted to the atmosphere as a vapor.

Water test areas—Areas within the eastern Gulf where U.S. Department of Defense research, development, and testing of military planes, ships, and weaponry take place.

Weathering (of oil)—The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

APPENDIX A

COOPERATING AGENCY
MEMORANDUM OF AGREEMENT

A COOPERATING AGENCY MEMORANDUM OF AGREEMENT

**MEMORANDUM OF AGREEMENT
BETWEEN
THE BUREAU OF OCEAN ENERGY MANAGEMENT
GULF OF MEXICO OCS REGION
AND
THE NATIONAL PARK SERVICE
SOUTHEAST REGION
DURING COMPLETION OF THE
SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE OUTER CONTINENTAL SHELF OIL AND GAS
PROPOSED 2018-2022 GULF OF MEXICO LEASE SALES**

INTRODUCTION

The Bureau of Ocean Energy Management (BOEM) is preparing a Supplemental Environmental Impact Statement (EIS) for Outer Continental Shelf (OCS) oil and gas proposed 2018-2022 Gulf of Mexico (GOM) Lease Sales 250, 251, 252, 253, 254, 256, 257, 259, and 261 (2018-2022 GOM Supplemental EIS). On August 19, 2016, a Notice of Intent to prepare this Supplemental EIS was published in the *Federal Register* for initial scoping and identification of scheduled scoping meetings.

The Council on Environmental Quality's regulations at 40 CFR § 1501.6 emphasize agency cooperation in the National Environmental Policy Act (NEPA) process between Federal agencies either having overlapping jurisdiction or special expertise related to a proposed action. The National Park Service (NPS) requested to be a cooperating agency on this Supplement EIS and BOEM has agreed to accept their request.

This Memorandum of Agreement (MOA) outlines the responsibilities of BOEM and NPS for this Supplemental EIS. Executing this MOA does not affect NPS's independent review and comment responsibilities under NEPA or its responsibilities for any other environmental consultations required by law. This MOA does not affect BOEM's responsibilities under the Outer Continental Shelf Lands Act and regulations under 30 CFR parts 550 or 560, or any other statutory or regulatory authorities.

BOEM RESPONSIBILITIES

(1) BOEM will designate a primary point of contact (POC) for matters related to this MOA. At the present time, Michelle Nannen is the POC for the Gulf of Mexico OCS Region. BOEM will notify NPS if the POC changes during the period of time this MOA is in effect.

(2) BOEM will provide an EIS preparation schedule for all solicited inputs and review periods, including administrative reviews.

(3) BOEM will set up and hold public meetings for the Draft Supplemental EIS.

(4) BOEM will provide NPS a copy of pertinent comments received during preparation of this Supplemental EIS (including scoping and the Draft Supplemental EIS public comment period).

(5) BOEM will publish a copy of this MOA in an appendix to this Supplemental EIS.

(6) BOEM will provide NPS with early versions of relevant Draft Supplemental EIS chapters, as arranged between the BOEM and NPS Points of Contact.

(7) BOEM will provide NPS with a preliminary copy of the Final Supplemental EIS for review prior to final lead agency approval and distribution of the document.

NPS RESPONSIBILITIES

(1) NPS will designate a primary POC to represent NPS in matters related to this MOA. At the present time, the NPS's Point of Contact is Bryan Faehner. The NPS will notify BOEM if the POC changes during the period of time this MOA is in effect.

(2) NPS will provide applicable data, information, and analyses regarding their expertise on potential impacts to the Gulf Islands National Seashore and the experience of park visitors.

(3) NPS will comply with BOEM's Supplemental EIS preparation schedule for all solicited inputs and review periods, including administrative reviews.

(4) NPS shall be responsible for any expenses incurred by NPS related to this MOA.

TERMINATION

This MOA is designed to establish expectations between the two agencies that apply for the duration of the 2018-2022 GOM Supplemental EIS, whereupon it terminates upon publication of the Final Supplemental EIS or upon written notice of termination. This MOA may be terminated by written notice by either of the below signatories or their successor at any time. This MOA terminates with publication of the Final 2018-2022 GOM Supplemental EIS.

LIMITATIONS

All commitments made in this MOA are subject to the availability of appropriated funds and each agency's budget priorities. Nothing in this MOA obligates BOEM or NPS to expend appropriations or to enter into any contract, assistance agreement, or interagency agreement, or to incur other financial obligations. This MOA is neither a fiscal nor a funds obligation document. Any endeavor involving reimbursement or contribution of funds between the parties of this MOA will be handled in accordance with applicable laws, regulations, and procedures, and will be subject to separate subsidiary agreements that will be effected in writing by representatives of both parties. This MOA does not create any right or benefit enforceable against BOEM or NPS, their officers or employees, or any other person. This MOA does not apply to any person outside BOEM and NPS.

RESOLUTION OF DISPUTES

The parties agree to make every attempt to settle any disputes regarding this MOA at the lowest operational level. In the case of a substantial disagreement between BOEM and NPS, each agency will designate a senior management official at the regional level to seek resolution. If these officials do not resolve the dispute within 30 days, the agencies will further elevate the matter to the Director of BOEM and the Director of NPS for prompt resolution.

NOTICES

Except as otherwise provided herein, all notices relating to this MOA must be provided to the following:

To BOEM: Michelle Nannen
1201 Elmwood Park Blvd.
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michelle.nannen@boem.gov
504-731-6682

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11th Floor, Room 48
Washington, DC 20005
bryan_faehner@nps.gov
202-513-7256

PREDECISIONAL MATERIALS

The undersigned hereby agree to maintain the confidentiality of pre-decisional information and documents shared in furtherance of this MOA during completion of this Supplemental EIS. This agreement to maintain confidentiality of information and documents applies to all pre-decisional documents and communications, including, but not limited to, the following: email messages; notes to the file; agendas, pre-meeting materials, presentations, meeting notes, and summaries; letters; review evaluations; drafts of documents; and all documents created and shared as part of the collaboration established in this MOA. Any information that is required to be released to the public due to Agency legal obligations should not contain confidential or privileged information, including deliberative process privilege materials related to preparation of the Draft and Final Supplemental EISs. Upon receipt of a Freedom of Information Act request requesting information related to the activities carried out under this MOA, each agency will coordinate with or refer the request to the agency who generated the information prior to releasing the information to the requester.

* * *

This MOA may be executed in counterparts, each of which will be deemed to be an original. The signatures on this MOA may be executed on separate pages and all of which together will constitute one and the same agreement.

Michael A. Celata
Regional Director
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

12/29/16
Date

Stan Austin
Regional Director
National Park Service
Southeast Region

12/28/16
Date

APPENDIX B

AIR QUALITY:
WRF MODEL PERFORMANCE

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ABBREVIATIONS AND ACRONYMS

ARW	Advanced Research WRF
BOEM	Bureau of Ocean Energy Management
CAI	Climatologically Aided Interpolation
CAAA	Clean Air Act Amendments
CAMx	Comprehensive Air Quality Model with Extensions
CFL	Courant-Friedrichs-Lewy
CFSR	Climate Forecast System Reanalysis
CFSv2	Climate Forecast System Version 2
CMAQ	Community Multi-scale Air Quality model
ECMWF	European Center for Medium-Range Weather Forecasting
EIS	Environmental Impact Statement
ERA	European Center for Medium-Range Weather Forecasting Re-Analysis
ERG	Eastern Research Group, Inc.
ESRL	Earth System Research Laboratory
FDDA	Four-Dimensional Data Assimilation
FNMOC	Fleet Numerical Meteorology and Oceanography Center
IC/BC	Initial Conditions/Boundary Conditions
IOA	Index of Agreement
ISHO	Integrated Surface Hourly Observation
KBRO	Meteorological Call Sign for Brownsville
KSIL	Meteorological Call Sign for Slidell
KTPA	Meteorological Call Sign for Tampa
KEYW	Meteorological Call Sign for Key West
LCC	Lambert Conformal Conic
LSM	Land-Surface Model
MADIS	Meteorological Assimilation Data Ingest System
METSTAT	Meteorological Statistical Program
MM5	Mesoscale Meteorological Model version 5
MMIF	Mesoscale Model Interface Program
MPE	Model Performance Evaluation
NAAQS	National Ambient Air Quality Standards
NAM	North American Model
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NMM	Nonhydrostatic Mesoscale Model

NOAA	National Oceanographic Atmospheric Administration
NWS	National Weather Service
OCS	Outer Continental Shelf
OCSLA	OCS Lands Act
PBL	Planetary Boundary Layer
PGM	Photochemical Grid Model
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RMSE	Root Mean Square Error
RRTMG	Rapid Radiative Transfer Model for GCMs
SCAS-OSU	Spatial Climate Analysis Service at Oregon State University
SST	Sea-Surface Temperature
TRMM	Tropical Rainfall Measurement Mission
USEPA	United States Environmental Protection Agency
USDOC	United States Department of Commerce
USGS	United States Geological Survey
UTC	Universal Time Coordinate
WPS	WRF Pre-processing System
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecasting model

B AIR QUALITY: WRF MODEL PERFORMANCE

B.1 INTRODUCTION

The U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) is required under the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. § 1334(a)(8)) to comply with the National Ambient Air Quality Standards (NAAQS) to the extent that Outer Continental Shelf (OCS) offshore oil and gas exploration, development, and production sources do not significantly affect the air quality of any state. The Gulf of Mexico OCS Region's area of possible influence includes the States of Texas, Louisiana, Mississippi, Alabama, and Florida. BOEM's Gulf of Mexico Region manages the responsible development of oil, gas, and mineral resources for the 430 million acres in the Western, Central, and Eastern Planning Areas on the OCS, including the areas under moratoria (shown in **Figure B-1**). The Clean Air Act Amendments (CAAA) of 1990 designate air quality authorities, giving BOEM air quality jurisdiction westward of 87°30'W. longitude and the U.S. Environmental Protection Agency (USEPA) air quality jurisdiction eastward of 87°30'W. longitude. In 2006, oil and gas leasing operations within 125 miles (201 kilometers [km]) of the Florida coastline were banned until 2022 under the Gulf of Mexico Energy Security Act (GOMESA). The GOMESA moratoria area is depicted on **Figure B-1**.

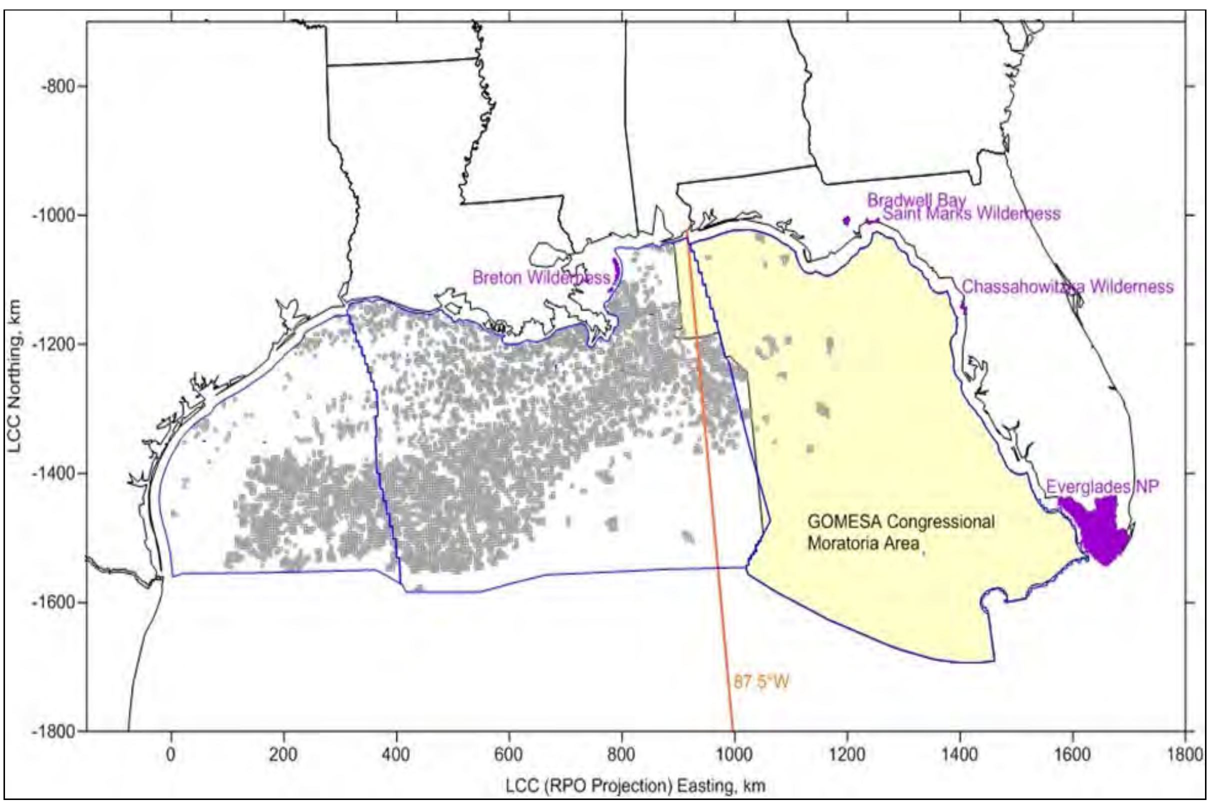


Figure B-1. Location of the "Air Quality Modeling in the Gulf of Mexico Region" Study with Class I Areas (purple) and Platform Locations (gray dots).

The USEPA has set NAAQS for six regulated air quality pollutants: ozone; particulate matter with an aerodynamic diameter of 2.5 micrometers and smaller ($PM_{2.5}$); particulate matter with an aerodynamic diameter of 10 micrometers and smaller (PM_{10}); sulfur dioxide (SO_2); nitrogen dioxide (NO_2); carbon monoxide (CO); and lead (Pb). After promulgation of a NAAQS, the USEPA designates areas that fail to achieve the NAAQS as nonattainment areas (NAAs) and States are required to submit State Implementation Plans (SIPs) to the USEPA that contain emission control plans and a demonstration that the NAA will achieve the NAAQS by the required date. After an area comes into attainment of the NAAQS, the area can be redesignated as a maintenance area and must continue to demonstrate compliance with the NAAQS.

In 1997, the USEPA promulgated the first 8-hour ozone NAAQS with a threshold of 0.08 parts per million (ppm) (84 parts per billion [ppb]). On March 12, 2008, the USEPA promulgated a more stringent 0.075 ppm (75 ppb) 8-hour ozone NAAQS. **Figure B-2** presents the current ozone nonattainment areas in the southeastern U.S. On October 1, 2015, the USEPA strengthened the 8-hour NAAQS for ozone to 0.07 ppm (70 ppb). Under this more stringent ozone NAAQS, there may be more areas in the southeastern U.S. that will be in nonattainment. The USEPA plans to make attainment and nonattainment designations for the revised standards by October 2017, with the designations based on 2014-2016 air quality data.

On December 14, 2012, the USEPA revised the $PM_{2.5}$ primary NAAQS by lowering the annual $PM_{2.5}$ NAAQS threshold from 15.0 micrograms per cubic meter ($\mu g/m^3$) to 12.0 $\mu g/m^3$. The USEPA retained the 24-hour $PM_{2.5}$ primary NAAQS at 35 $\mu g/m^3$. The 24-hour coarse PM NAAQS (PM_{10}) was also retained at 150 $\mu g/m^3$.

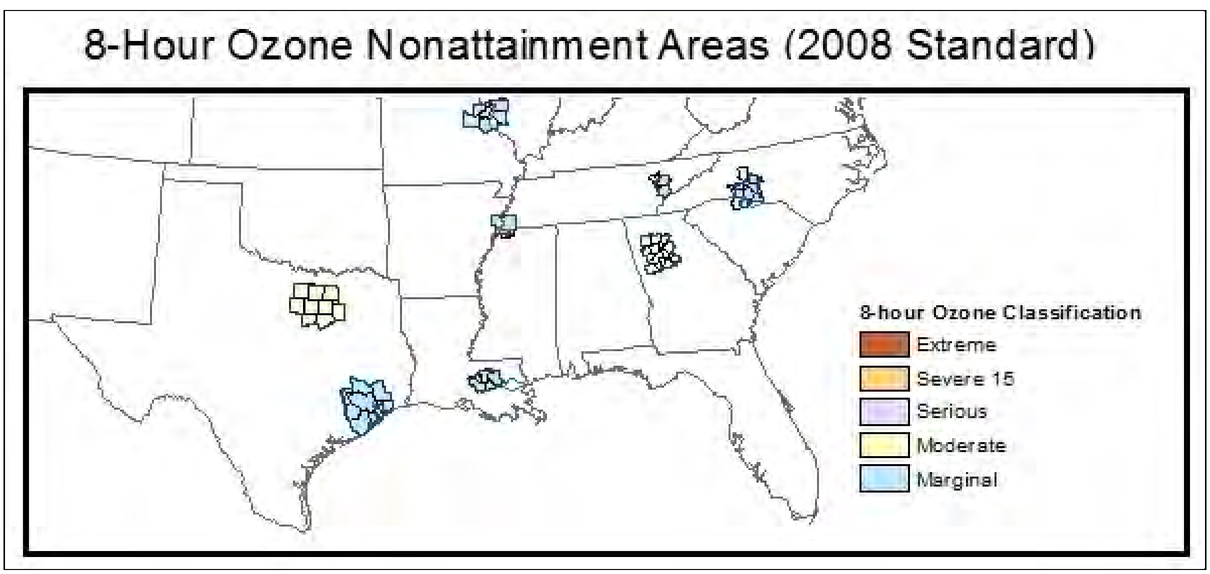


Figure B-2. Ozone Nonattainment Areas in the Southeastern U.S. (USEPA, 2016a).

In February 2010, the USEPA issued a new 1-hour NO_2 NAAQS with a threshold of 100 ppb (98^{th} percentile daily maximum average over three-years) and a new 1-hour SO_2 NAAQS was promulgated in June 2010 with a threshold of 75 ppb (99^{th} percentile averaged over 3 years). The USEPA has not yet designated the nonattainment areas for the 1-hour NO_2 and 1 hour SO_2 NAAQS.

A new lead NAAQS was issued in 2008; NAAs for lead are associated with specific industrial sources. As oil and gas sources in the Gulf of Mexico OCS region produce negligible amounts of lead emissions and to be consistent with onshore oil and gas analysis, which does not include lead, lead was not included in the air quality analysis. The NAAQS for carbon monoxide has remained essentially unchanged since it was originally promulgated in 1971. As of September 27, 2010, all NAAs for carbon monoxide have been redesignated as maintenance areas. **Table B-1** summarizes the nonattainment and maintenance areas in the southeastern U.S.

Table B-1. Nonattainment and Maintenance Areas in the Southeastern U.S.

State	Area	8-hr O_3 (1997)	8-hr O_3 (2008)	SO_2 (2010)	Lead (2008)
Alabama	Troy, AL				NAA[a]
Florida	Tampa, FL				NAA
	Hillsborough County, FL			NAA	
	Nassau County, FL			NAA	
Louisiana	Baton Rouge, LA	M[b]	NAA		
	St. Bernard Parish, LA			NAA	
Texas	Beaumont-Port Arthur, TX	M			
	Houston-Galveston-Brazoria, TX	NAA	NAA		
	Frisco, TX				NAA

[a] NAA = nonattainment area
[b] M = maintenance area
Blank cells indicate the area is in attainment of the NAAQS.

The CAAA designated 156 Class I areas consisting of National Parks and Wilderness Areas that are offered special protection for air quality and air quality-related values (AQRVs). The Class I areas, compared to Class II areas, have lower Prevention of Significant Deterioration (PSD) air quality increments that new sources may not exceed and are protected against excessive increases in several AQRVs, including visibility impairment, acid (sulfur and nitrogen) deposition, and nitrogen eutrophication. The Regional Haze Rule (RHR) has a goal of natural visibility conditions by 2064 at Class I areas, and States must submit RHR SIPs that demonstrate progress towards that goal. **Figure B-1** displays the locations of the mandatory Class I areas (in purple) in the Gulf of Mexico OCS region. In addition to the Class I areas, Federal Land Management (FLM) agencies have designated certain other areas as sensitive Class II areas for tracking PSD increment consumption and AQRV impacts.

On August 26, 2014, BOEM contracted with Eastern Research Group, Inc. (ERG) and team members Ramboll Environ US Corporation (Ramboll Environ) and Alpine Geophysics, LLC to complete a comprehensive air quality modeling study in the Gulf of Mexico OCS region. Under BOEM Contract Number M14PC00007, air quality photochemical grid modeling (PGM) will be conducted in the region to assess the impacts to nearby States of OCS oil and gas exploration, development, and production as required under OCSLA. This assessment is used by BOEM in the cumulative and visibility impacts analyses of the National Environmental Policy Act (NEPA) environmental impact statements (EIS), which are the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS) and this Supplemental EIS. These analyses address both current and proposed NAAQS.

Air quality modeling requires several input datasets, including meteorology, emissions inventories, and ambient pollutant concentrations. **Figure B-3** presents an overview of how these project datasets fit together for the "Air Quality Modeling in the Gulf of Mexico Region" study.

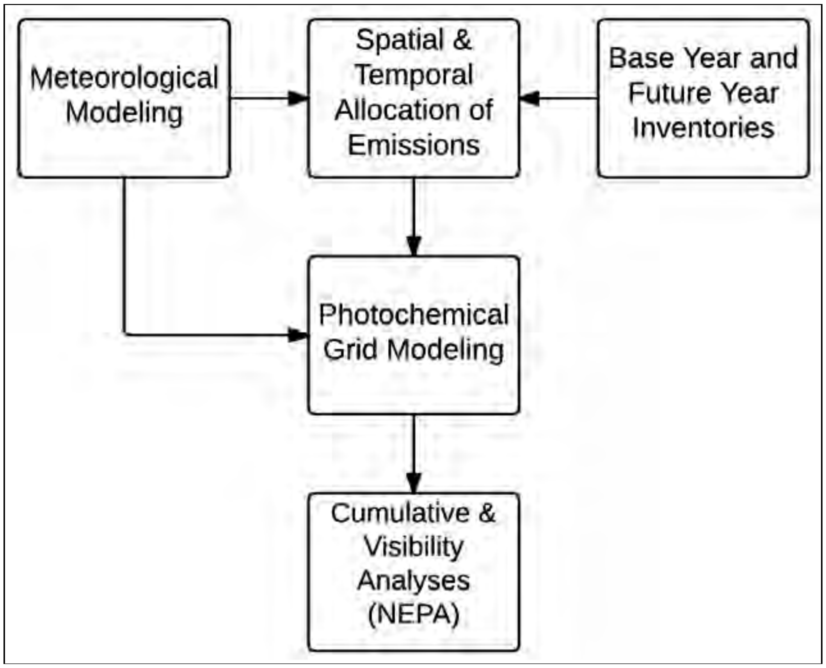


Figure B-3. Overview of the "Air Quality Modeling in the Gulf of Mexico Region" Study Tasks.

This report details the meteorological modeling performance evaluation (MPE) of a Weather and Research Forecast (WRF) model for 2012, the PGM year. A separate report (referred to herein as the "full WRF modeling report") will provide a more comprehensive evaluation of the full 5-year WRF dataset.

Meteorological information is needed for air quality modeling. Parameters such as wind speed, wind direction, air temperature, and humidity are required by models to determine the rate that pollutants disperse and react in the atmosphere. Sources of meteorological information include datasets of measurements gathered at various locations within the Gulf of Mexico OCS Region's domain. However, the spatial coverage of measurements is insufficient to describe the three-dimensional structure of the atmosphere away from measurement locations. Using measurement data as inputs, gridded meteorological models capable of simulating the fluid dynamics of the atmospheric data can be used to estimate meteorological conditions over a complete modeling domain—including regions far from measurement sites—in a physically consistent fashion. The results of these models are often used to establish conditions near remote pollutant sources or remote locations downwind of pollutant sources. Within the domain of the Gulf of Mexico OCS Region, the WRF meteorological model has been identified and was used to provide meteorological inputs for the air quality models.

Ramboll Environ previously evaluated the existing meteorological datasets and concluded that enough deficiencies were present in the datasets and there were not enough positive attributes to select any of them for air quality modeling in the study area (Brashers et al., official communication, 2014) and, therefore, new meteorological modeling was required. One purpose of the modeling is to provide the meteorological dataset for the 2012 simulation using PGM modeling in the OCS region.

B.2 WRF MODELING METHODOLOGY

Over the past decade, emergent requirements for numerical simulation of urban and regional scale air quality have led to intensified efforts to construct high-resolution emissions, meteorological and air quality datasets. It is now possible, for example, to exercise sophisticated mesoscale prognostic meteorological models and Eulerian and Lagrangian photochemical/aerosol models for multi-seasonal periods over near-continental scale domains in a matter of weeks with the application tailored to a specific air quality modeling project.

The WRF model is the current preferred model for atmospheric research and operational forecasting needs at mesoscale resolution (approximately 5 to several hundred km). The model is the state-of-the-art atmospheric simulation system, commonly used to drive air quality dispersion models on the regional level.

The operational version of the model is the Nonhydrostatic Mesoscale Model (NMM) WRF core version 3, developed and maintained by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and the National Centers for Environmental Prediction (NCEP). The Advanced Research WRF (ARW) core, currently version WRF 3.7.1, is supported by the National Center for Atmospheric Research (NCAR), Mesoscale and Microscale Meteorology Division (NCAR, 2015). The modeling described in this report used WRF version 3.7.

The WRF model contains separate modules to compute different physical processes such as surface energy budgets and soil interactions, turbulence, cloud microphysics, and atmospheric radiation. Within WRF, the user has many options for selecting the different schemes for each type of physical process. There is a WRF Pre-processing System (WPS) that generates the initial and boundary conditions used by WRF, based on topographic datasets, land use information, and larger-scale atmospheric and oceanic models.

B.2.1 Gulf of Mexico Region Air Quality Meteorological Modeling

The USEPA CONUS WRF and Ramboll Environ Training WRF datasets were previously examined in detail and evaluated using both quantitative and qualitative techniques. Both datasets were identified as being inadequate for the study area, particularly in the offshore portions (Brashers et al., official communication, 2014). The development of a new high-resolution dataset was necessary to more accurately represent meteorological conditions in the over-water portions of the OCS region for use in air quality modeling.

B.2.2 Model Domain Configuration

The WRF domain configuration is comprised of a system of simultaneous nested grids. **Figure B-3** shows the WRF modeling grids at 36/12/4 km. All WRF grids are defined on a Lambert Conformal Conic (LCC) projection centered at 40°N. latitude, 97°W. longitude with true latitudes at 33°N. and 45°N. (the “standard RPO” projection). The outermost domain (outer box) with 36-km resolution includes the entire continental U.S. and parts of Canada and Mexico, and captures synoptic-scale (storm system-scale) structures in the atmosphere. The inner 12-km regional grid (d02) covers the southeastern U.S. and was used to ensure that large-scale meteorological patterns across the region are adequately represented and to provide boundary conditions to the 4-km domain.

The 4-km domain (d03) shown in **Figure B-4** is centered on the coastal areas of the southeastern U.S. and over-water portions of the Gulf of Mexico. **Table B-2** provides the input configurations for this WRF domain. The NX and NY are the number of east-west and north-south staggered grid points, respectively, in each domain. I-start and J-start indicate the western and southern nested grid starting indices with respect to the parent grid. Geographic resolution relates to the geographic datasets employed for each grid in terms of minutes or seconds of degrees.

The 36-, 12-, and 4-km grids were run simultaneously with one-way nesting, meaning that meteorological information flows down-scale via boundary conditions introduced from the coarser to finer grids without feedback from the finer to coarser grids. The WRF modeling domain was defined to be slightly larger than the CAMx/CMAQ PGM modeling domains to eliminate boundary artifacts in the meteorological fields. Such boundary artifacts occur for both numerical reason (the 3:1 grid spacing ratio) and because the imposed boundary conditions require some time/space to come into dynamic balance with WRF’s atmospheric equations.

Table B-2. BOEM’s Gulf of Mexico OCS Region WRF Domain Configuration.

Grid Resolution	NX	NY	I-start	J-start	Geographic Resolution	Coverage
36 km	165	129	1	1	10 minute	CONUS
12 km	265	187	55	9	2 minute	SE CONUS
4 km	481	211	72	27	30 second	OCS Region

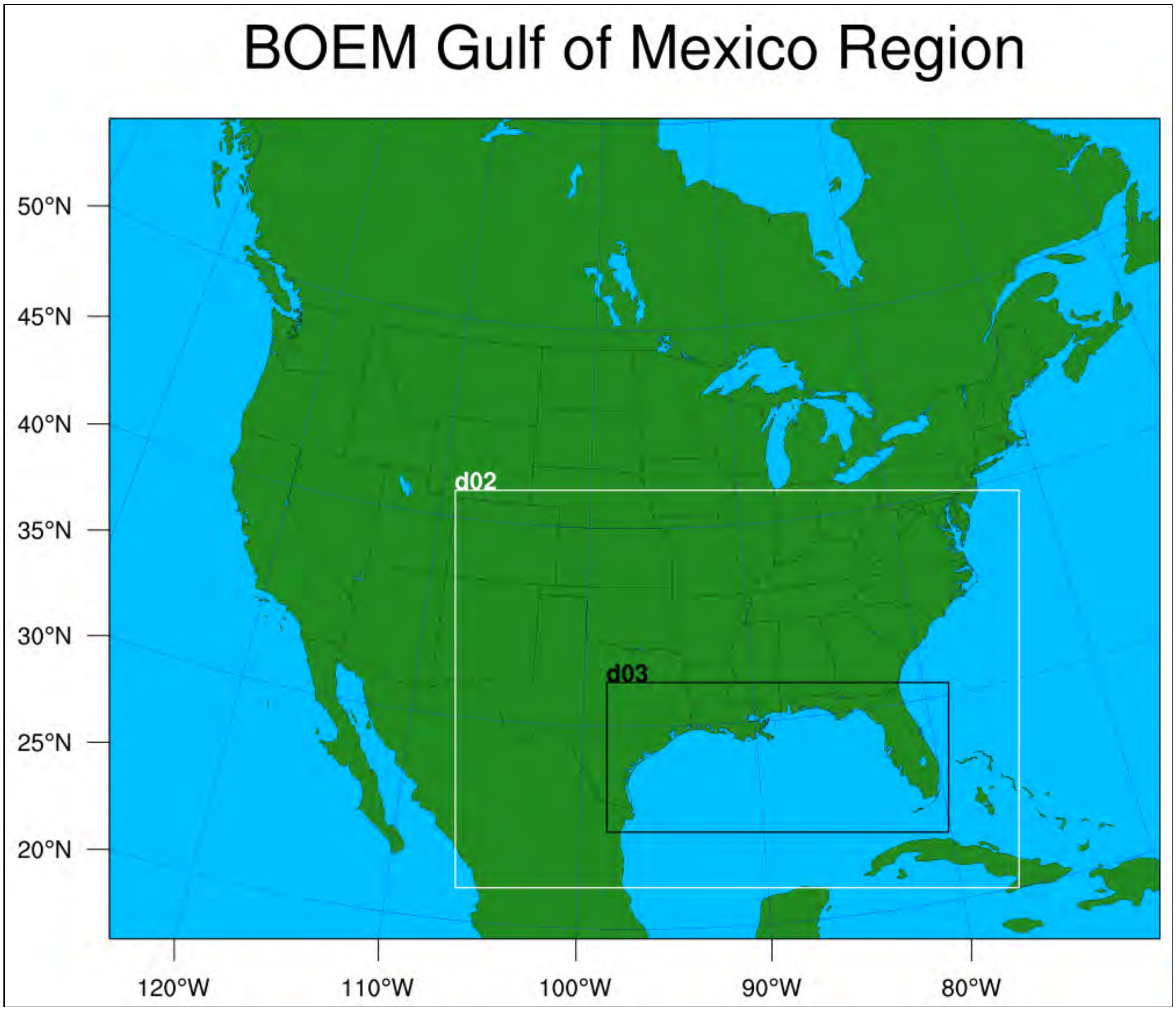


Figure B-4. WRF 36-km CONUS (d01), 12-km SE Regional (d02), and 4-km Gulf of Mexico Region (d03) Domains.

B.2.3 Model Application

The publicly available version of WRF, version 3.7, was used in the Gulf of Mexico OCS Region's meteorological modeling. The WRF pre-processor programs, including GEOGRID, UNGRIB, METGRID, and OBSGRID, were used to develop model inputs.

B.2.3.1 Model Vertical Resolution

The dataset was tested using both 33 and 37 vertical layers. Thirty-seven vertical layers allowed for higher vertical resolutions near the surface, which enabled the model to more accurately capture low-level inversions frequently present during winter. Additional layers in the mid-levels also allowed the model to more accurately re-create the convective updraft velocities seen in the summer months. The dataset model levels are shown in **Table B-3**.

Table B-3. BOEM Gulf of Mexico OCS Region WRF Dataset Model Levels.

Level	eta	Pressure (mb)	Height (m)	Mid Height (m)	Thickness (m)
0	1	1,000	0.0		
1	0.9985	999	12.2	6.1	12.2
2	0.9970	997	24.5	18.4	12.2
3	0.9950	995	40.8	32.7	16.4
4	0.9930	993	57.2	49.0	16.4
5	0.9910	991	73.6	65.4	16.4
6	0.9880	989	98.3	85.9	24.7
7	0.9850	986	123.0	110.6	24.7
8	0.9800	981	164.3	143.6	41.3
9	0.9700	972	247.4	205.9	83.1
10	0.9600	962	331.2	289.3	83.8
11	0.9500	953	415.7	373.4	84.5
12	0.9400	943	500.8	458.2	85.1
13	0.9300	934	586.6	543.7	85.8
14	0.9100	915	760.5	673.5	173.8
15	0.8900	896	937.2	848.8	176.8
16	0.8700	877	1,117.1	1,027.1	179.8
17	0.8400	848	1,392.8	1,254.9	275.8
18	0.8000	810	1,772.4	1,582.6	379.6
19	0.7600	772	2,166.7	1,969.6	394.3
20	0.7200	734	2,577.0	2,371.9	410.3
21	0.6800	696	3,005.0	2,791.0	427.9
22	0.6400	658	3,452.2	3,228.6	447.3
23	0.6000	620	3,921.0	3,686.6	468.7
24	0.5500	573	4,540.7	4,230.8	619.8
25	0.5000	525	5,203.7	4,872.2	662.9
26	0.4500	478	5,917.1	5,560.4	713.4
27	0.4000	430	6,690.5	6,303.8	773.4
28	0.3500	383	7,536.4	7,113.5	846.0
29	0.3000	335	8,472.3	8,004.4	935.8
30	0.2500	288	9,522.5	8,997.4	1,050.2
31	0.2000	240	10,724.1	10,123.3	1,201.6
32	0.1500	193	12,136.7	11,430.4	1,412.6
33	0.1000	145	13,866.9	13,001.8	1,730.1
34	0.0600	107	15,621.6	14,744.2	1,754.7
35	0.0270	76	17,503.4	16,562.5	1,881.8
36	0.0000	50	19,594.2	18,548.8	2,090.8

B.2.3.2 Topographic Inputs

Topographic information for WRF was developed using the standard WRF terrain databases available from NCAR. The 36-km CONUS domain was based on the 10-min (18-km) global data. The 12-km southeastern CONUS domain was based on the 2 min (~4-km) data. The 4-km Gulf of Mexico OCS region domain was based on the 30-sec (~900-m) data.

B.2.3.3 Vegetation Type and Land Use Inputs

Vegetation type and land-use information was developed using the U.S. Department of the Interior, Geological Survey (USGS) land-use database from the most recently released WRF databases provided with the WRF distribution. The number of land categories in input data was the USGS default of 24. Standard WRF surface characteristics corresponding to each land-use category were employed.

B.2.3.4 Atmospheric Data Inputs

The WRF relies on some other model or re-analysis output to provide initial and boundary conditions (IC/BC). Sensitivity tests were performed on several datasets to evaluate their effectiveness over the Gulf of Mexico. The datasets tested include the ERA-Interim reanalysis product, available from the European Center for Medium-range Weather Forecasting (ECMWF) Data Portal website; the Climate Forecast System Reanalysis (CFSR, ended in 2010), and the Climate Forecast System model version 2 (CFSv2, after 2010) (Saha et al., 2014); and the 12-km North American Model (NAM) archives available from the National Climatic Data Center (NCDC) NOMADS server.

The NAM dataset was chosen for the lowest bias and error in model performance and was used as first guess fields for WRF. This dataset was objectively re-analyzed using traditional observation site data (meteorological towers) to the higher resolution of each WRF grid, using the OBSGRID program. These fields are then used both to initialize the model and to conduct analysis nudging to guide the model to best match the observations.

B.2.3.5 Time Integration

Adaptive time stepping was used to maximize the time step that the model can use while keeping the model numerically stable. The model time step was adjusted based on the domain-wide horizontal and vertical stability Courant-Friedrichs-Lewy (CFL) target value of 0.8.

B.2.3.6 Diffusion Options

Horizontal Smagorinsky first-order closure (km_opt = 4) with sixth-order numerical diffusion and suppressed up-gradient diffusion (diff_6th_opt = 2) was used.

B.2.3.7 Lateral Boundary Conditions

Lateral boundary conditions were specified from the initialization dataset on the 36-km domain with continuous updates nested from the 36-km domain to the 12-km domain and from the 12-km domain to the 4-km domain, using one-way nesting (feedback = 0).

B.2.3.8 Top and Bottom Boundary Conditions

The top boundary condition was selected as an implicit Rayleigh dampening for the vertical velocity. Consistent with the model application for non-idealized cases, the bottom boundary condition was selected as physical, not free-slip.

B.2.3.9 Sea-Surface Temperature Inputs

High-resolution, sea-surface temperature (SST) inputs aid in improving meteorological conditions for the over-water portions of the Gulf of Mexico OCS region. The Fleet Numerical Meteorology and Oceanography Center (FNMOC) dataset, available from the Global Ocean Data Assimilation Experiment (GODAE) archives, was selected after extensive testing of several SST databases. The FNMOC high-resolution database is updated every 6 hours using satellite-derived (AVHRR) SST and in-situ SST from ships and buoys with resolutions, ranging from 12 km at the equator to 9 km at the mid-latitudes. The FNMOC SST database was chosen for the lowest SST bias and error in model performance evaluation tests, which used open water observations from the National Data Buoy Center (NDBC) archives.

B.2.3.10 FDDA Data Assimilation

The WRF was created as a forecast tool, but it can also be applied in “hindcast” mode. In forecast mode, the initial conditions for a run might be the most recent analysis (a gridded version of the current state of the atmosphere). In hindcast mode, we know the state of the atmosphere both at the beginning and end of (and during) the WRF run. Using these 6-hourly analyses, an extra error term is introduced into the WRF equations, nudging the WRF atmosphere toward the real atmosphere. This is known as Four Dimensional Data Assimilation (FDDA) or analysis nudging and is applied to every grid cell in the domain. It works best at larger grid spacing scales and for larger domains.

Observational nudging is the process of nudging just the single grid cell toward a single-point observation. The observation could be taken at a traditional meteorological tower or by a weather balloon or other non-traditional sources. Observation nudging works best at finer grid spacing scales and could have been performed on higher resolution domains using the Meteorological Assimilation Data Ingest System (MADIS) observation archive.

The WRF model was run with analysis nudging and no observation nudging. For winds and temperature, analysis nudging coefficients of $5x10^{-4}$ and $3.0x10^{-4}$ were used on the 36- and 12-km domains, respectively. For mixing ratio, an analysis nudging coefficient of $1.0x10^{-5}$ was used for both the 36- and 12-km domains. Analysis nudging of winds was applied both at near the surface and aloft, but nudging for temperature and mixing ratio was not performed in the lower atmosphere (i.e., within the boundary layer).

Significant sensitivity testing was used to evaluate impacts of observational nudging on the 4-km domain. The observational nudging coefficients for winds were tested at values set from 0 to

$1.2x10^{-3}$ with a radius of influence at 50 km. Ramboll Environ concluded that any observational nudging coefficient for winds above zero caused excessive convection in the offshore portions of the Gulf of Mexico, resulting in an extreme overstatement of precipitation. Additionally, humidity nudging was tested at values ranging from 0 to $1.0x10^{-5}$. The lower nudging values also prevented excess moisture in the model, primarily through the summer months. Setting wind, temperature, and moisture coefficients all to zero produced the most accurate precipitation results and are very similar to the nudging used in the USEPA 2011 CONUS WRF dataset (Gilliam and Pleim, 2010).

B.2.3.11 WRF Physics Options

The WRF model contains many different physics options. Model tests for the months of January and July 2012 were performed to evaluate various cumulus parameterizations, times between radiation physics calls, and land surface models to achieve the best WRF performance in the dataset. **Table B-4** lists the BOEM Gulf of Mexico OCS Region WRF physics options.

Table B-4. BOEM Gulf of Mexico OCS Region WRF Physics Options.

Option	Scheme	Notes
Microphysics	Thompson	State-of-the-art microphysics model
Longwave Radiation	RRTMG	Rapid Radiative Transfer Model for GCMs includes random cloud overlap and improved efficiency over RRTM.
Shortwave Radiation	RRTMG	Same as above, but for shortwave radiation.
Land Surface Model (LSM)	Noah	Four-layer scheme with vegetation and sub-grid tiling.
Planetary Boundary Layer (PBL) scheme	YSU	Yonsie University (Korea) Asymmetric Convective Model with non-local upward mixing and local downward mixing.
Cumulus Parameterization	Kain-Fritsch in the 36-km and 12-km domains.	Deep and shallow convection sub-grid scheme using a mass flux approach with downdrafts and CAPE removal time scale.
Analysis Nudging	Nudging applied to winds, temperature and moisture in the 36-km and 12-km domains.	Temperature and moisture nudged above PBL only.
Observation Nudging	No nudging applied	Surface wind and moisture observational nudging can induce excessive convection, leading to increased rainfall.
Surface Layer	Revised MM5 Monin-Obukhov scheme	In conjunction with YSU PBL scheme.

B.2.3.12 WRF Application Methodology

The WRF model was executed in 5-day blocks initialized at 12Z every 5 days for calendar year 2012. Model results are output every 60 minutes and output files are split at 12-hour intervals. Twelve (12) hours of spin-up were included in each 5-day block before the data were used in the subsequent evaluation.

B.3 WRF MODEL PERFORMANCE EVALUATION RESULTS

A quantitative and qualitative evaluation of the BOEM Gulf of Mexico OCS Region WRF simulation was conducted. The quantitative evaluation compared integrated surface hourly meteorological observations and offshore buoy observations with WRF predictions matched by time and location. The qualitative evaluation compared twice daily vertical profiles with upper-air data with WRF predictions matched by time and location and wind roses of coastal sites. Additionally, monthly and daily total spatial precipitation fields based on observations and satellite were compared with the WRF gridded monthly and daily total precipitation fields. Below, we summarize the main features of the WRF simulation model performance evaluation.

B.3.1 Quantitative Evaluation Using Metstat

A quantitative model performance evaluation of the BOEM Gulf of Mexico OCS Region WRF simulation was performed using integrated hourly surface and on-site meteorological measurements and the publicly available METSTAT software (Ramboll Environ, 2015) evaluation tool. METSTAT calculates statistical performance metrics for bias, error and correlation for surface winds, temperature, and mixing ratio (i.e., water vapor or humidity). To evaluate the performance of a meteorological model simulation for air quality model applications, a number of performance benchmarks for comparison are typically used. **Table B-5** lists the meteorological model performance benchmarks for simple (Emery et al., 2001) and complex (Kemball-Cook et al., 2005) situations. The simple benchmarks were developed by analyzing well-performing meteorological model evaluation results for simple, mostly flat terrain conditions and simple meteorological conditions (e.g., stationary high pressure) that were mostly conducted to support air quality modeling studies (e.g., ozone SIP modeling). The complex benchmarks were developed during the Western Regional Air Partnership (WRAP) regional haze modeling and are performance benchmarks for more complex conditions, such as the complex terrain of the Rocky Mountains and Alaska (Kemball-Cook et al., 2005). McNally (2009) analyzed multiple annual runs that included complex terrain conditions and suggested an alternative set of benchmarks for temperature under more complex conditions. The purpose of the benchmarks is to understand how good or poor the results are relative to other model applications run for the U.S.

In this section, Ramboll Environ compare the WRF meteorological variables to the benchmarks as an indication of the BOEM Gulf of Mexico OCS Region WRF model performance. These benchmarks include bias and error in temperature, wind direction, and mixing ratio, as well as the wind speed bias and Root Mean Squared Error (RMSE) between the models and databases.

Table B-5. Meteorological Model Performance Benchmarks for Simple and Complex Conditions.

Parameter	Emery et al. (2001)	Kemball-Cook et al. (2005)	McNally (2009)
Conditions	Simple	Complex	Both
Temperature Bias	≤ ±0.5 K	≤ ±2.0 K	≤ ±1.0 K
Temperature Error	≤ 2.0 K	≤ 3.5 K	≤ 3.0 K
Temperature IOA	≥ 0.8	(not addressed)	(not addressed)
Humidity Bias	≤ ±1.0 g/kg	≤ ±0.8 g/kg	≤ ±1.0 g/kg

Parameter	Emery et al. (2001)	Kemball-Cook et al. (2005)	McNally (2009)
Humidity Error	≤ 2.0 g/kg	≤ 2.0 g/kg	≤ 2.0 g/kg
Humidity IOA	≥ 0.6	(not addressed)	(not addressed)
Wind Speed Bias	≤ ±0.5 m/s	≤ ±1.5 m/s	(not addressed)
Wind Speed RMSE	≤ 2.0 m/s	≤ 2.5 m/s	(not addressed)
Wind Speed IOA	≥ 0.6	(not addressed)	(not addressed)
Wind Dir. Bias	≤ ±10 degrees	(not addressed)	(not addressed)
Wind Dir. Error	≤ 30 degrees	≤ 55 degrees	(not addressed)

The output from the BOEM Gulf of Mexico OCS Region WRF simulation was compared against the NCDC's global-scale, quality-controlled DS3505 integrated surface hourly observational (ISHO) data (USDOC, NOAA, NCDC, 2015) and the NDBC's buoy database (USDOC, NOAA, NDBC, 2015) as verification data. Global hourly and synoptic observations are compiled from numerous sources into a single common ASCII format and common data model. The DS3505 database contains records of most official surface meteorological stations from airports, military bases, reservoirs/dams, agricultural sites, and other sources dating from 1901 to the present, and quality control has corrected well over 99% of the errors present in the original data. The NDBC database contains records of moored buoys, coastal-marine automated network stations, and other sources dating from 1970 to the present.

B.3.1.1 Quantitative Statistics

Several statistical measures are calculated as part of the meteorological model evaluation. Additional plots and graphs are used to present these statistics on both hourly and daily timeframes. These measures are calculated for wind speed, wind direction, temperature, and humidity at the surface. The various statistical measures used for this evaluation are described below.

The statistics used to evaluate meteorological model performance are all given in absolute terms (e.g., wind speed error in meters per second [m/s]) rather than in relative terms (percent error) as is commonly shown for air quality assessments. The major reason for this is that a very different significance is associated with a given relative error for different meteorological parameters. For example, a 10 percent error for wind speed measured at 10 m/s is an absolute error of 1 m/s, a minor error. Yet a 10 percent error for temperature at 300 K is an absolute error of 30 K, an unacceptably large error. On the other hand, pollutant concentration errors of 10 percent at 1 ppb or 10 ppm carry practically the same significance.

Statistical Measures

Mean Observation (M_o): Calculated from all sites with valid data within a given analysis region and for a given time period (hourly or daily):

$$M_o = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I} O_j^i$$

where $O^i j$ is the individual observed quantity at site *i* and time *j*, and the summations are over all sites (I) and over time periods (*J*).

Mean Prediction (M_p): Calculated from simulation results that are interpolated to each observation used to calculate the mean observation (hourly or daily):

$$M_p = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I} P_j^i$$

where $P^i j$ is the individual predicted quantity at site *i* and time *j*. Note that mean observed and predicted winds are vector-averaged (for east-west component u and north-south component v), from which the mean wind speed and mean resultant direction are derived.

Least Square Regression: Performed to fit the prediction set to a linear model that describes the observation set for all sites with valid data within a given analysis region and for a given time period (daily or episode). The y-intercept a and slope b of the resulting straight line fit is calculated to describe the regressed prediction for each observation:

$$P_j^i = a + bO_j^i$$

The goal is for a 1:1 slope and a "0" y-intercept (no net bias over the entire range of observations), and a regression coefficient of 1 (a perfect regression). The slope and intercept facilitate the calculation of several error and skill statistics described below.

Bias Error (B): Calculated as the mean difference in prediction-observation pairings with valid data within a given analysis region and for a given time period (hourly or daily):

$$B = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left(P_j^i - O_j^i\right)$$

Gross Error (E): Calculated as the mean absolute difference in prediction-observation pairings with valid data within a given analysis region and for a given time period (hourly or daily):

$$E = \frac{1}{IJ}\sum_{j=1}^{J}\sum_{i=1}^{I}\left|P_j^i - O_j^i\right|$$

Note that the bias and gross error for winds are calculated from the predicted-observed residuals in speed and direction (not from vector components u and v). The direction error for a given prediction-observation pairing is limited to range from 0 to 180.

Root Mean Square Error (RMSE): Calculated as the square root of the mean squared difference in prediction-observation pairings with valid data within a given analysis region and for a given time period (hourly or daily):

$$RMSE = \left[\frac{1}{IJ} \sum_{j=1}^{J} \sum_{i=1}^{I} \left(P_j^i - O_j^i \right)^2 \right]^{1/2}$$

The RMSE, as with the gross error, is a good overall measure of model performance. However, since large errors are weighted heavily (due to squaring), large errors in a small sub-region may produce a large RMSE even though the errors may be small and quite acceptable elsewhere.

It is important that RMSE is analyzed. For example, if only RMSE is estimated (and it appears acceptable), it could consist largely of the systemat¬ic component. This error might be removed through improvements in the model inputs or use of more appropriate options, thereby reducing the error transferred to the photochemical model. On the other hand, if the RMSE consists largely of the unsystematic component, this indicates that further error reduction may require model refinement (new algorithms, higher resolution grids, etc.) or that the phenomena to be replicated cannot be fully addressed by the model. It also provides error bars that may be used with the inputs in subsequent sensitivity analyses.

B.3.1.2 METSTAT Evaluation Using Integrated Surface Hourly Observations and Offshore Buoy Observations

The METSTAT results for 2012 are presented in **Figures B-5 through B-16**. The WRF wind direction performed very well, with the majority of months falling within the simple conditions threshold for all spatial domains (36, 12, and 4 km). For all domains, WRF wind speed, temperature, and humidity also performed very well. For most months, there are slight positive biases in wind speed and humidity in all three spatial domains. Overall, the WRF model performed exceptionally well in the 36- and 12-km domains and well in the 4-km domain for onshore surface wind direction, wind speed, humidity and temperature observation comparisons.

METSTAT was also used to evaluate WRF performance in the innermost 4-km domain using observations from meteorological buoys throughout the Gulf of Mexico for 2012. Overall, WRF wind direction performed well with over half of all months falling with the simple conditions benchmark. Wind speed performance was acceptable with all months falling within the complex conditions benchmark. Temperature bias and error is slightly higher (warmer) in the winter months compared to the summer months, suggesting that the model is over-forecasting surface temperatures, or is an influence from the SST database input to WRF. Humidity performed well with a majority of months, falling within the simple conditions benchmark. In general, the offshore METSTAT evaluation is very similar to the onshore evaluation, suggesting consistent performance over both the land and sea portions of the Gulf of Mexico OCS region.

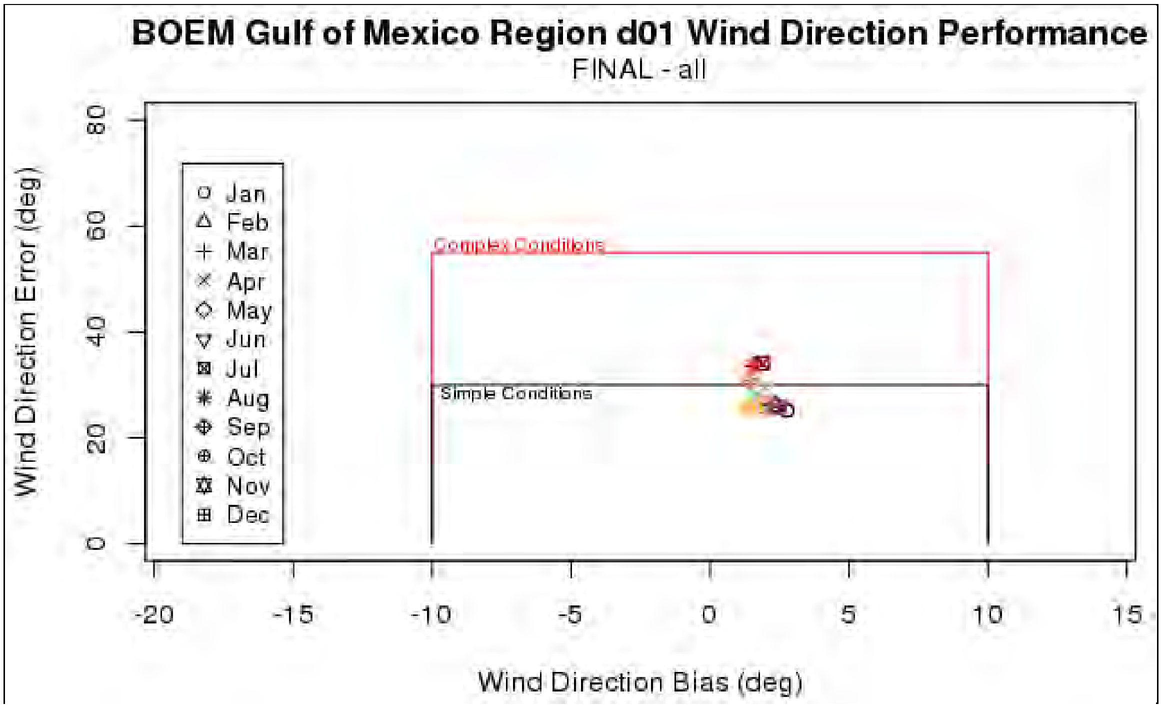


Figure B-5. BOEM Gulf of Mexico OCS Region WRF 36-km METSTAT Wind Direction Performance for 2012.

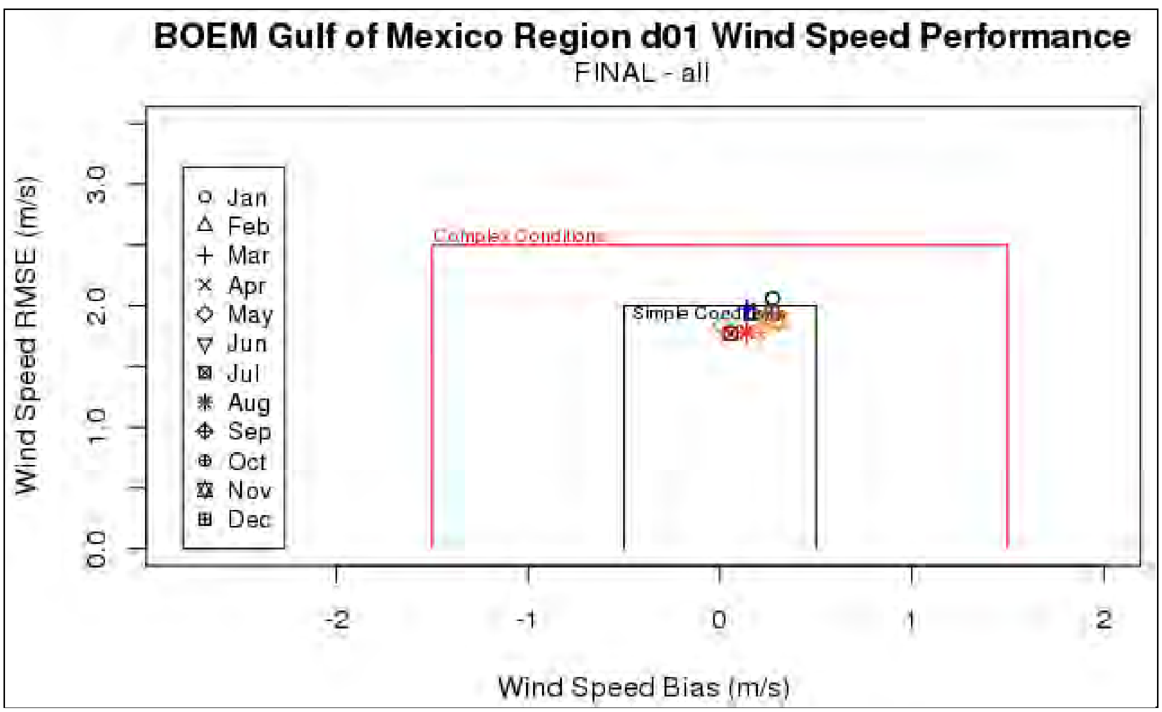


Figure B-6. BOEM Gulf of Mexico OCS Region WRF 36-km METSTAT Wind Speed Performance for 2012.

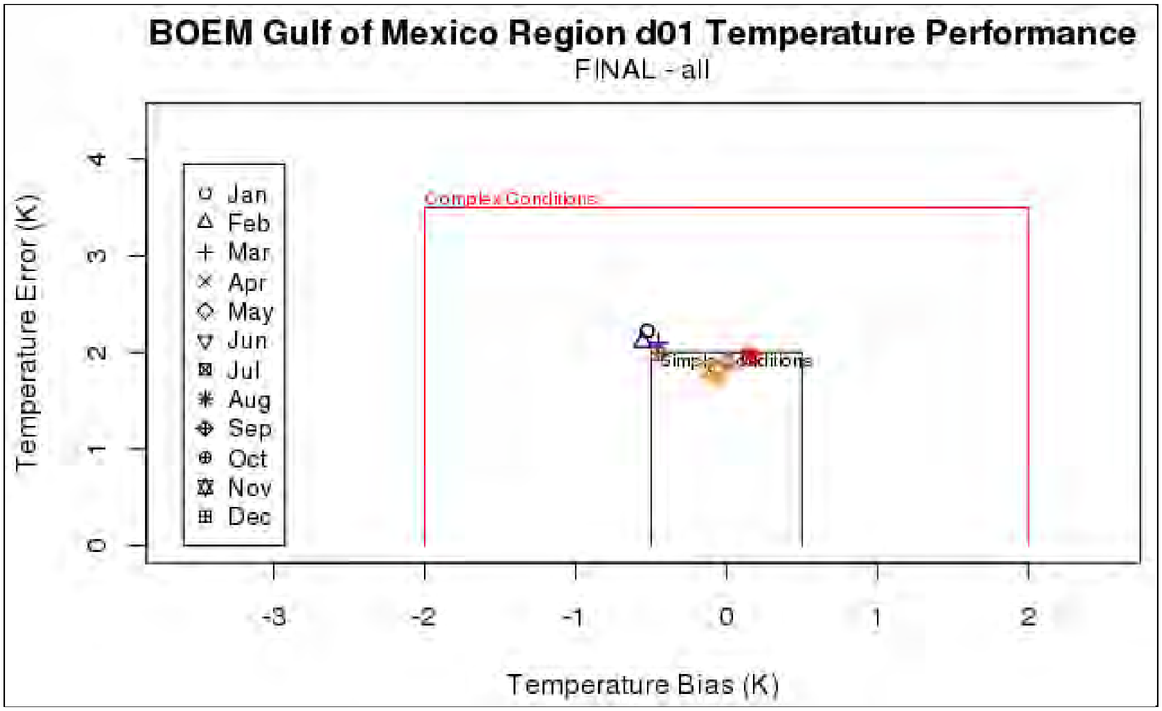


Figure B-7. BOEM Gulfof Mexico OCS Region WRF 36-km METSTAT Temperature Performance for 2012.

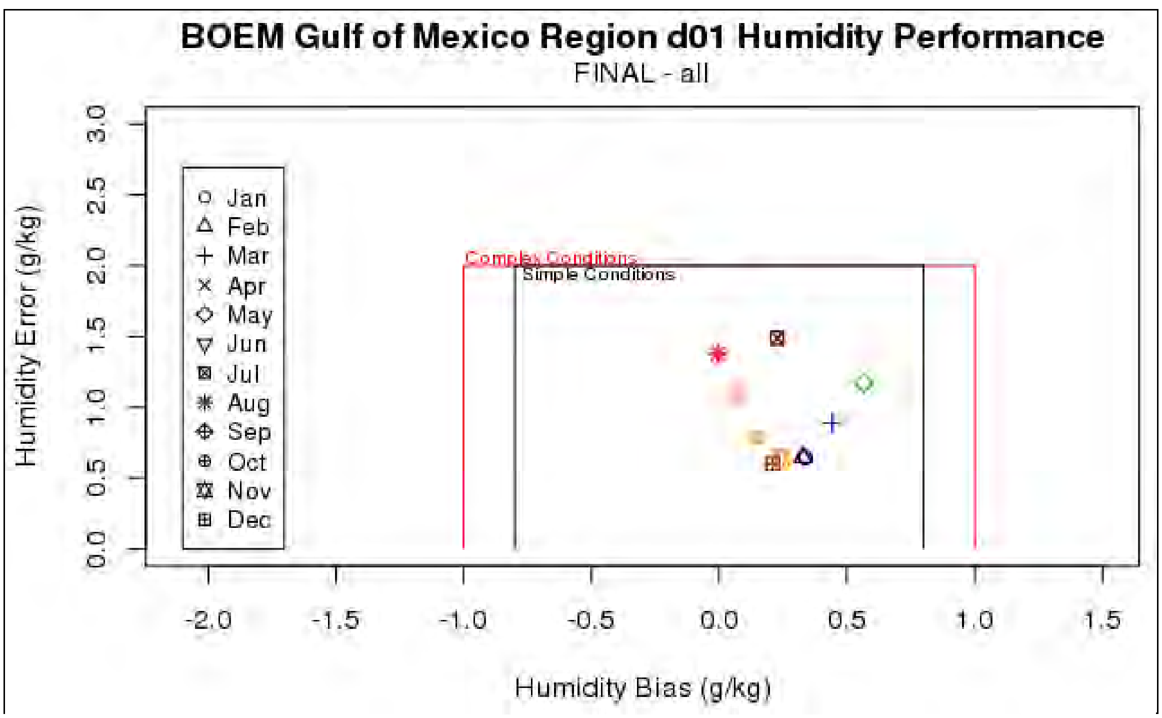


Figure B-8. BOEM Gulf of Mexico OCS Region WRF 36-km METSTAT Humidity Performance for 2012.

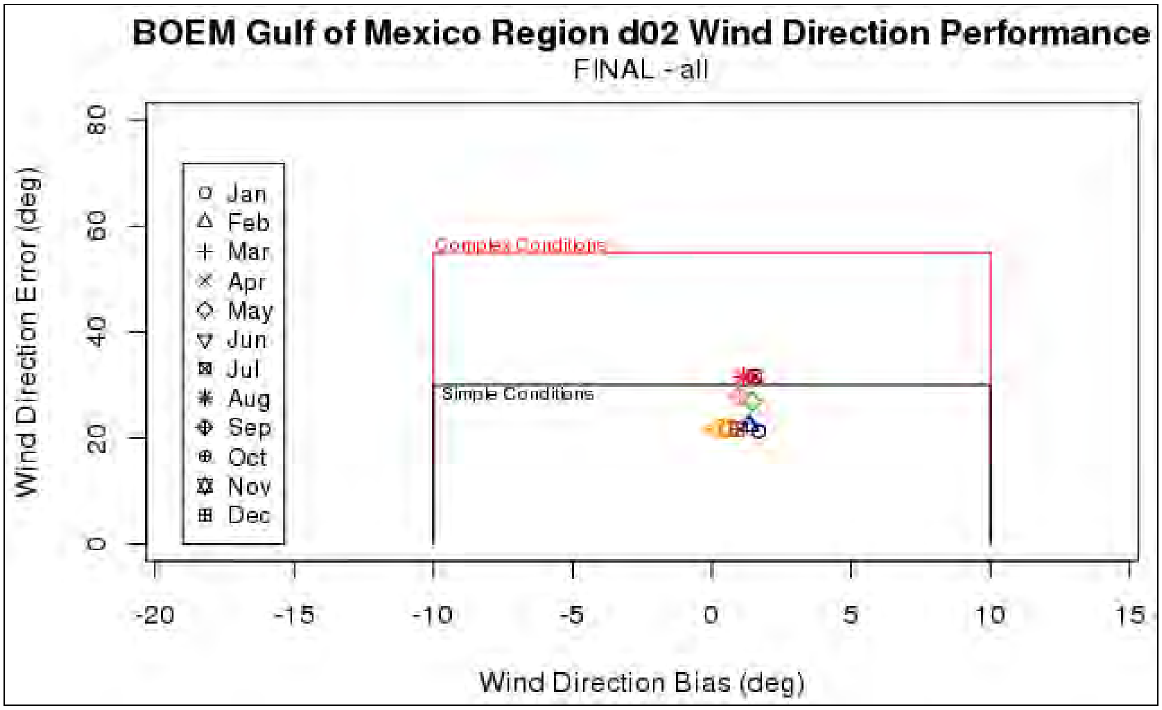


Figure B-9. BOEM Gulf of Mexico OCS Region WRF 12-km METSTAT Wind Direction Performance for 2012.

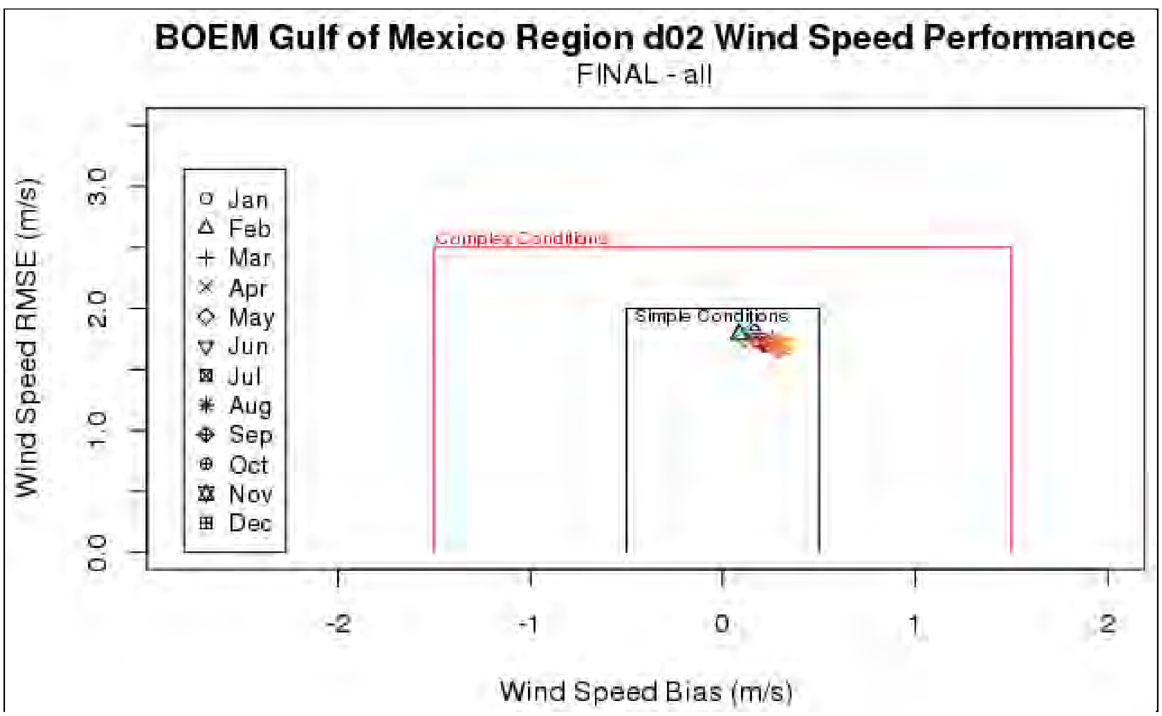


Figure B-10. BOEM Gulf of Mexico OCS Region WRF 12-km METSTAT Wind Speed Performance for 2012.

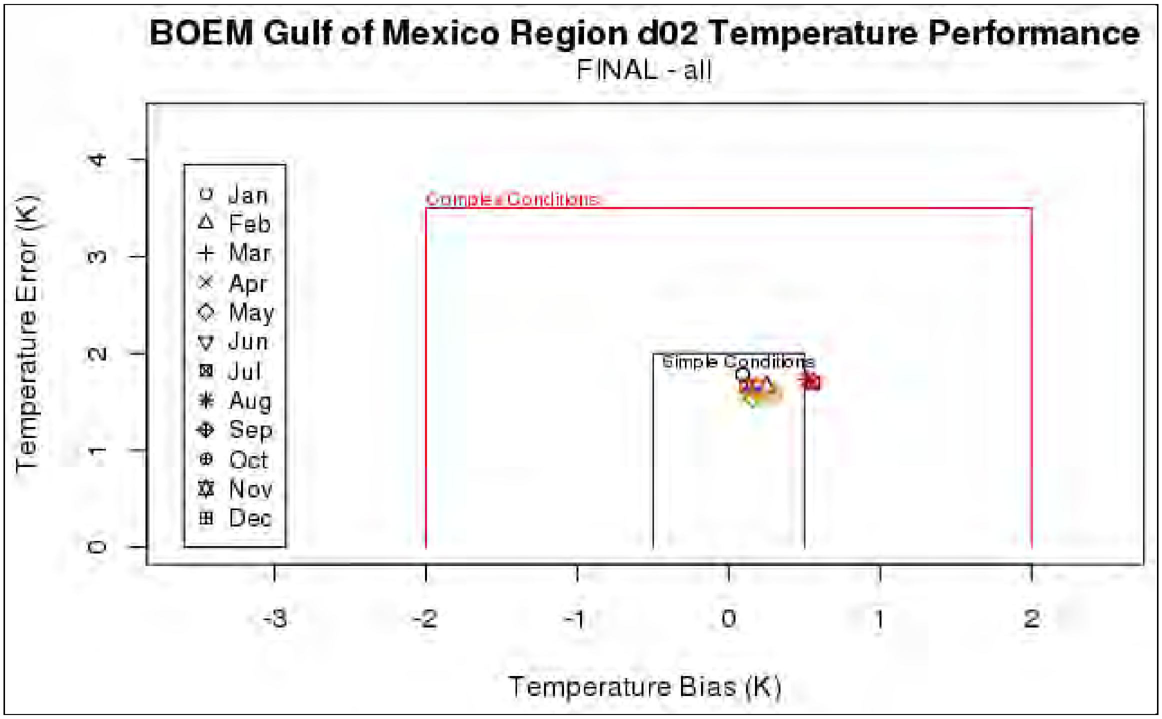


Figure B-11. BOEM Gulf of Mexico OCS Region WRF 12-km METSTAT Temperature Performance for 2012.

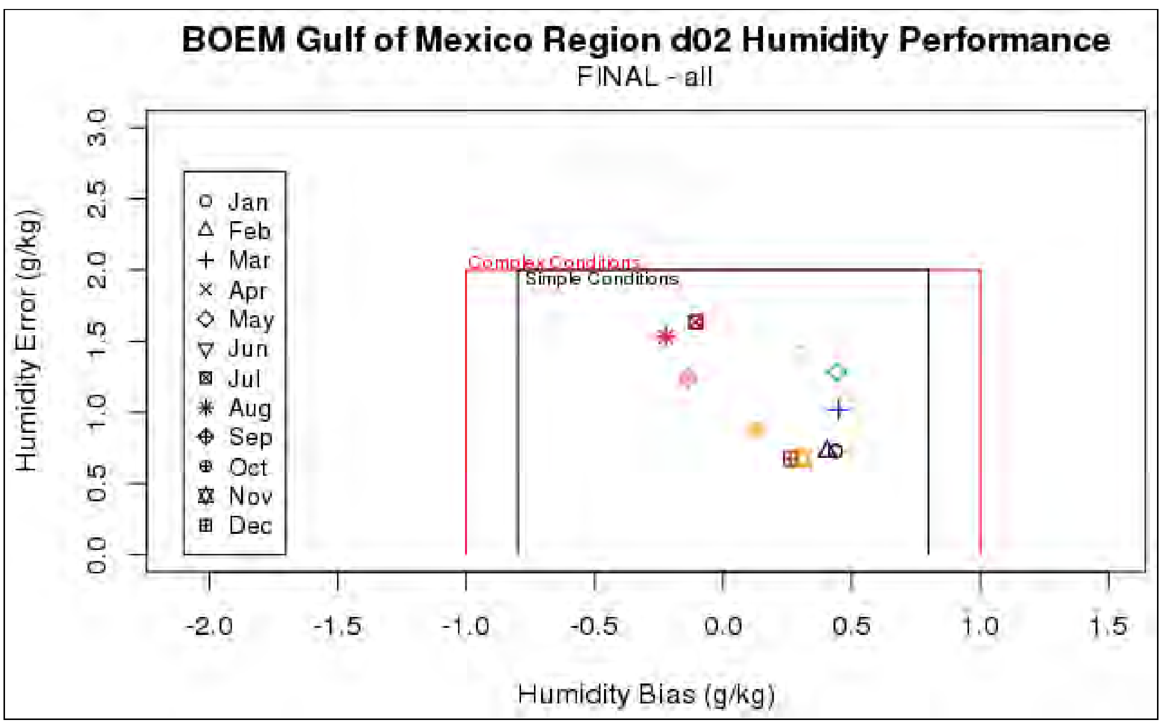


Figure B-12. BOEM Gulf of Mexico OCS Region WRF 12-km METSTAT Humidity Performance for 2012.

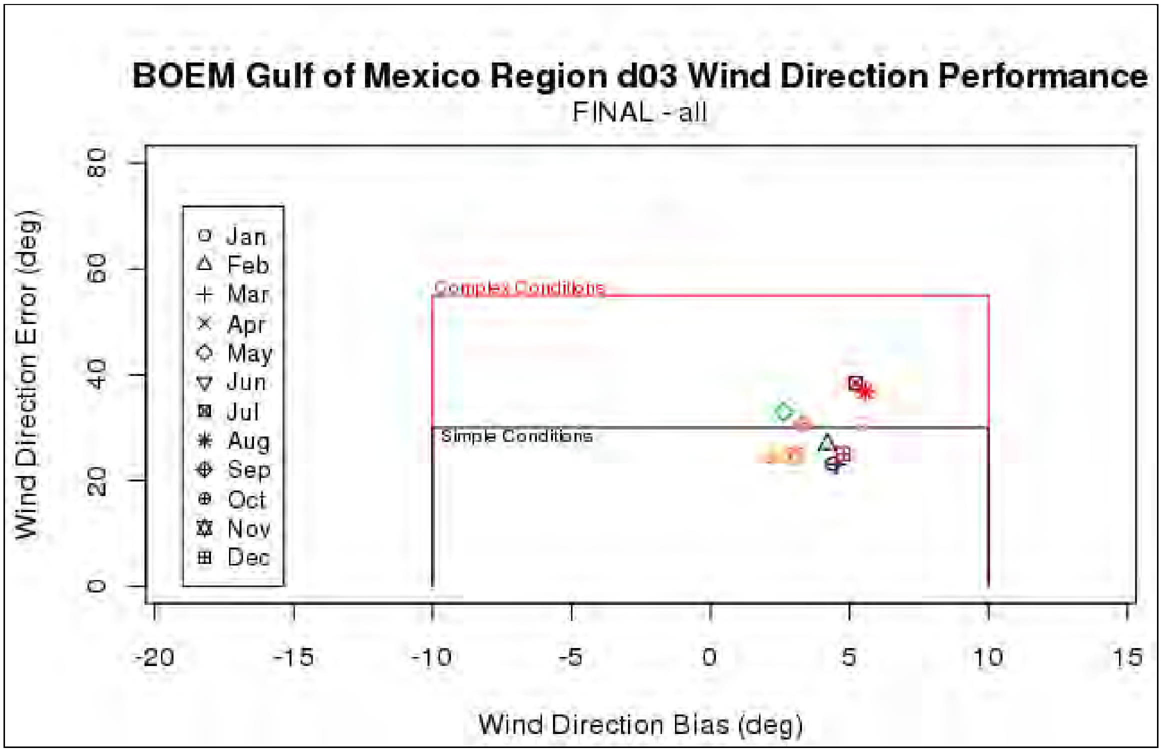


Figure B-13. BOEM Gulf of Mexico OCS Region WRF 4-km METSTAT Wind Direction Performance for 2012.

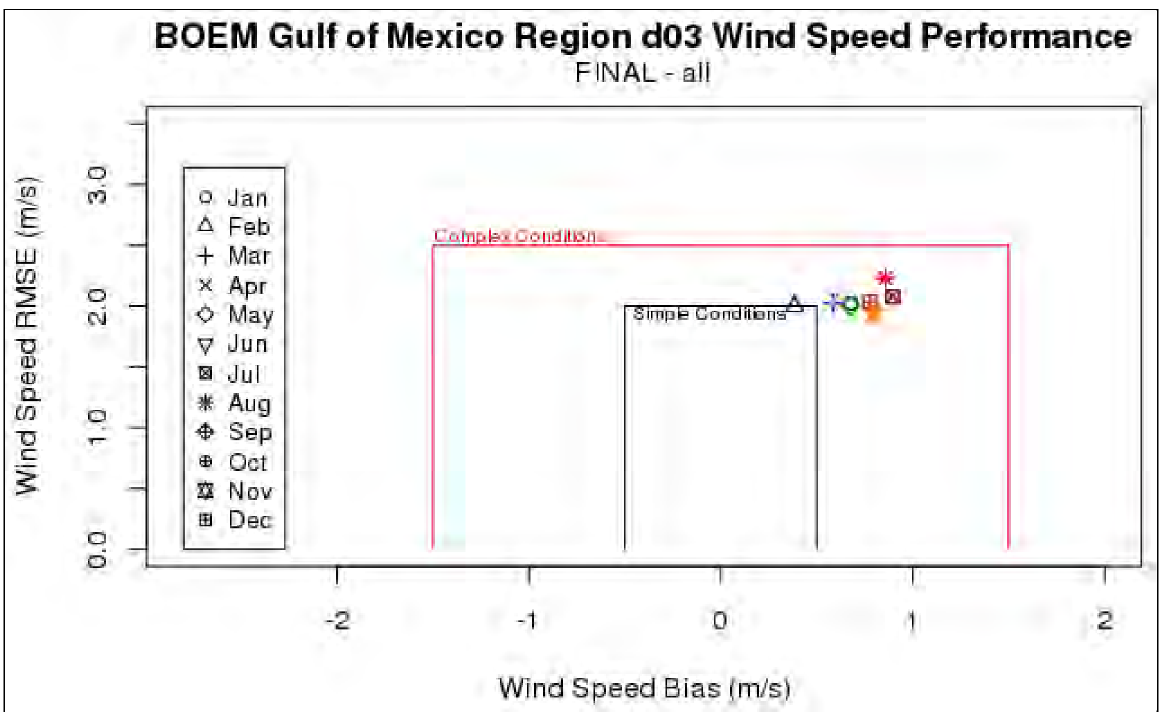


Figure B-14. BOEM Gulf of Mexico OCS Region WRF 4-km METSTAT Wind Speed Performance for 2012.

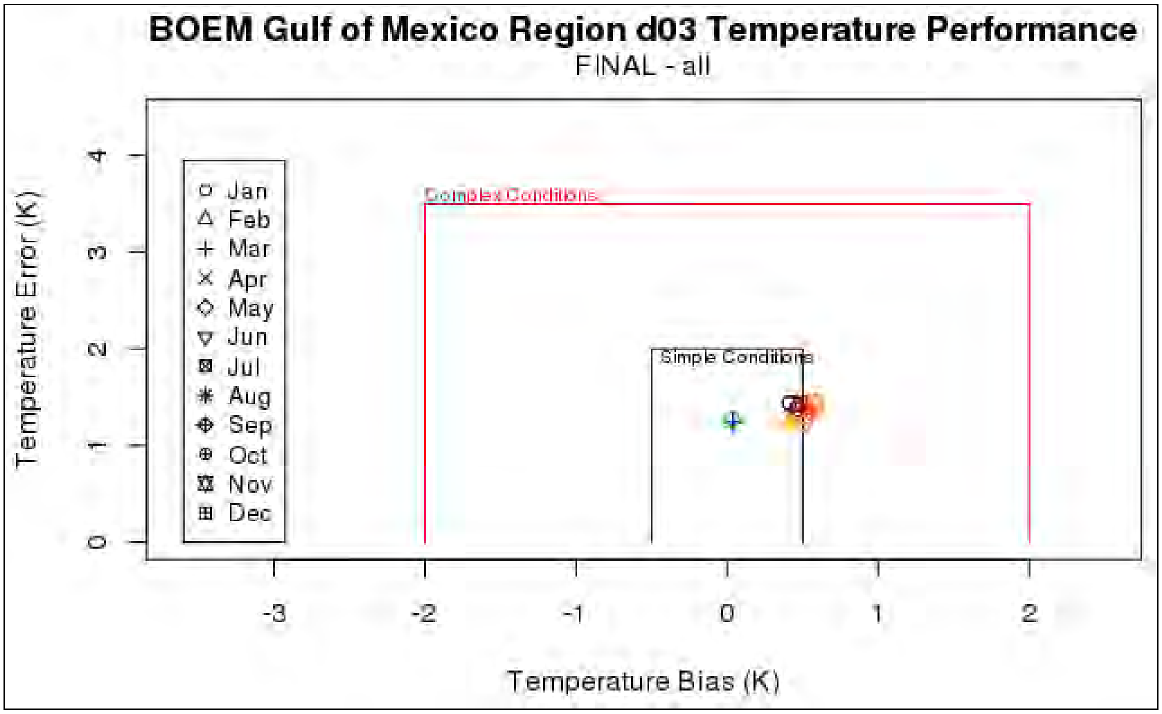


Figure B-15. BOEM Gulf of Mexico OCS Region WRF 4-km METSTAT Temperature Performance for 2012.

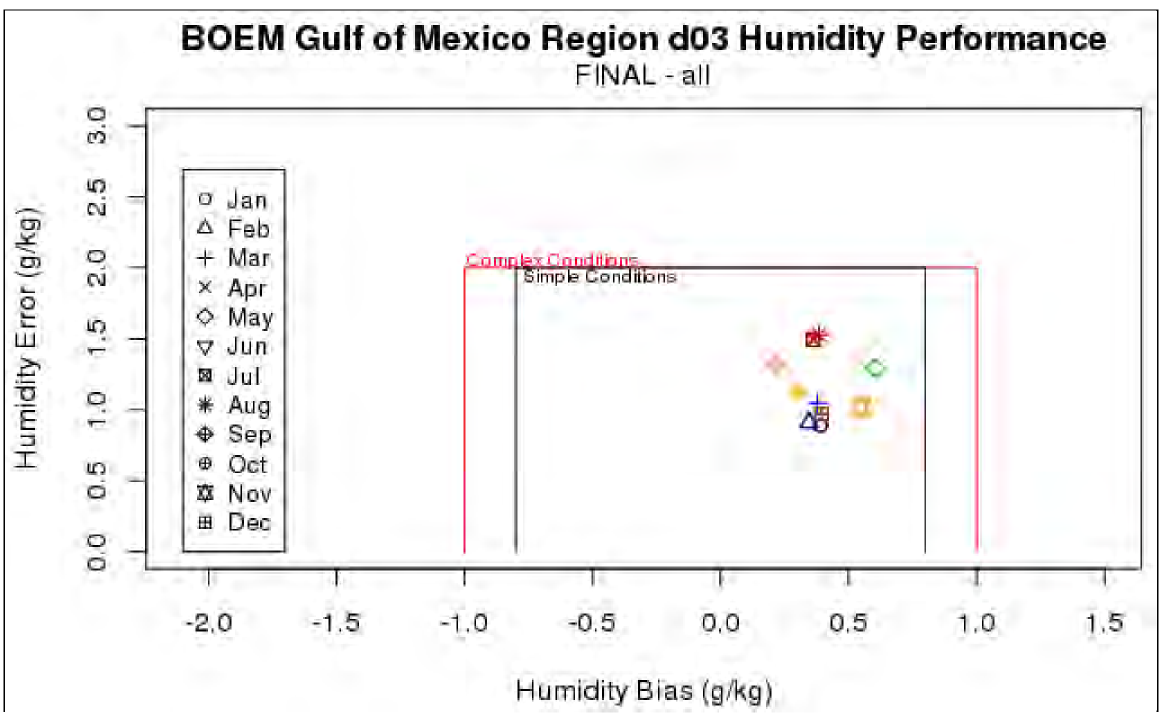


Figure B-16. BOEM Gulf of Mexico OCS Region WRF 4-km METSTAT Humidity Performance for 2012.

B.3.2 Qualitative Evaluation Using Wind Roses

The coastal sites of Gulfport, MS (KGPT); Naples, FL (NPSF); Port Isabel, TX (PTIT); and Calcasieu, LA (CAPL) were chosen to evaluate the frequency and intensity of onshore and offshore wind flow and WRF's performance at the land-sea interface. The locations of these sites are shown in **Figure B-17**. The 5-year comparisons of observed and modeled wind direction at each coastal site will be provided in the full WRF modeling report. Below, in **Figures B-17 through B-21**, the comparisons are made for only 2012. Wind direction observations were obtained from the DS3505 meteorological dataset, and modeled surface wind speed and wind direction were extracted from the 4-km WRF domain dataset using the Mesoscale Model Interface (MMIF) program (Brashers and Emery, 2015). Overall, WRF performs just satisfactorily at forecasting the frequency and intensity of onshore and offshore wind flow at the coastal sites. The WRF simulates the predominant NE wind direction at NPSF, as well as the strong SE winds at port PTIT and CAPL. However, WRF wind direction does not compare particularly well to KGPT in 2012 and does not replicate much of the NW wind at PTIT, or the SW wind at NPSF. The decline in apparent wind direction performance for 2012, compared to the 5-year analysis, is largely due to the shorter evaluation period.

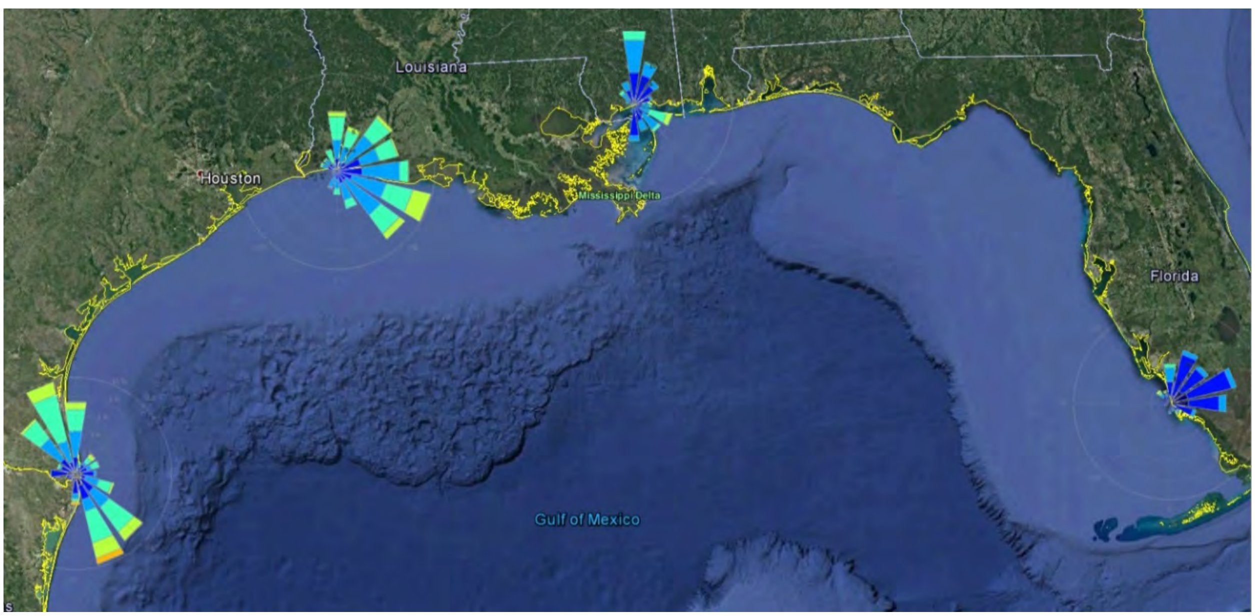


Figure B-17. Wind Rose Locations for Port Isabel, TX (PTIT), Calcasieu, LA (CAPL), Gulfport, MS (KGPT), and Naples, FL (NPSF).

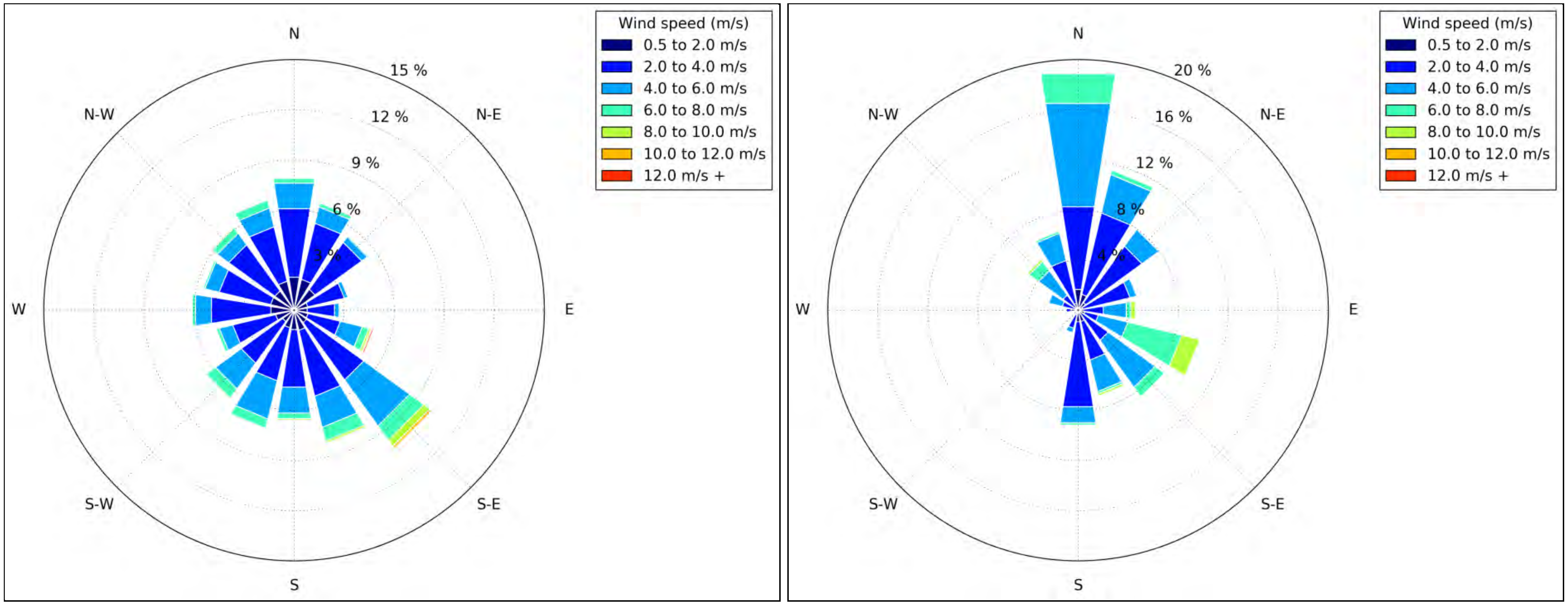


Figure B-18. 2012 WRF Wind Rose (left) Compared to 2012 Observation Wind Rose from Gulfport, MS (right) in 4-km Domain.

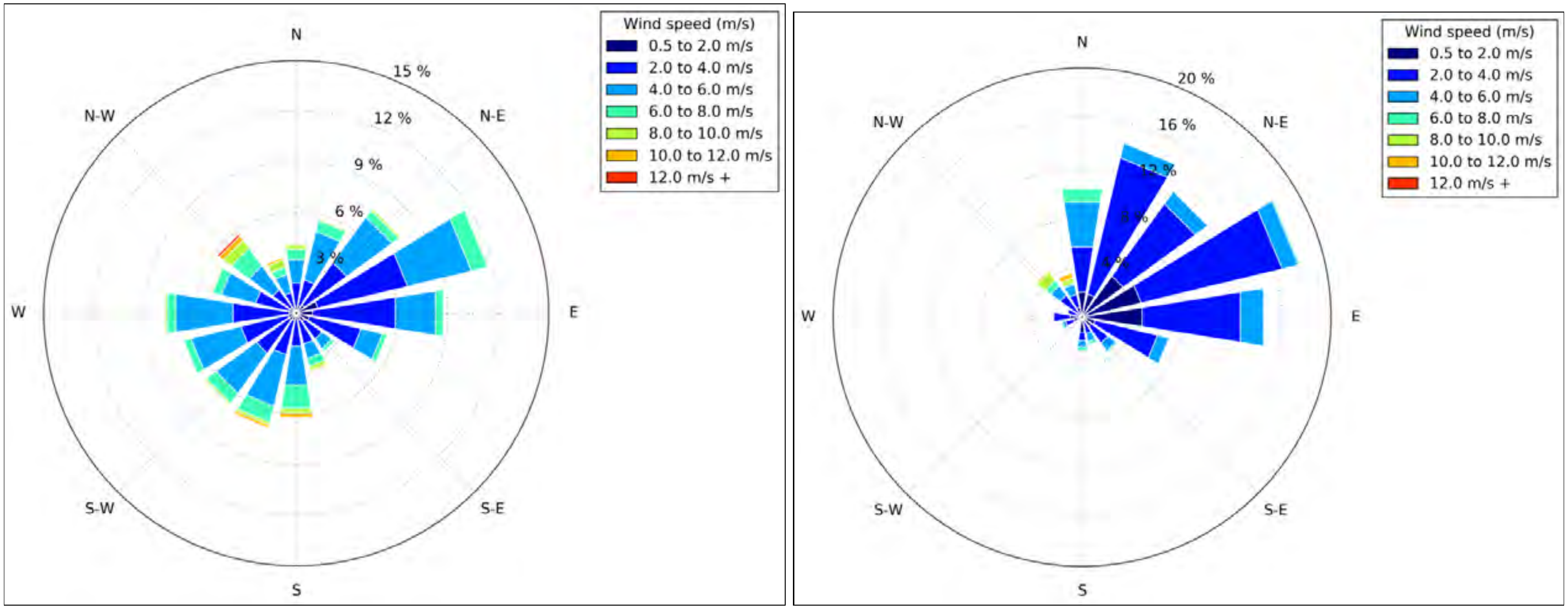


Figure B-19. 2012 WRF Wind Rose (left) Compared to 2012 Observation Wind Rose from Naples, FL (right) in 4-km Domain.

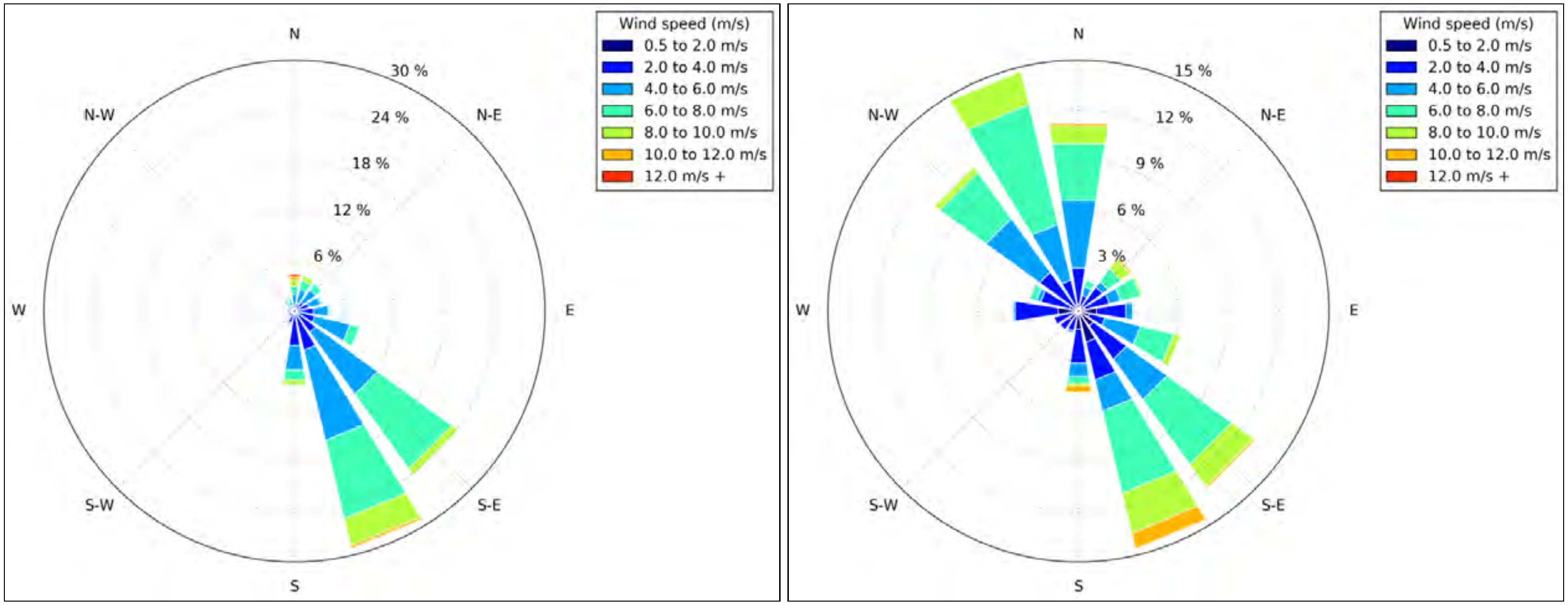


Figure B-20. 2012 WRF Wind Rose (left) Compared to 2012 Observation Wind Rose from Port Isabel, TX (right) in 4-km Domain.

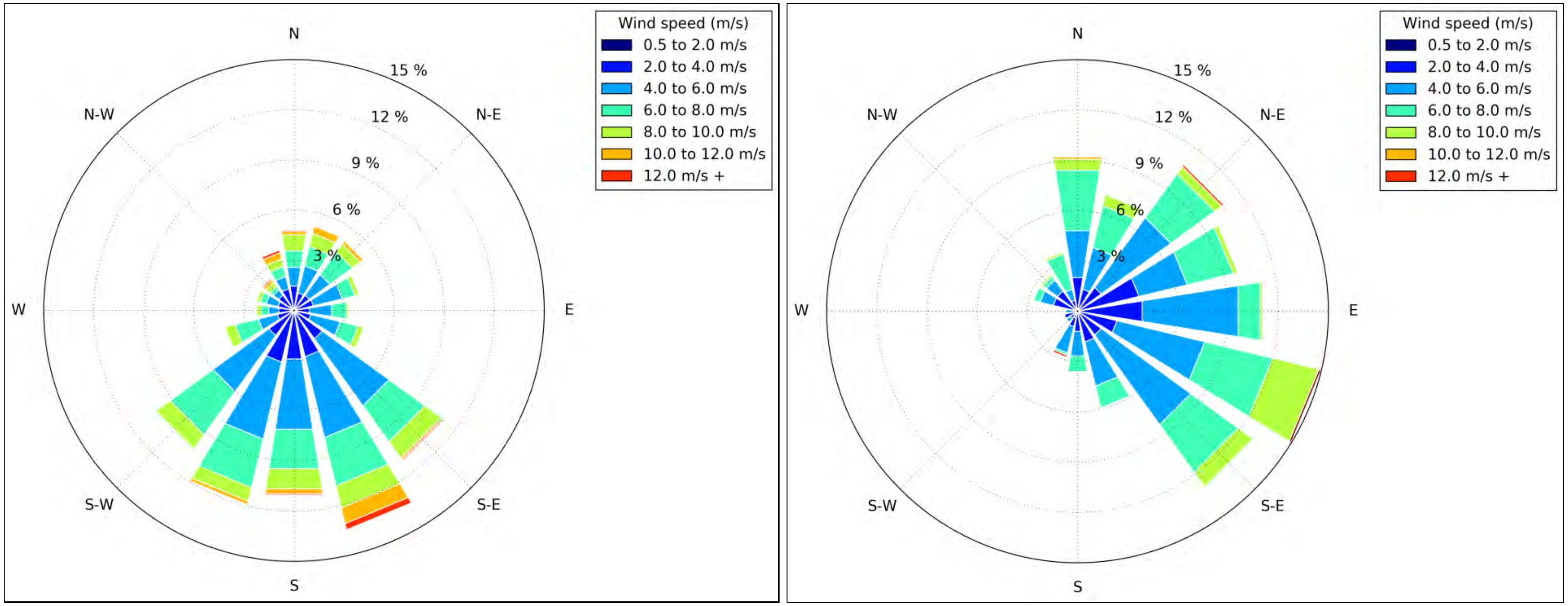


Figure B-21. 2012 WRF Wind Rose (left) Compared to 2012 Observation Wind Rose from Calcasieu, LA (right) in 4-km Domain.

B.3.3 Qualitative Evaluation Using Upper-Air Data

Plots of the sounding profiles of temperature and dew point for the vertical atmosphere were created using observational data from the Brownsville, TX (KBRO) and Key West, FL (KEYW) airports and the corresponding WRF data points. A random selection of upper air profiles was taken from the year-long dataset for a sampling of several different atmospheric situations. These are qualitatively compared, paying particular attention to how well the WRF model reproduces the observed near-surface inversion layers.

The KBRO and KEYW radiosonde datasets are collected by and maintained by the National Weather Service (NWS). Radiosondes are launched twice per day, at approximately 00 and 12 UTC. Radiosondes provide high-resolution vertical profiles of temperature, humidity, wind speed, and wind direction throughout the troposphere. The data are made publicly available by NOAA's Earth System Research Laboratory (USDOC, NOAA, ESRL, 2015). Ramboll Environ downloaded and stored the radiosonde data twice daily for 2012 for each upper air station in FSL format for use in WRF model dataset comparisons.

For the qualitative analysis, **Figure B-22** shows the vertical profiles of temperature and humidity from the observational and 4 km WRF datasets for Brownsville, TX and Key West, FL. The analysis focuses on how well the WRF model reproduces the vertical atmosphere structure using upper air observations from the selected sites within the 4-km domain, which have timeframes that overlap with the WRF model. The left panel in **Figure B-22** shows an evening sounding in August for Brownville, TX, which contains a weak elevated subsidence inversion. The WRF forecasts the base of the inversion well at around 900 meters. The right panel of **Figure B-22** shows observed and modeled vertical profiles for January in Key West, FL. The WRF forecasts the elevated subsidence inversion well, with a mixing height top at around 1,000 meters on the left panel. The dry air above the inversion is also represented well in the evening sounding at Key West, FL.

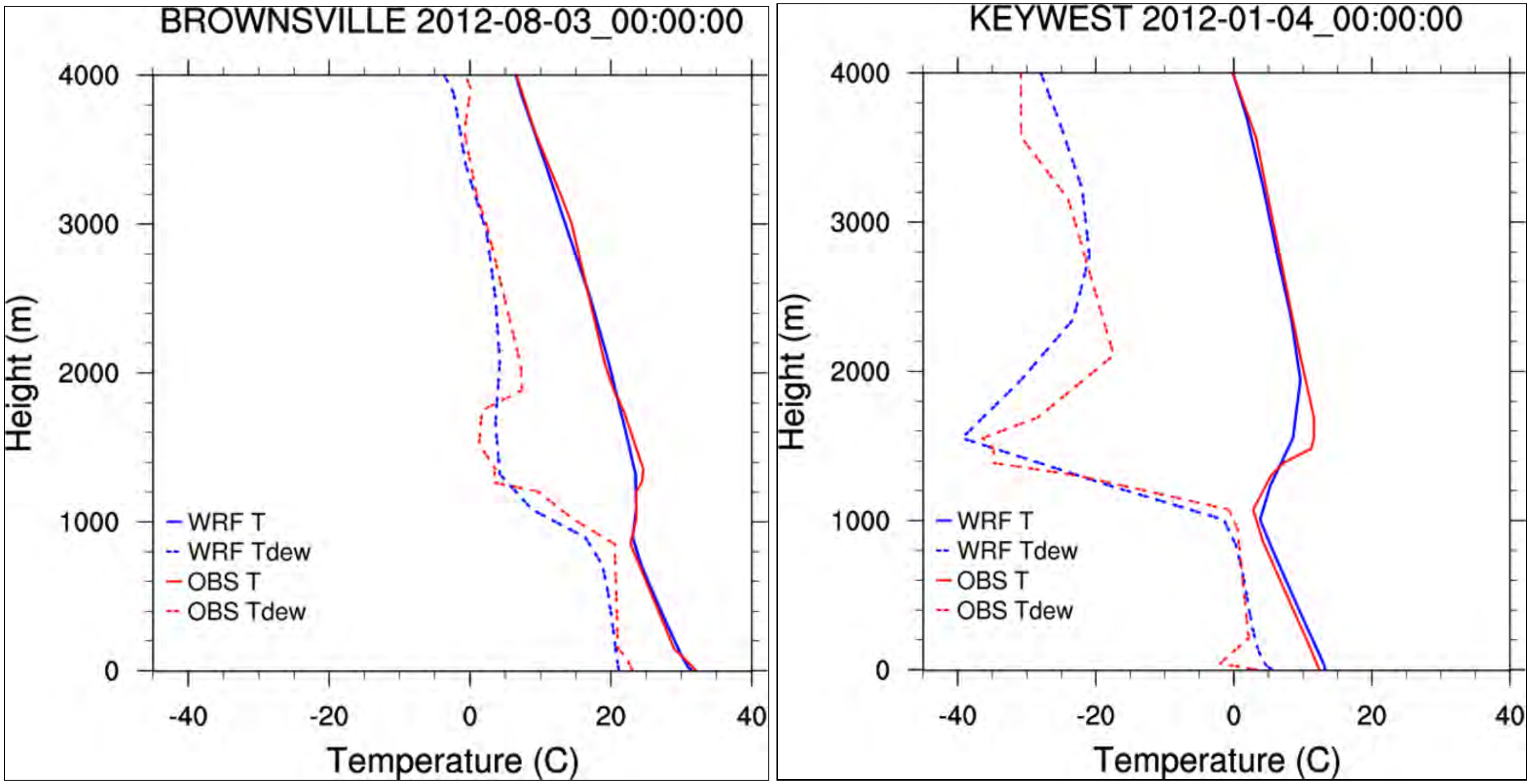


Figure B-22. Vertical Profile Soundings Comparing the 4-km WRF (blue lines) to Upper-Air Observations Data (red lines) for Brownsville, TX on August 3, 2012, and Key West, FL on January 4, 2012, at 00 UTC.

B.3.4 Qualitative Evaluation Using Precipitation

Precipitation removes chemicals and particulates from the air via wet deposition, and thus is an important parameter for high-quality dispersion modeling. Several precipitation datasets were evaluated for use in model comparisons. Ramboll Environ has used the Parameter-elevation Regressions on Independent Slopes Model (PRISM) dataset for rainfall extensively in the past, but it only covers the over-land portion of the modeling domain. Land-based RADAR retrievals of precipitation typically have larger uncertainty and are limited in geographic coverage to the area relatively near the coast and, as a result, were not chosen for this performance evaluation. Satellite-based retrievals are typically lower resolution and also feature larger uncertainty, but cover the entire Gulf of Mexico OCS region. Ramboll Environ performed comparisons between the BOEM Gulf of Mexico OCS Region WRF modeled precipitation output with the PRISM and Tropical Rainfall Measurements Mission (TRMM) satellite datasets.

The Oregon State University PRISM Climate Group gathers temperature and precipitation data from a range of monitoring networks, applies sophisticated quality control methods, and uses the data to produce spatial grids of climate parameters (Daly et al., 2008). The time series datasets are modeled using climatologically-aided interpolation (CAI), which uses the long-term average pattern as first-guess of the spatial pattern of climatic conditions. Both a daily product and a monthly product are available. The precipitation observations used in the daily PRISM product includes radar measurements, which the monthly product does not take into account. This may cause dramatic local differences between the two datasets in monthly totals.

TRMM was a joint mission being flown by the National Aeronautics and Space Administration (NASA, U.S.) and the Japan Aerospace Exploration Agency (JAXA, Japan) to improve our quantitative knowledge of the 3-dimensional distribution of precipitation in the tropics. TRMM had a passive microwave radiometer (TRMM Microwave Imager, TMI), the first active space-borne Precipitation Radar (PR), a Visible-Infrared Scanner (VIRS), and other instruments. Coordinated observations are intended to result in a "flying raingauge" capability. The TRMM dataset is coarser than the PRISM data (0.5 degrees, or about 55 km, vs. 4 km) but is available every 3 hours.

B.3.4.1 Evaluation Over Land Using PRISM Precipitation

High-resolution (4 km) PRISM datasets cover the contiguous U.S. in both monthly and daily output versions (Daly et al., 2008). Here WRF precipitation output is compared to the PRISM over-land portions of the Gulf of Mexico. Ramboll Environ re-projected and aggregated the PRISM data to the WRF projection’s grid cell locations, and the resulting gridded data was plotted and the gridded fields saved. This allows for consistent visual qualitative comparison.

The full WRF modeling report will display 5-year average (2010-2014) monthly precipitation plots constructed from BOEM Gulf of Mexico OCS Region WRF output, masked to only display over-land measurements, and compared to PRISM 5-year average (2010-2014) monthly plots for January through December in the 4-km domain. Below, WRF monthly precipitation totals are compared to corresponding PRISM totals for 2012 only. The results are mostly representative of the 5-year monthly averages and are briefly summarized in the following paragraph.

For the months of January through March, shown in **Figures B-23 through B-25**, WRF represents the spatial extent of the precipitation well, recreating the comparatively drier areas of central Texas and southern Florida. However, the model does under-estimate the total amount of average monthly rainfall across a small portion of southern Mississippi and south central Louisiana during this period. In April and May, **Figures B-26 and B-27**, the model shifts to overestimating rainfall in the same region, but otherwise depicts both the spatial distribution and amount of precipitation well over land, compared to PRISM. During the summer months of June through August, shown in **Figures B-28 through B-30**, WRF performs exceptionally well in re-creating the precipitation extent across the land portions of the domain, including the convergence zones across the east and west coasts of Florida. The model does slightly over-predict the amount of rainfall accumulations in the southern Georgia and southern Alabama areas. This is likely due to the higher humidity rates in the model during the summertime period. In September, shown in **Figure B-31**, WRF slightly under-predicts averaged precipitation rates over the land portion of the domain but over-forecasts the extent of rainfall over the northern Florida area. The WRF performed exceptionally well from October through December, shown in **Figures B-32 through B-34**, reproducing the extent and amount of rainfall very accurately, compared to PRISM totals. Overall, WRF performed very well in reproducing the spatial extent of precipitation over the land portions of Gulf of Mexico OCS region throughout 2012.

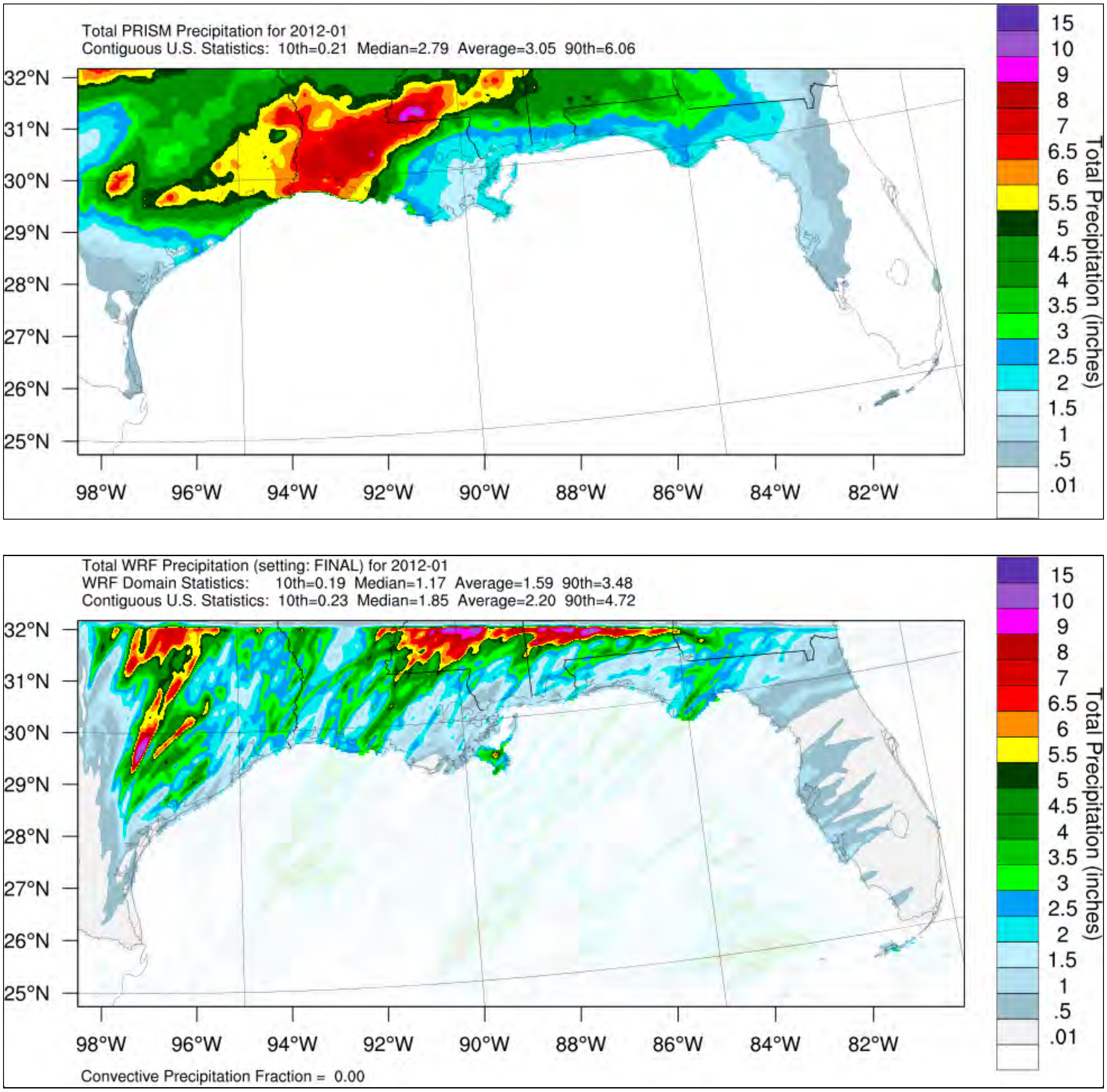
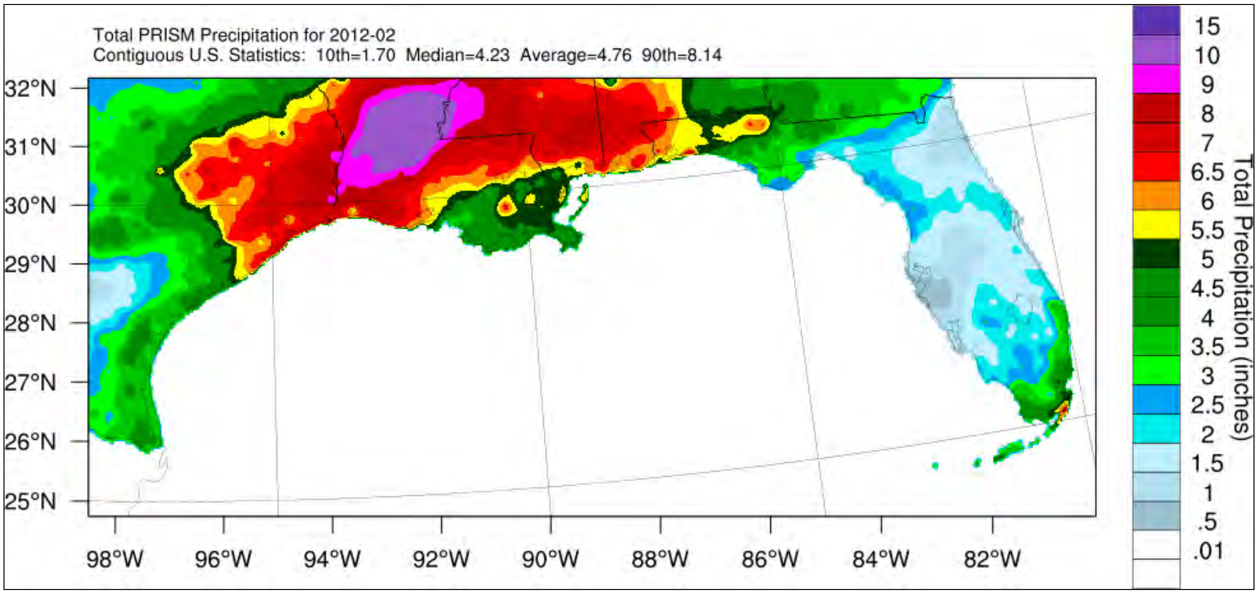


Figure B-23. January 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.



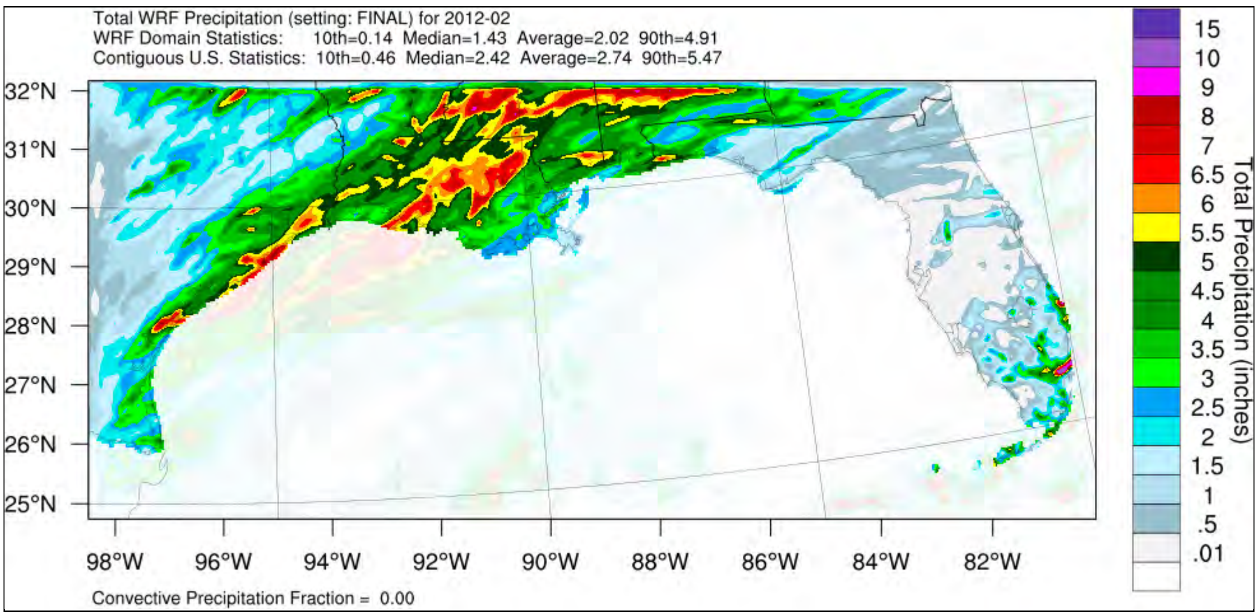


Figure B-24. February 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.

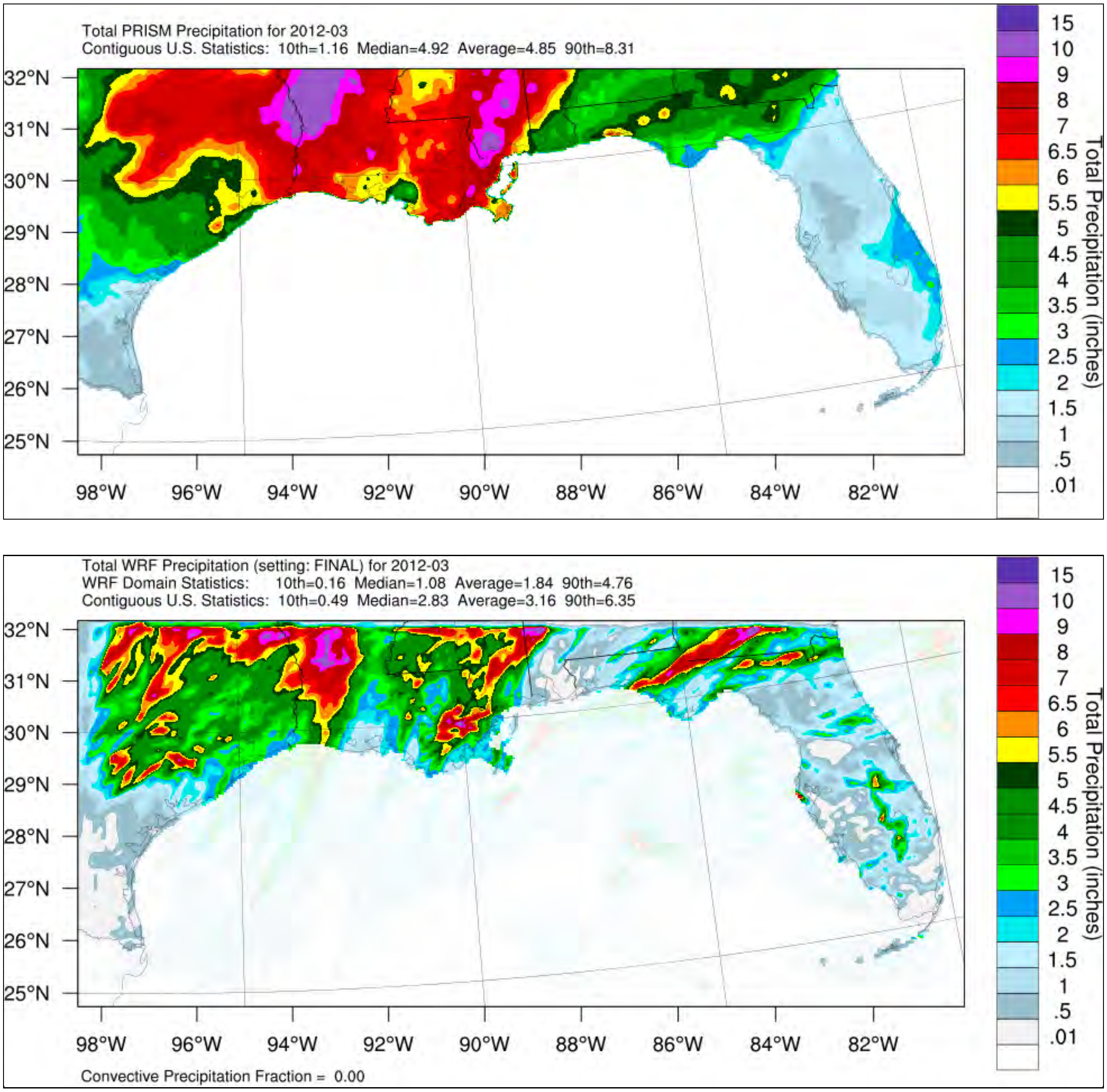
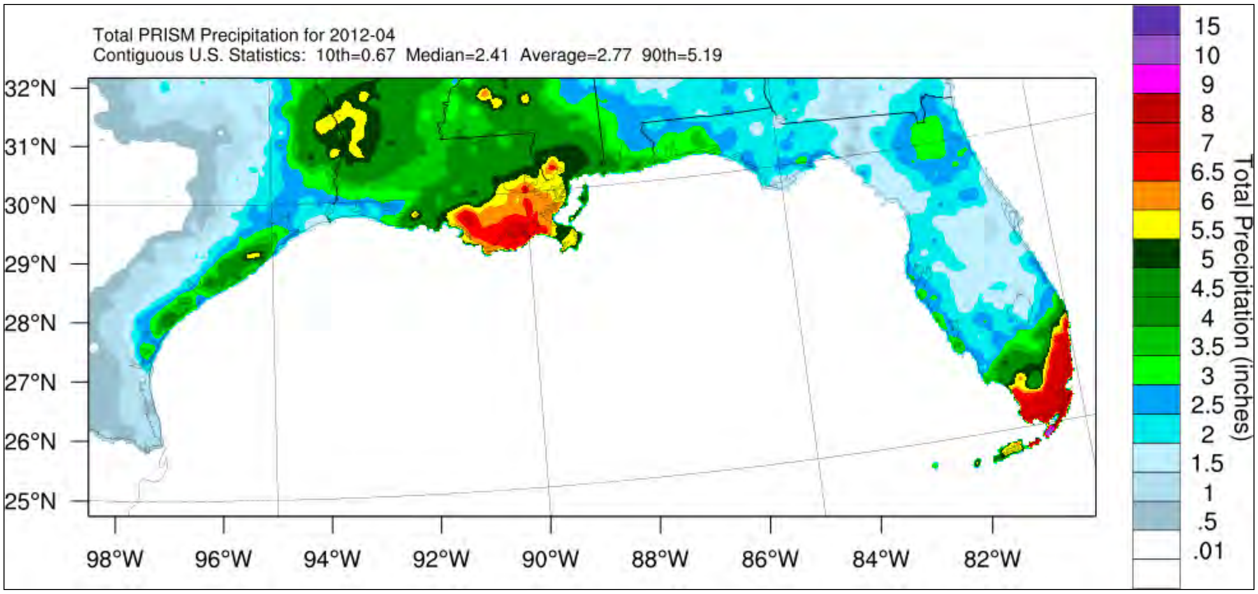


Figure B-25. March 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.



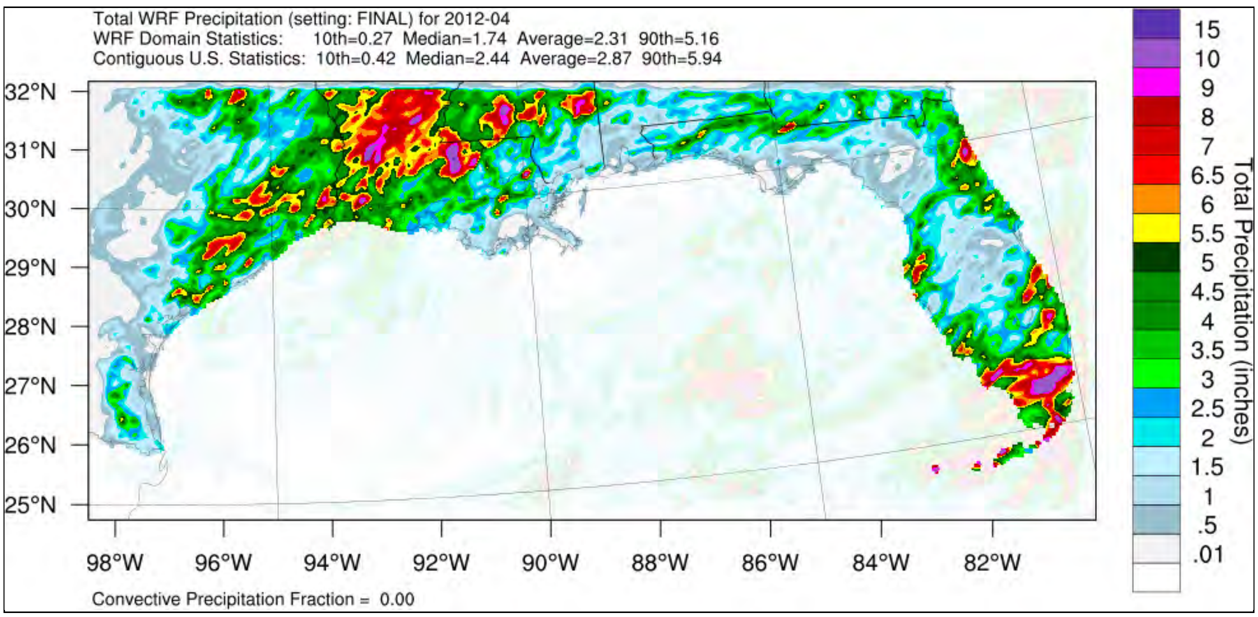


Figure B-26. April 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.

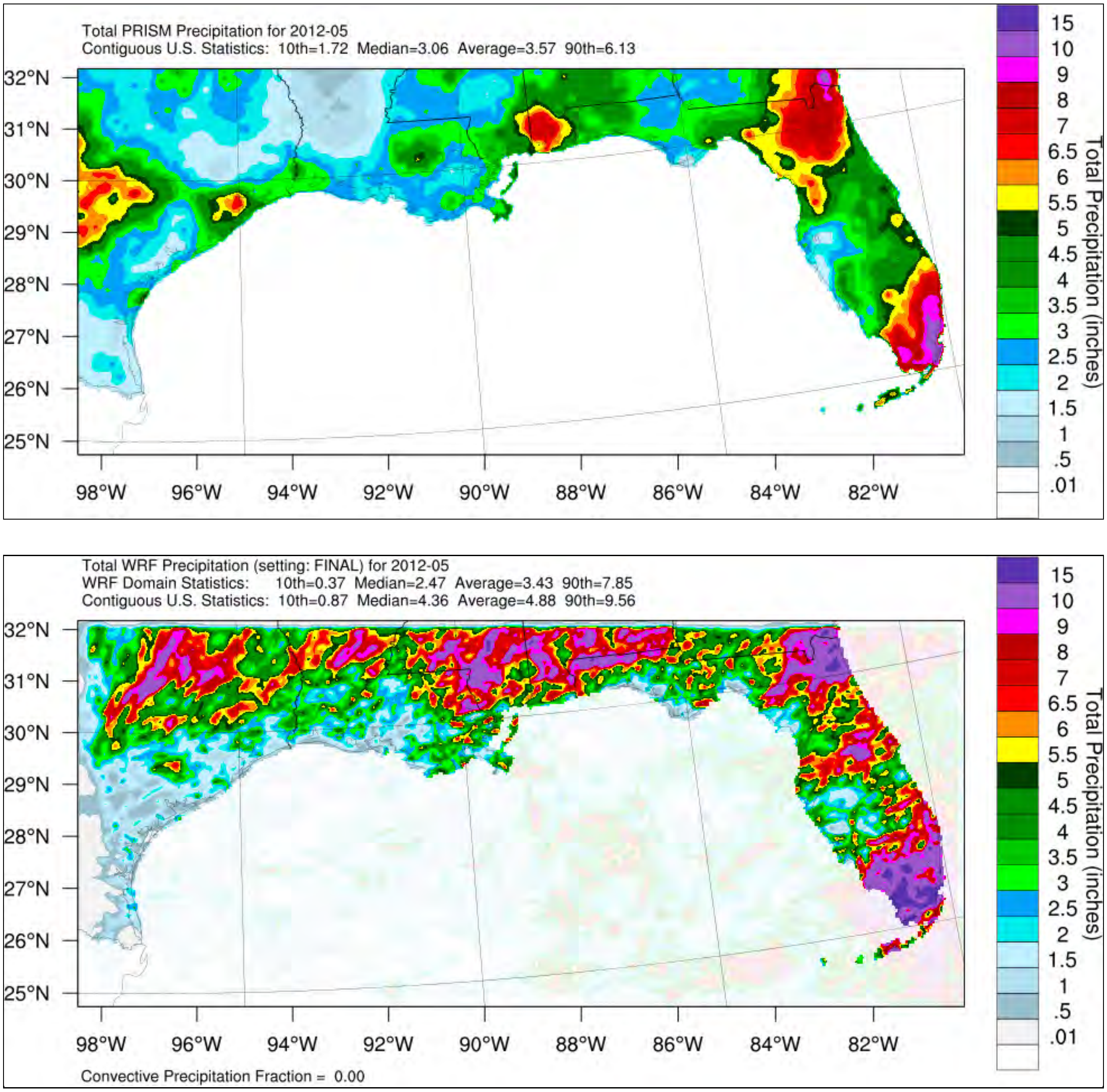
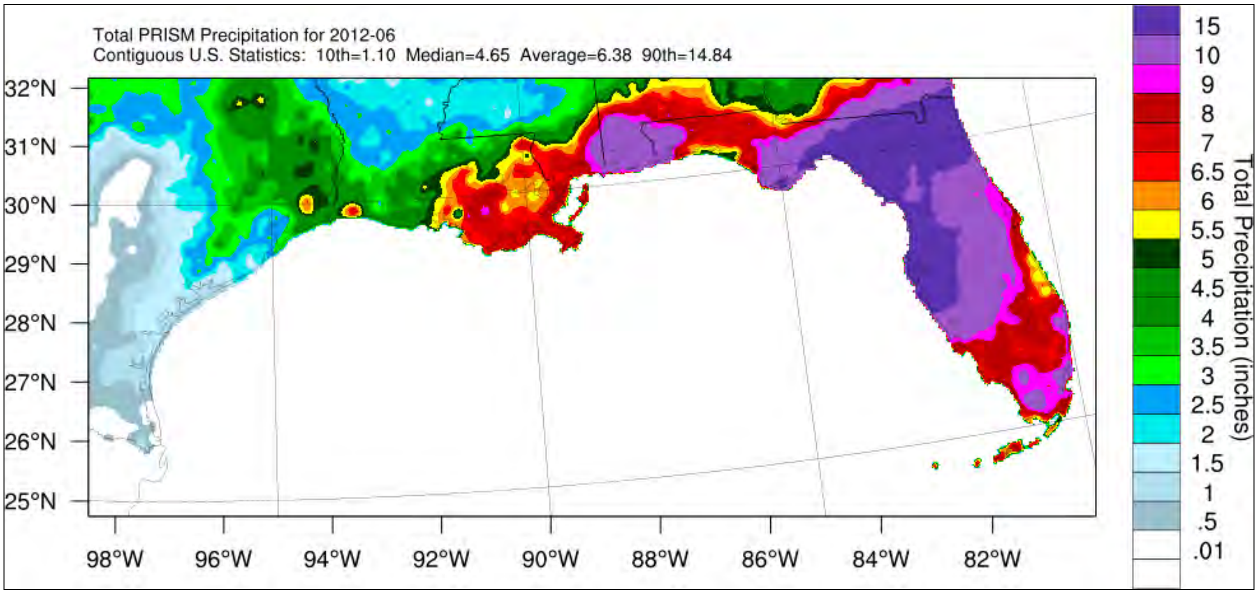


Figure B-27.   May 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.



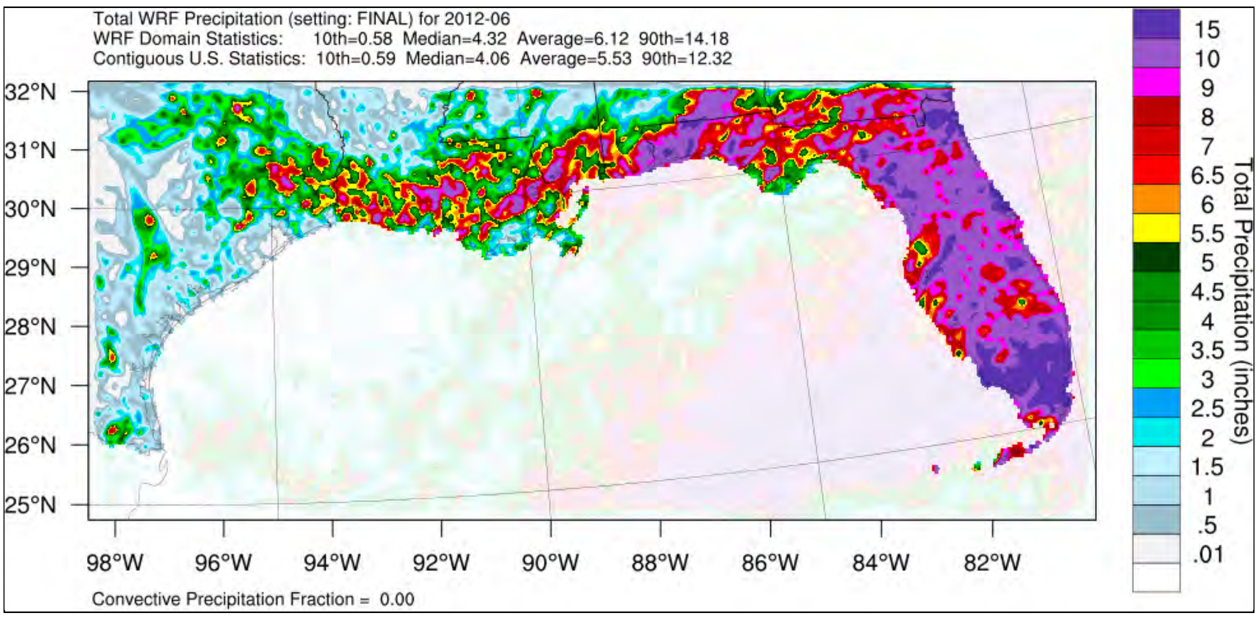
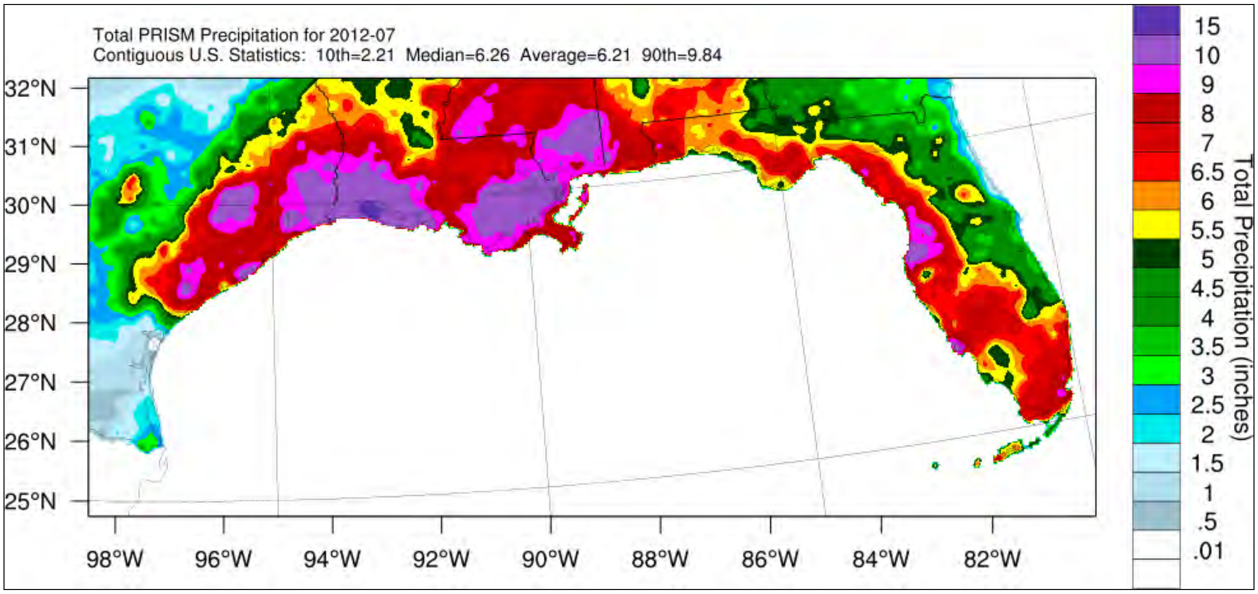


Figure B-28. June 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.



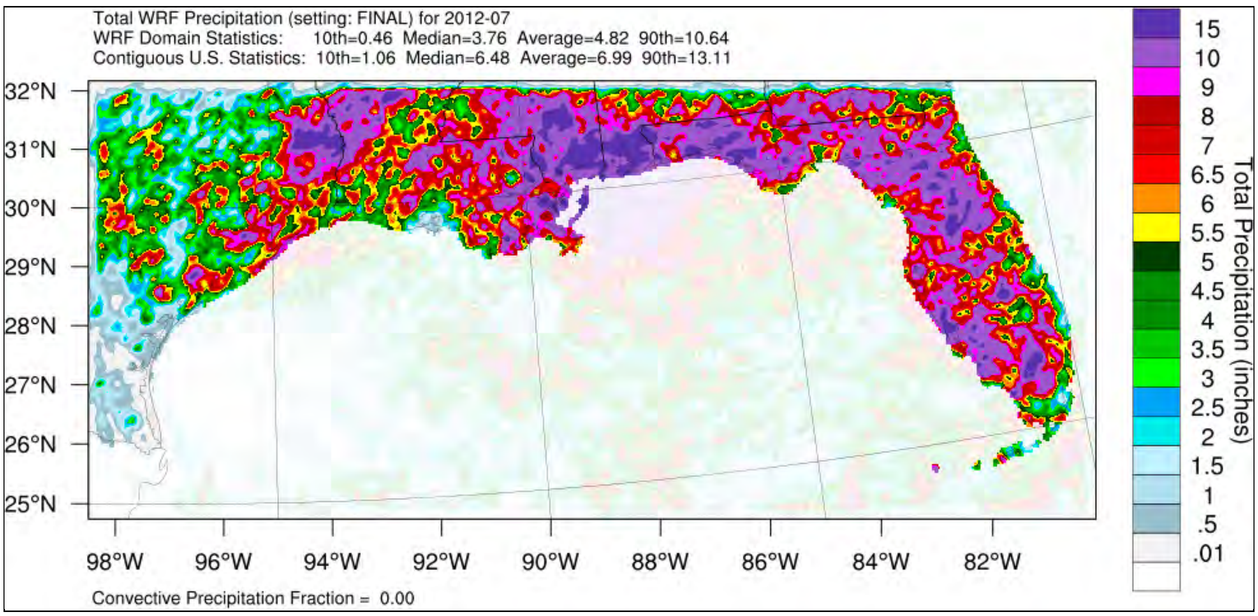


Figure B-29. July 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.

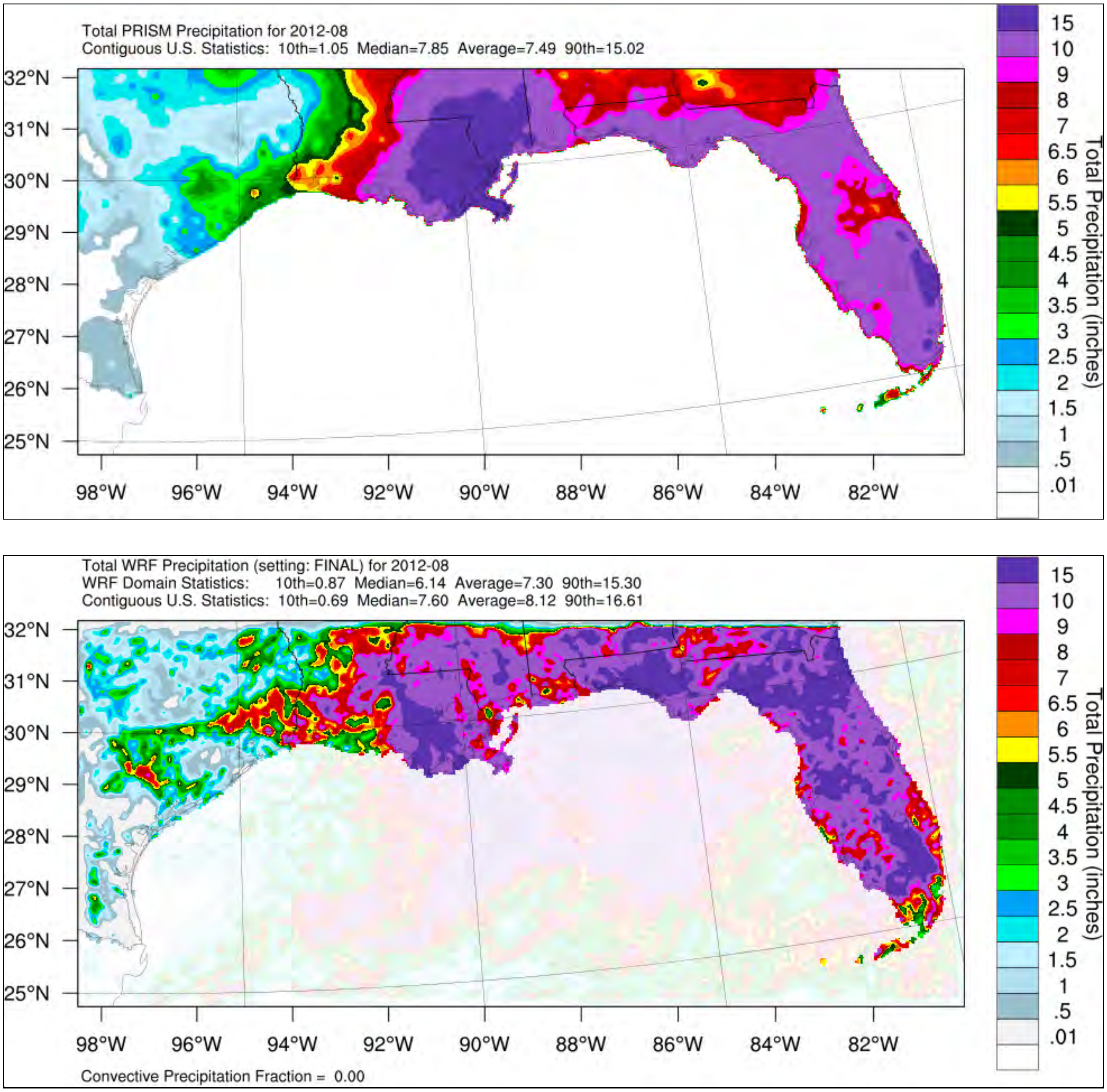


Figure B-30. August 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.

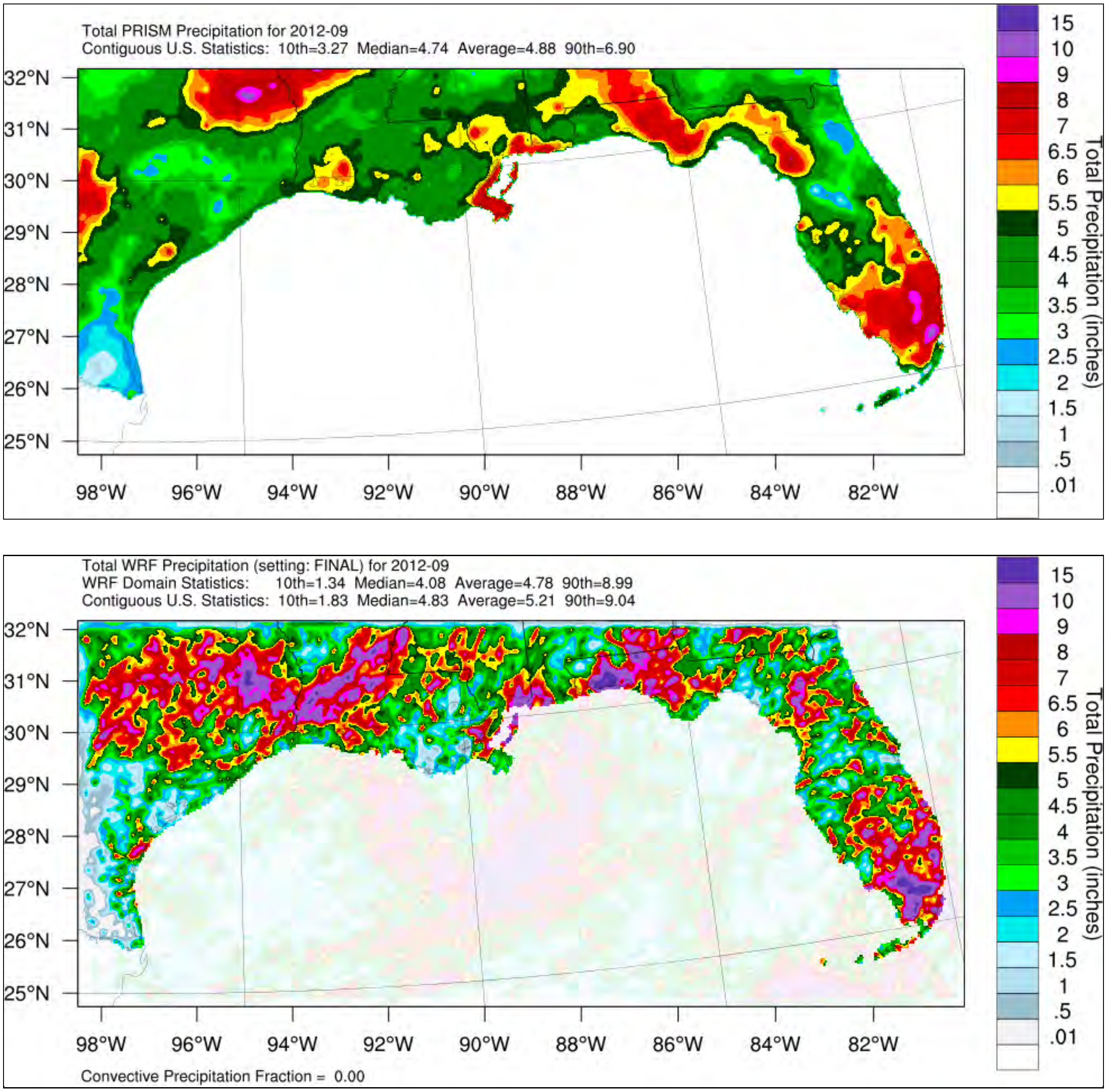
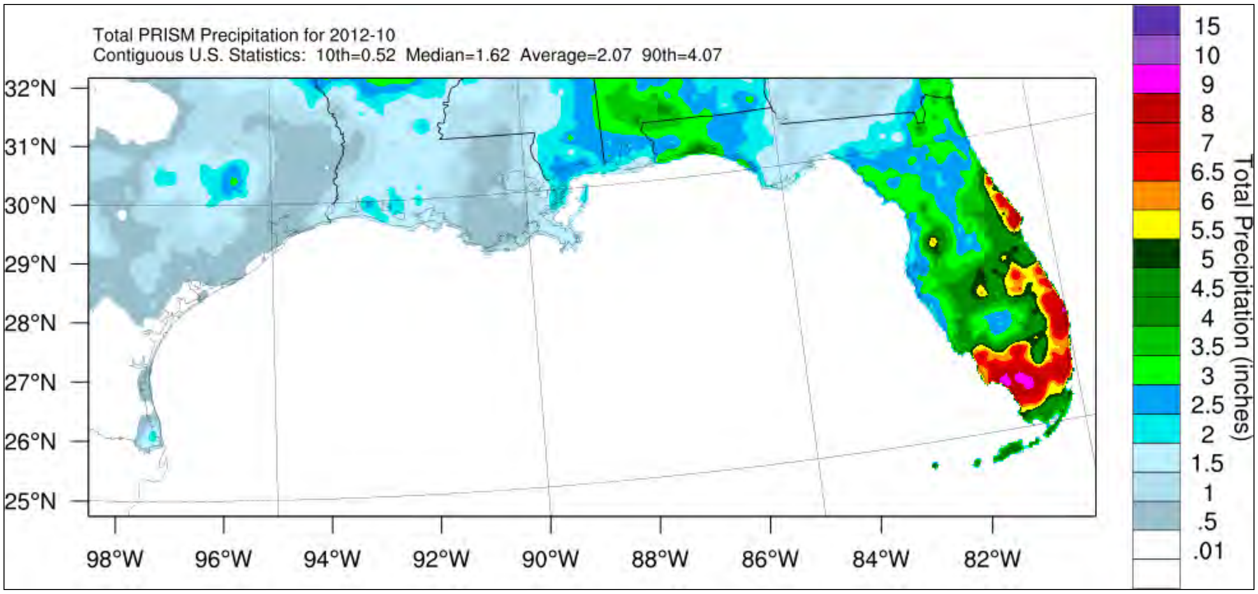


Figure B-31. September 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.



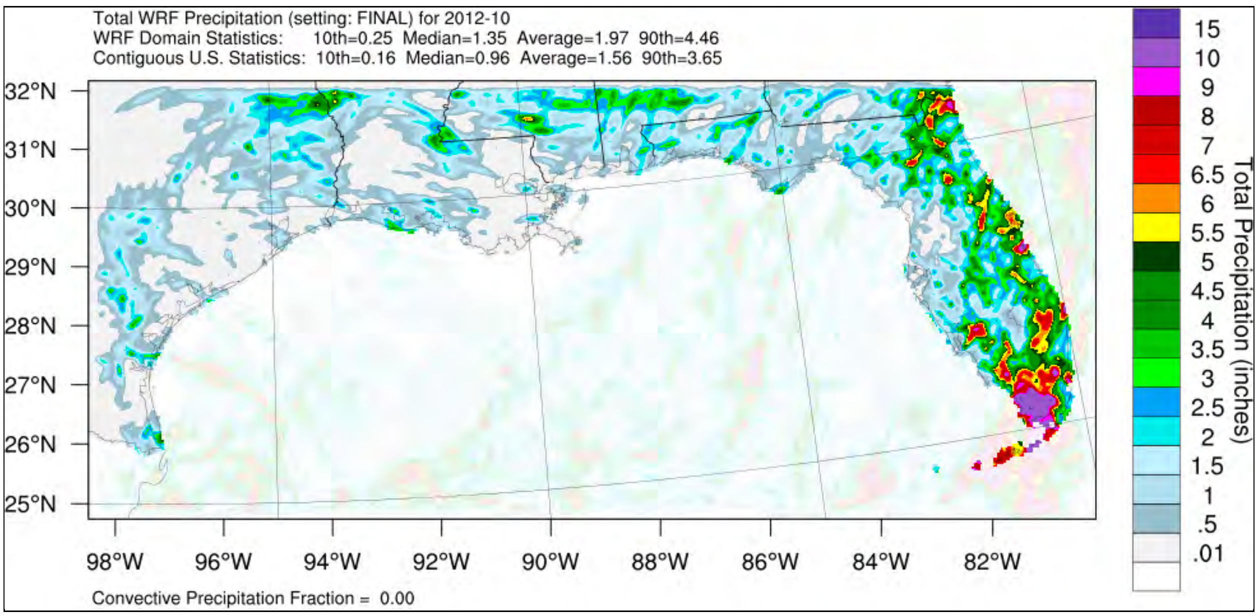


Figure B-32. October 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.

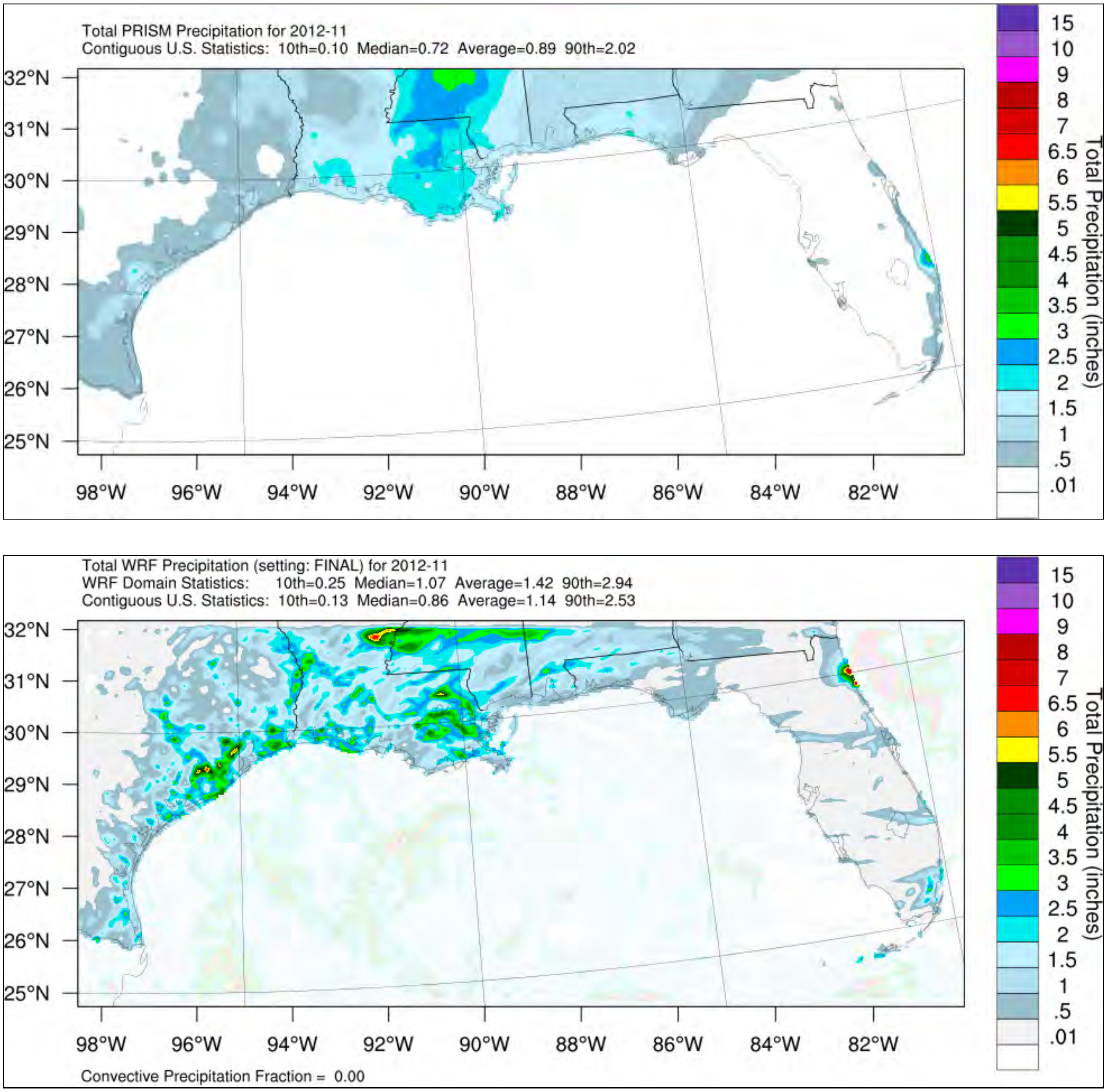
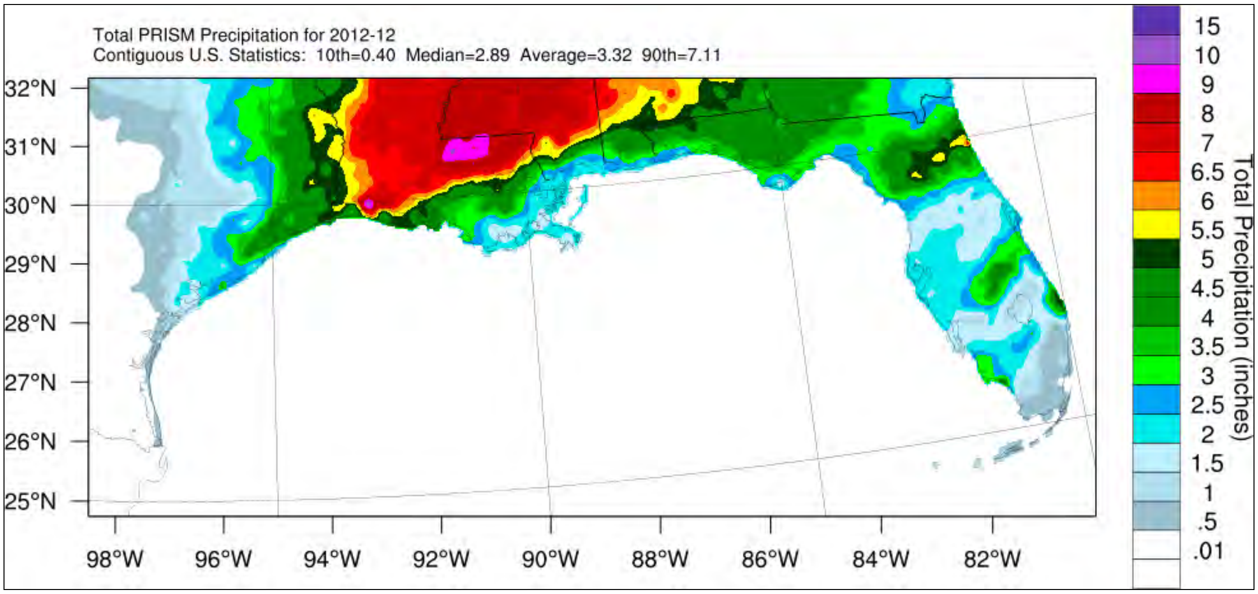


Figure B-33. November 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.



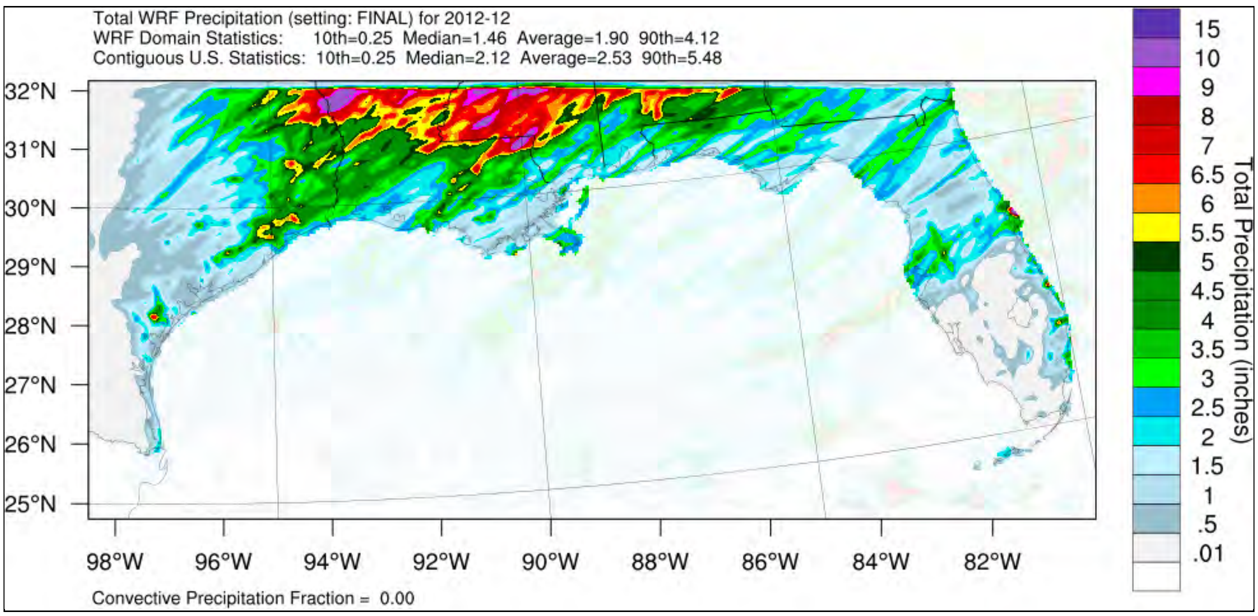


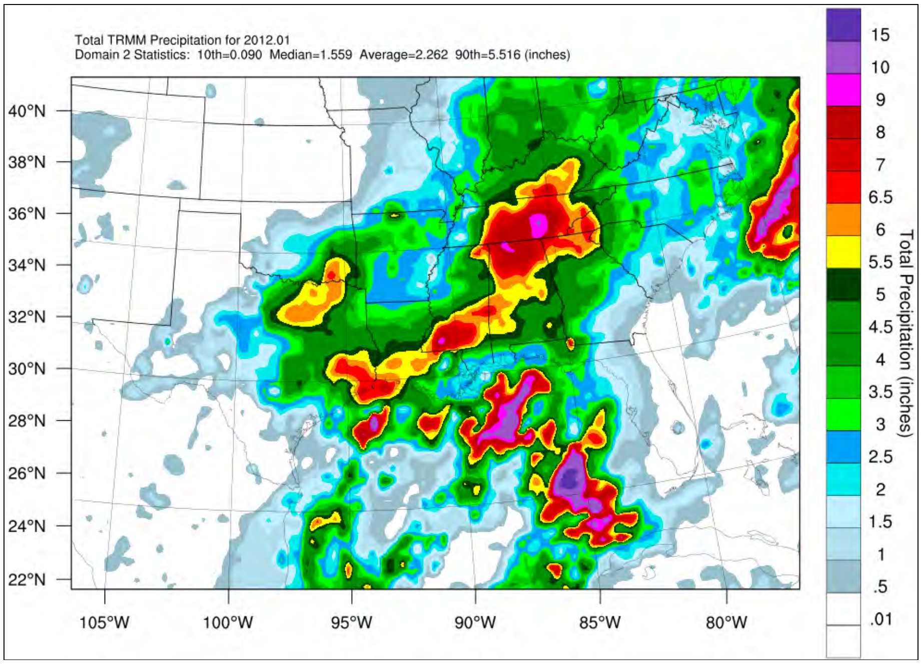
Figure B-34. December 2012 PRISM Precipitation (top) and WRF Precipitation (bottom), 4-km Domain.

B.3.4.2 Evaluation Over Water Using Satellite Precipitation

In this analysis, WRF precipitation data are also compared to TRMM satellite precipitation data to assess the accuracy of the WRF precipitation. Ramboll Environ re-projected and aggregated the TRMM data to the WRF projection's grid cell locations, and the resulting gridded data was plotted and the gridded fields saved. This allows for a consistent visual qualitative comparison, although the 0.5-degree (~55-km) TRMM dataset is at a lower resolution than the 4-km PRISM dataset and as a result, the satellite precipitation fields appear much coarser in the 4-km domain. Additionally, near the end of the WRF modeling period, the satellite hosting the TRMM sensor ran out of propellant. This caused its orbit to slowly decay, casting into doubt the validity of the derived rainfall quantities and is the reason only a qualitative comparison is presented below. Below, **Figures B-35 through B-46** show monthly WRF precipitation averages compared to TRMM precipitation averages throughout 2012 in the 12-km domain.

The WRF under-predicts precipitation over the offshore portions of the domain, compared to TRMM for the averaging months of January through May, as shown in **Figures B-35 through B-39**. From June through October, WRF performs well at predicting precipitation spatially and numerically, shown in **Figures B-40 through B-44**. The increased amount of rainfall over the southeast Gulf Coast States, stretching out over the coastlines, is well represented through the summertime months. The WRF slightly under-predicts the amount of rainfall in the offshore portions of the Gulf, compared to the TRMM precipitation averages for November and December, shown in **Figures B-45 and B-46**. Even with the coarse TRMM resolution, it appears the model has a slight dry bias in the over-water portions of the domain in the colder months.

Given the coarser resolution of the TRMM plots, WRF tends to under-forecast precipitation intensity overall in the offshore portions of the Gulf throughout the winter and spring months and does a satisfactory job at forecasting the amount of rainfall over water in the summer and fall months in the 4-km domain.



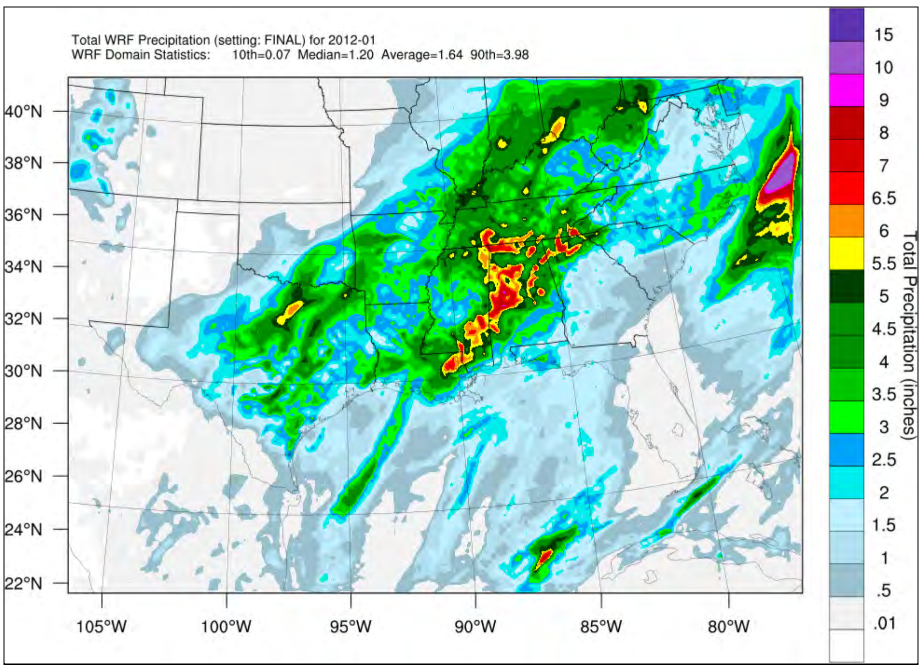
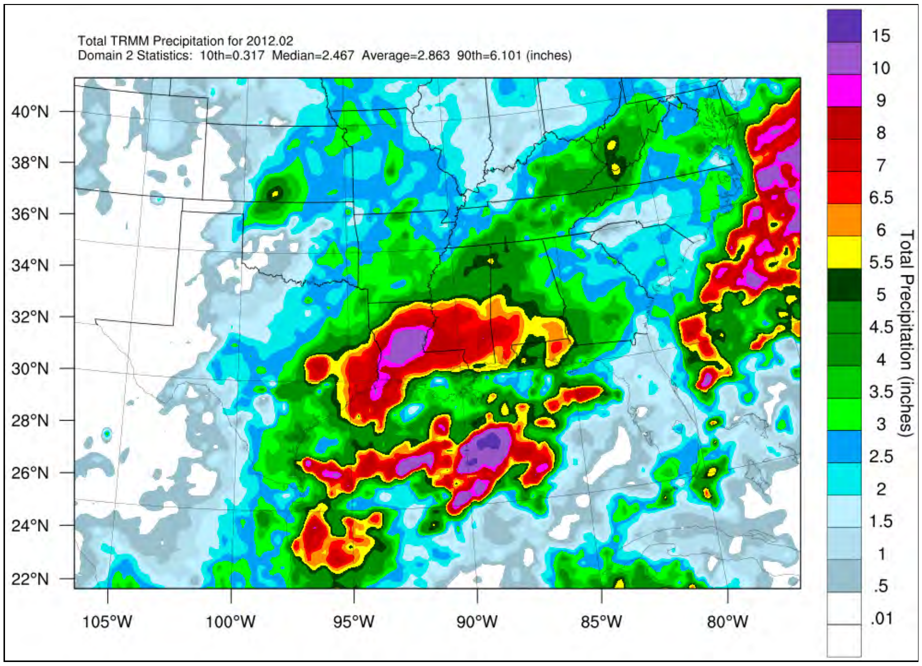


Figure B-35. January 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.



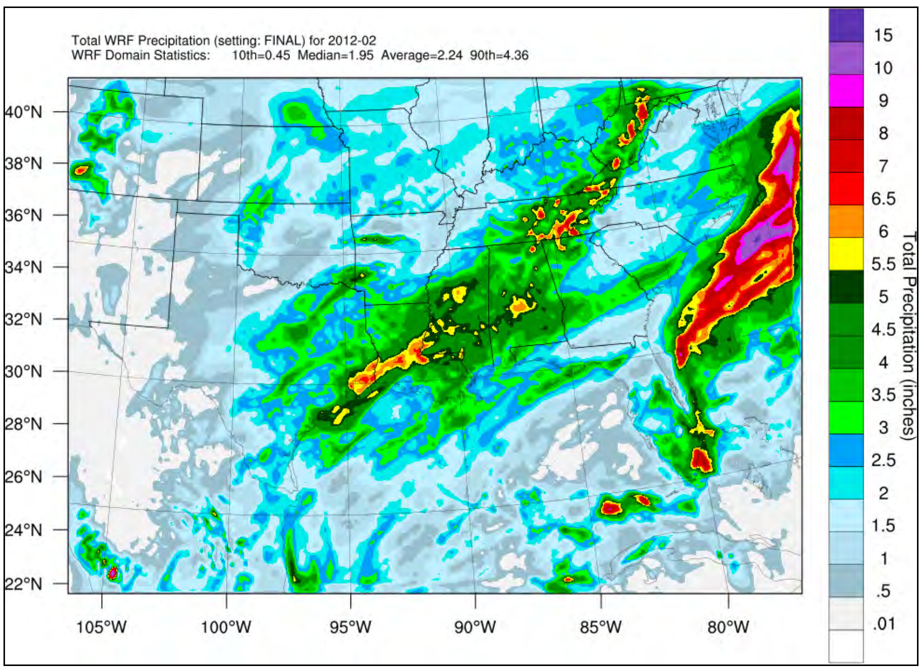


Figure B-36. February 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.

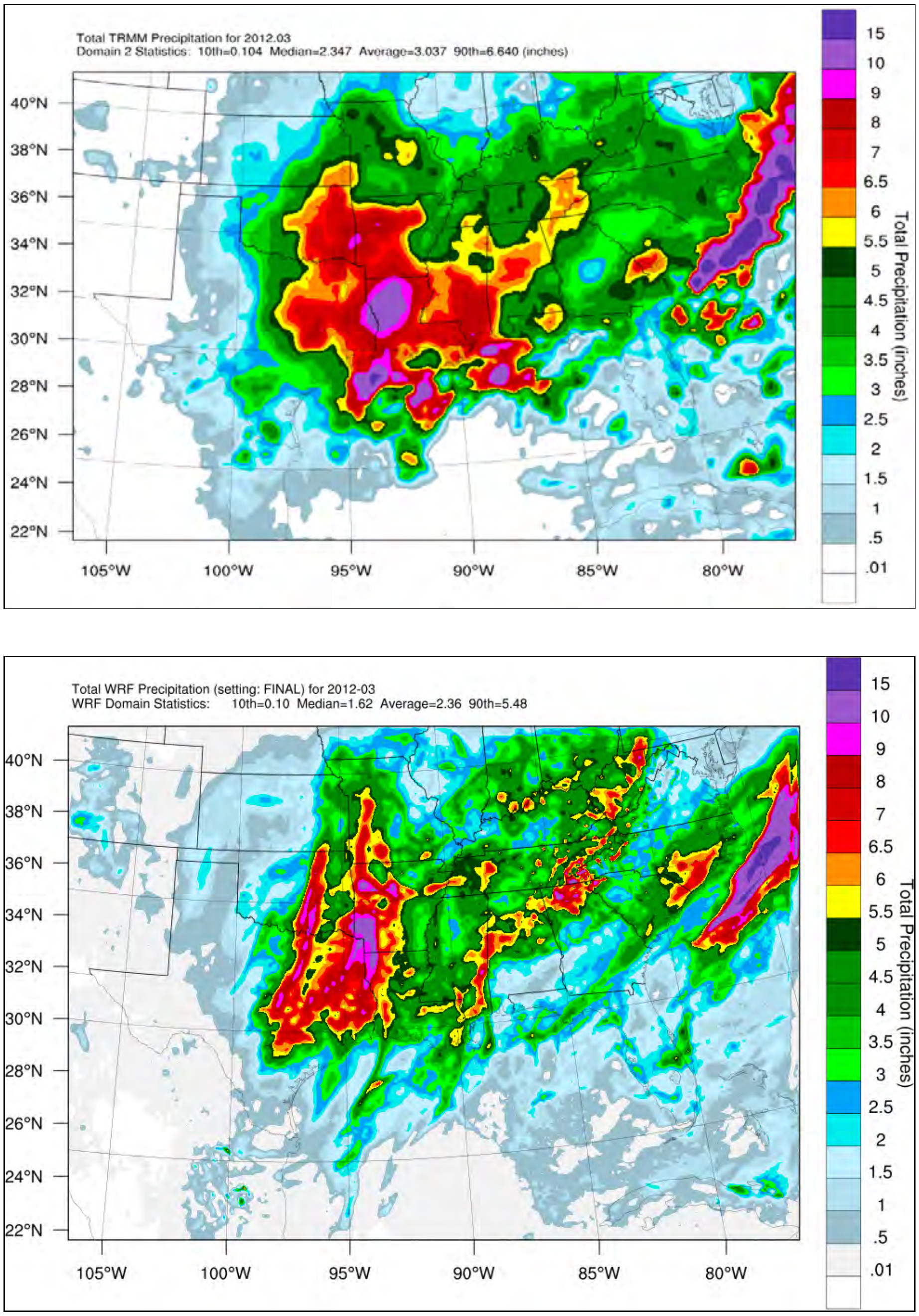


Figure B-37. March 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.

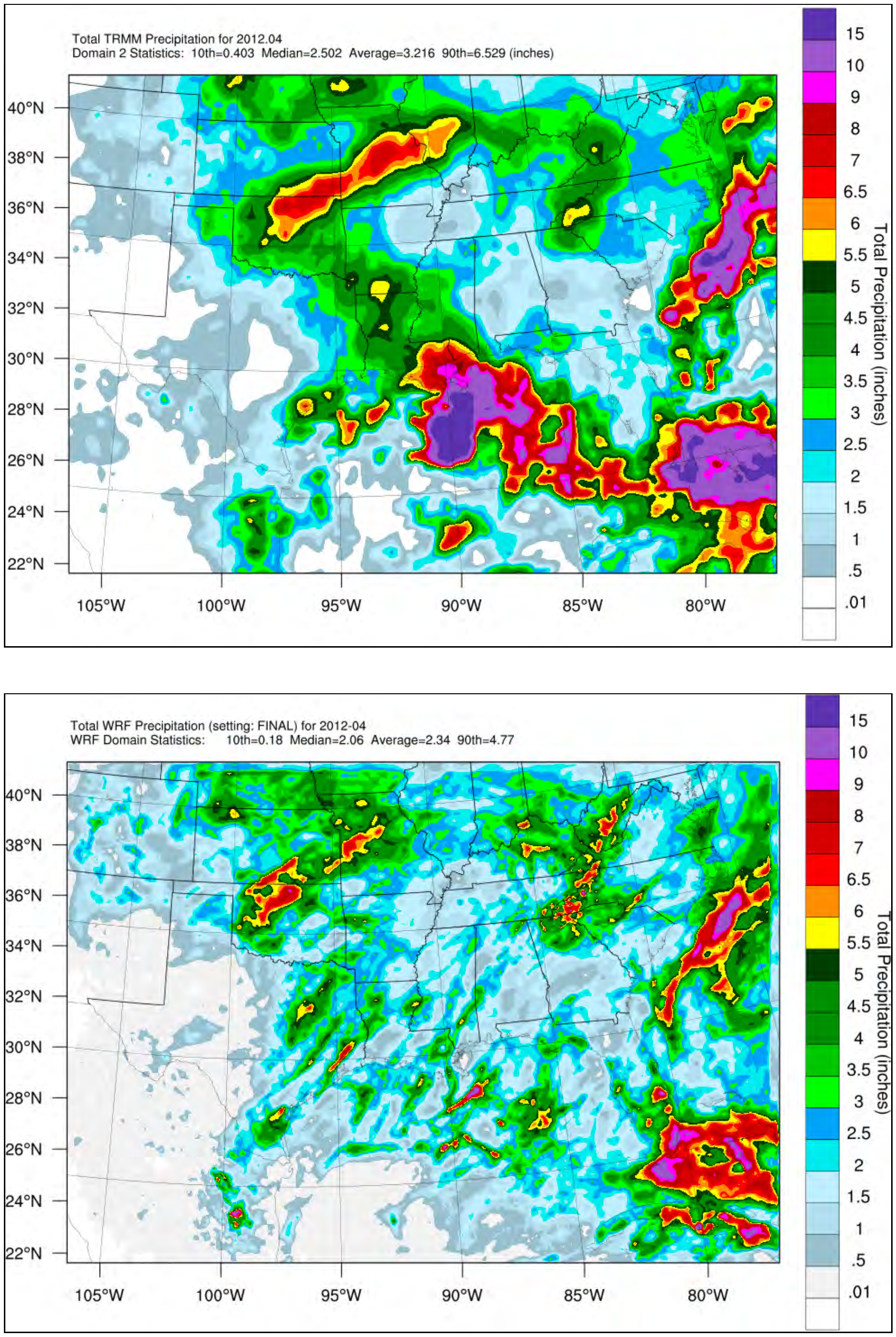


Figure B-38. April 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.

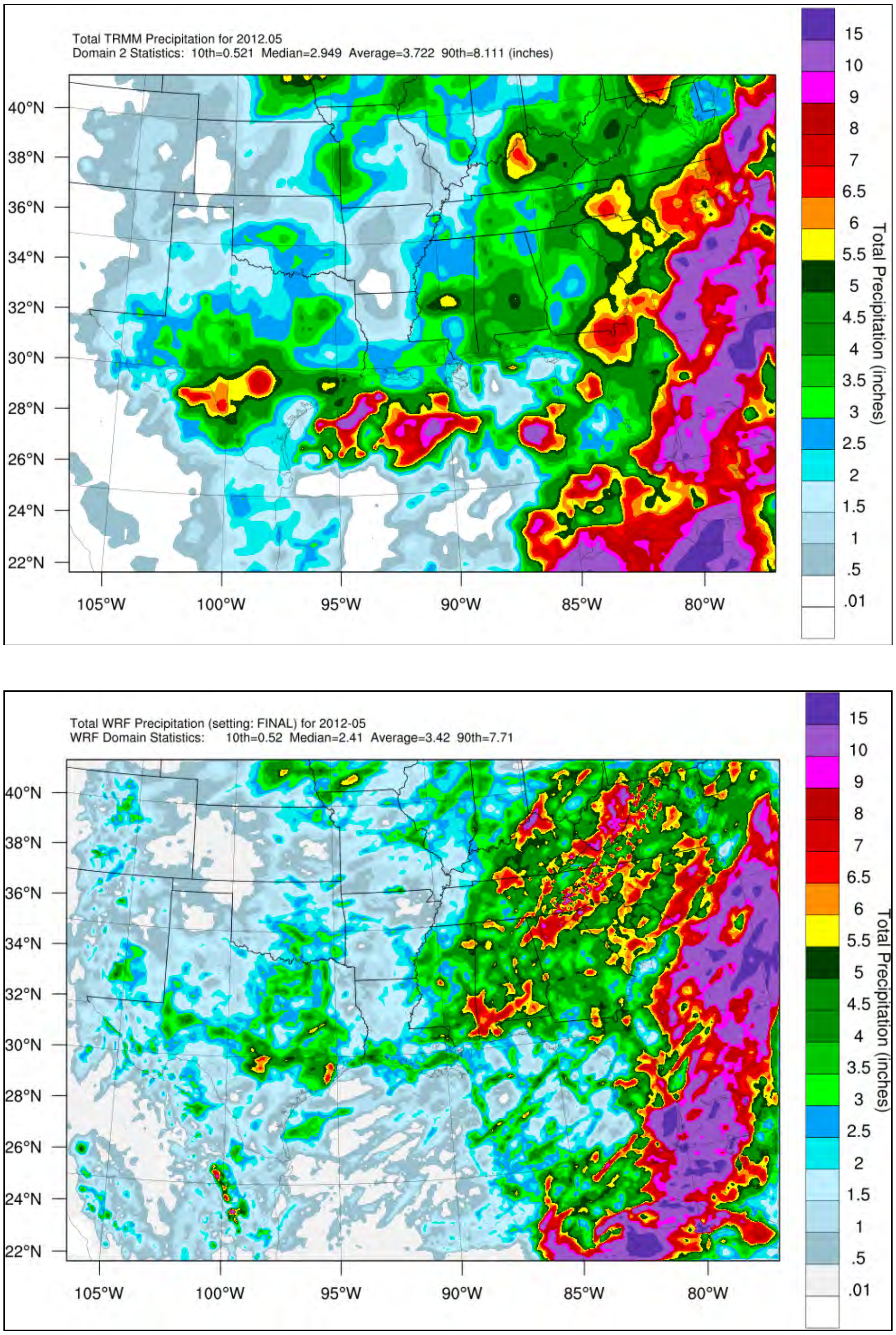
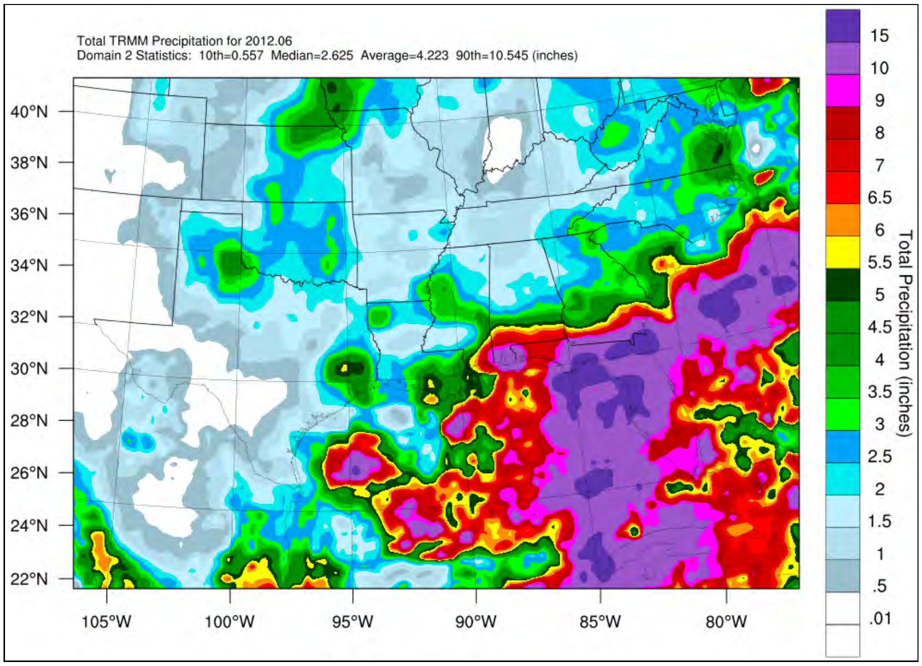


Figure B-39. May 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.



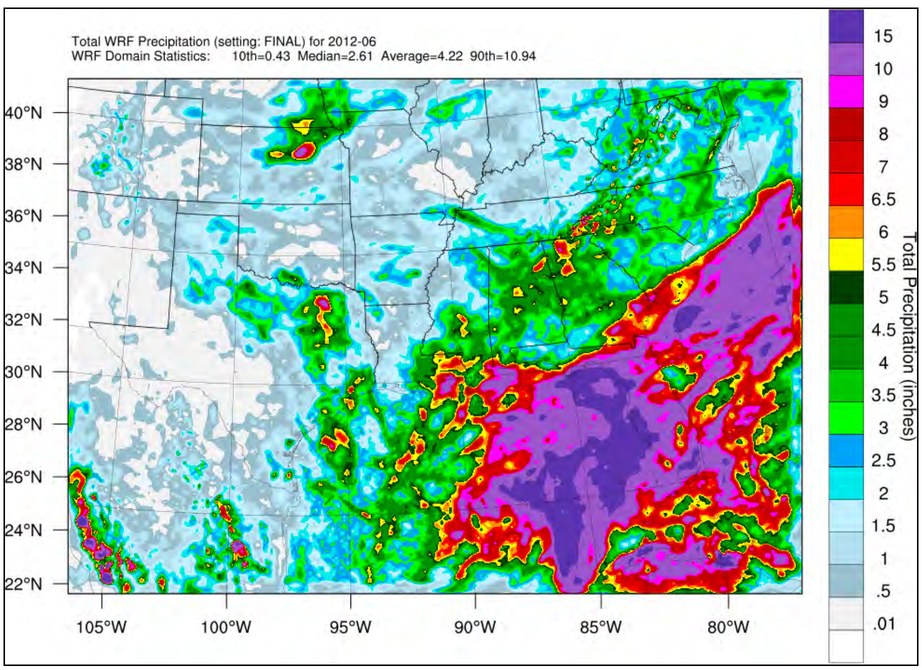


Figure B-40. June 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.

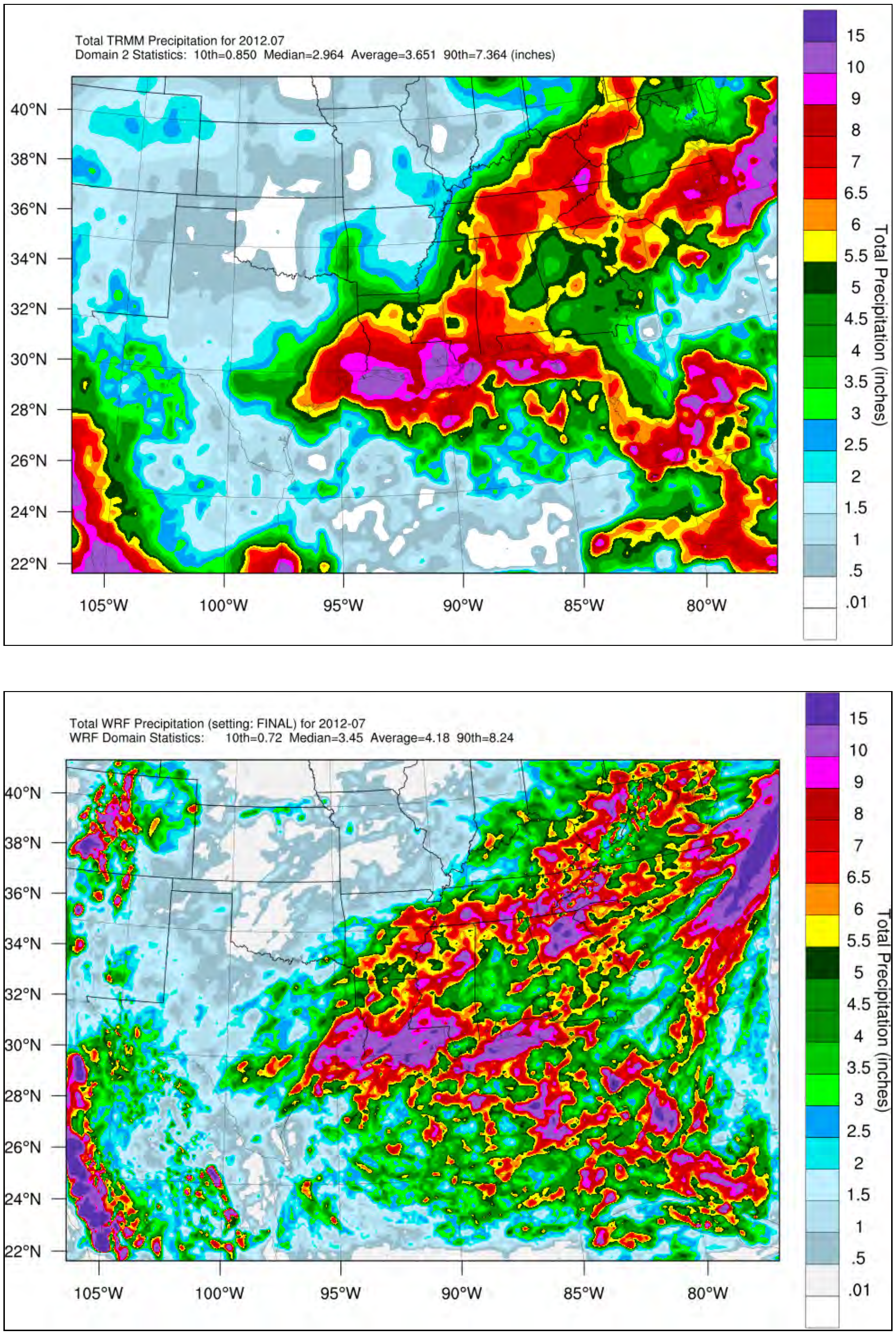


Figure B-41. July 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.

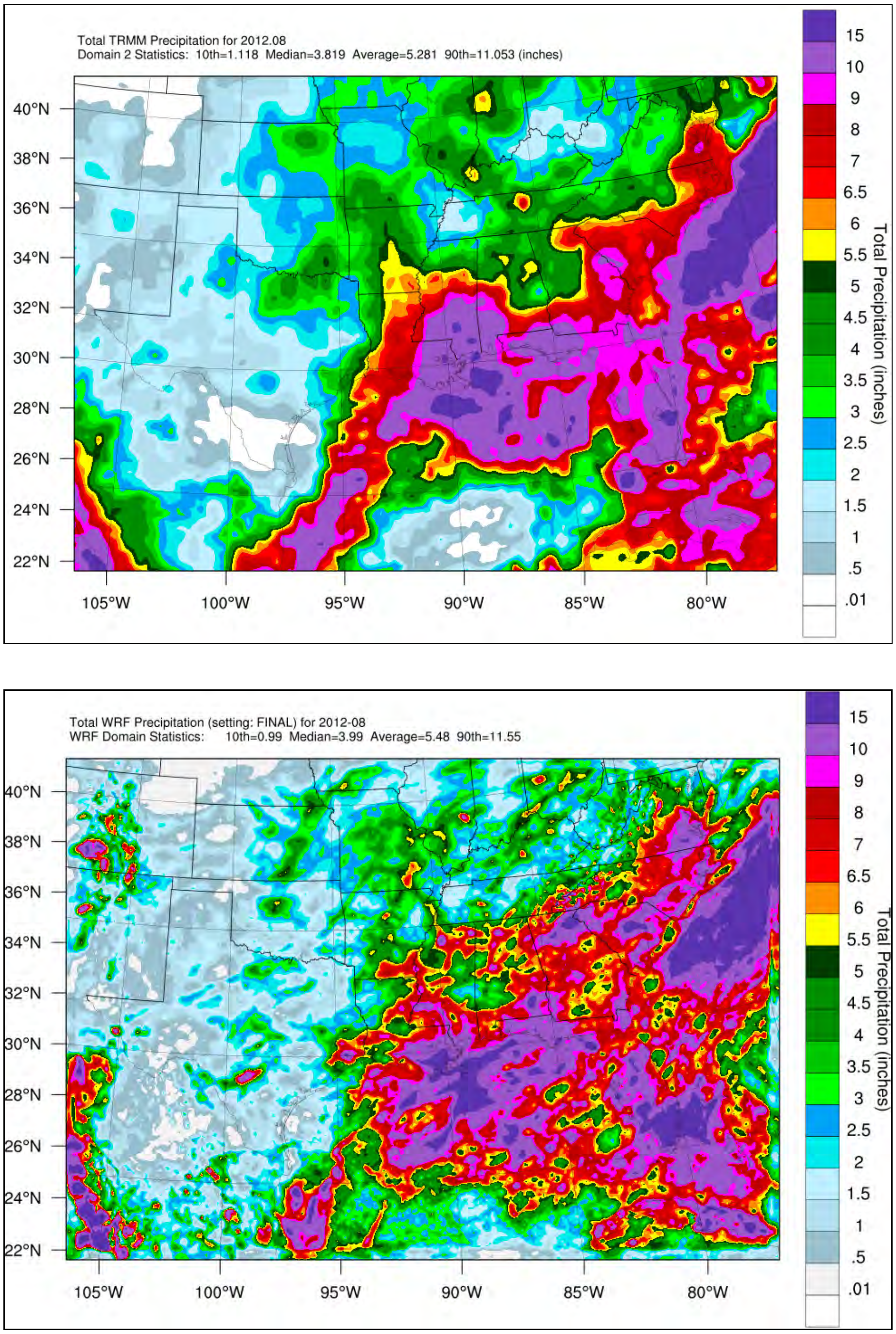
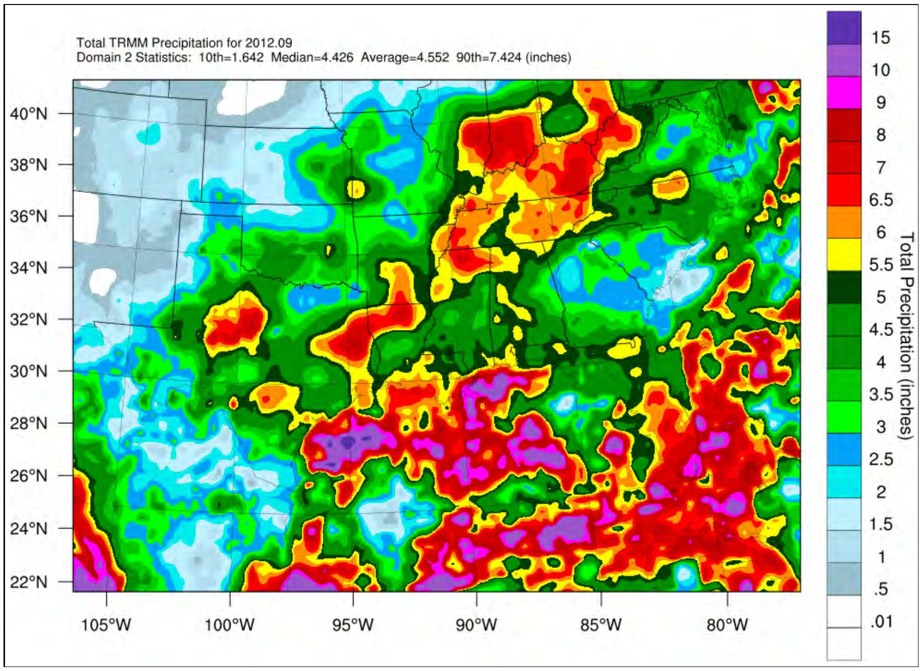


Figure B-42. August 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.



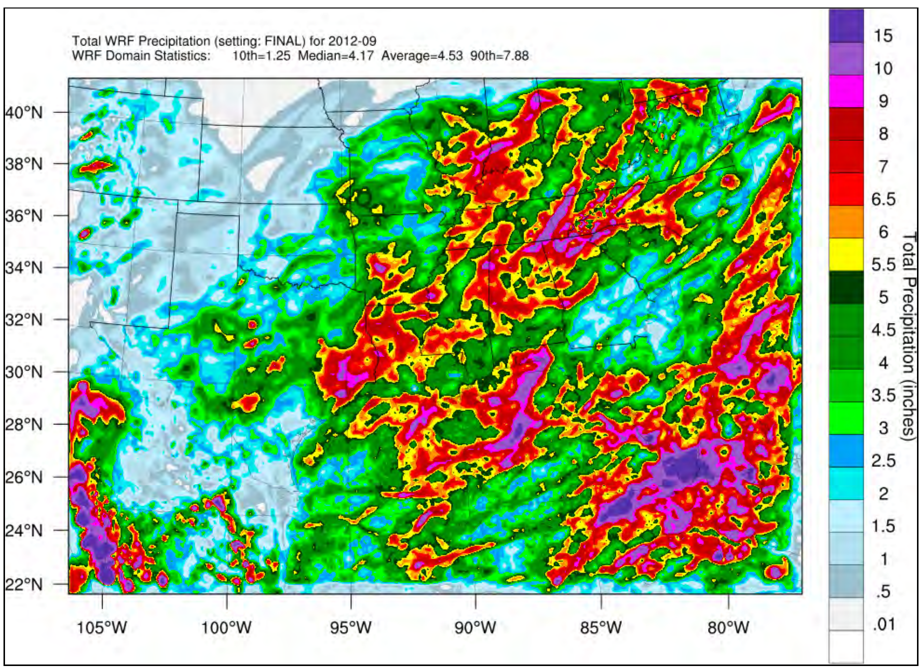
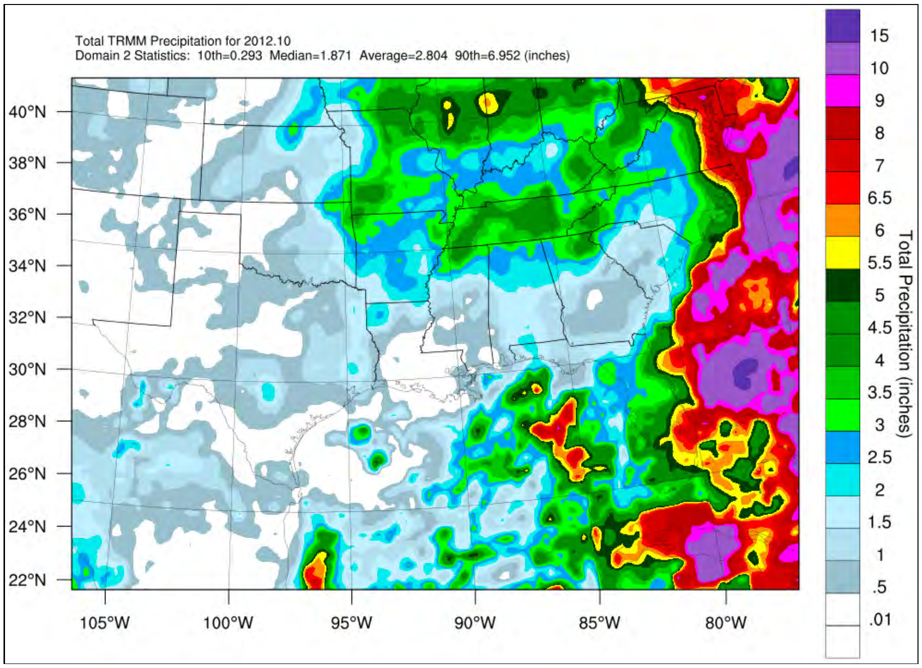


Figure B-43. September 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.



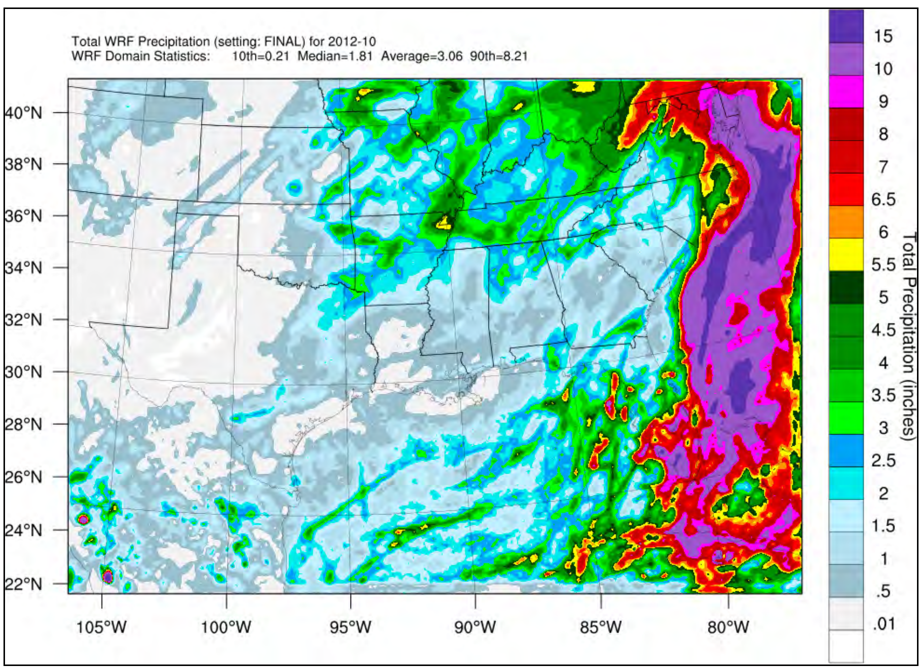
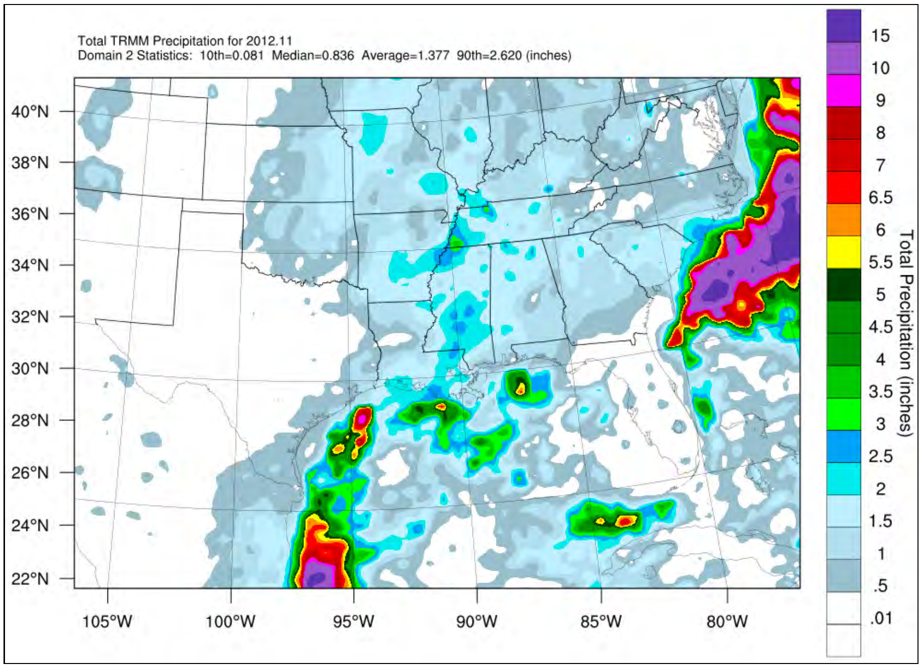


Figure B-44. October 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.



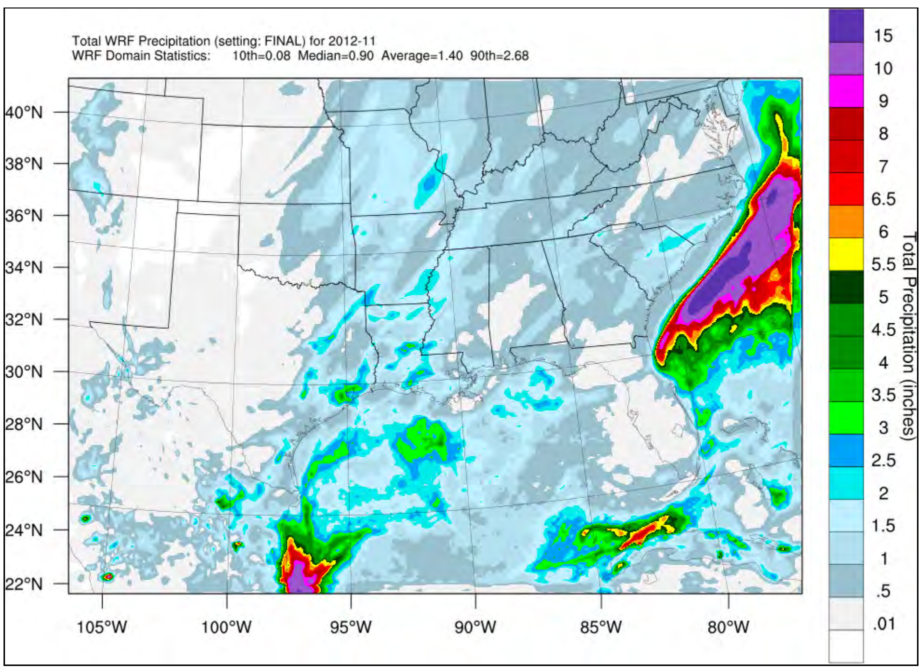
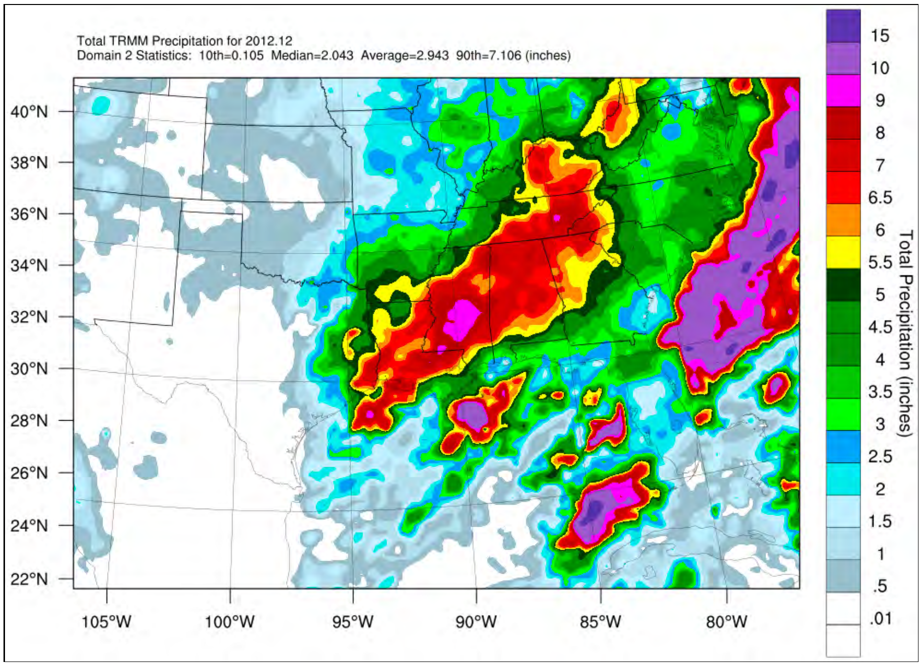


Figure B-45. November 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.



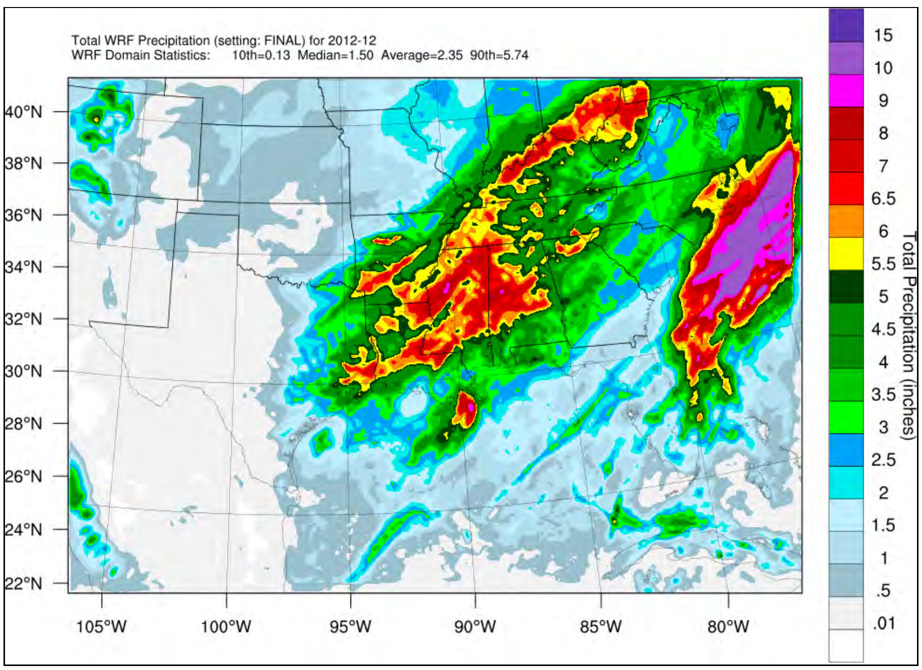


Figure B-46. December 2012 TRMM Precipitation Average (top) and Corresponding WRF Precipitation Average (bottom) in the 12-km Domain.

B.3.4.3 Evaluation Using Tropical Cyclone Precipitation Events

In order to evaluate the accuracy of the WRF model for precipitation performance, short-term rainfall events were also analyzed for local and regional scale impacts. Daily precipitation plots were created for every 24-hour period from the WRF, PRISM, and TRMM databases. Tropical cyclone events were chosen as each storm system typically produces a wide area of enhanced rainfall for both onshore and offshore areas.

A tropical cyclone is a warm-core, non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center (NHC, 2015). Increased rainfall events from two cyclones, Hurricane Isaac and Tropical Storm Debby, are presented in a qualitative comparison.

Hurricane Isaac made landfall along the coast of southern Louisiana on August 29, 2012, and moved northward, where it was downgraded to a tropical storm on August 30th. Daily precipitation plots from each dataset on August 30th are shown in **Figure B-47**. The WRF depicts the large cyclonic rotation and enhanced precipitation bands from Isaac over southeast Louisiana very well, compared to the PRISM dataset. Compared to TRMM, the model does appear to over-forecast the rainfall intensity for this 24-hour period.

Figure B-48 shows daily precipitation plots as Tropical Storm Debby's outer rain bands begin to impact Florida's west coast on June 25, 2012. The WRF performed very well in comparison to both PRISM and TRMM, forecasting the spatial extent of the large storm throughout the eastern Gulf of Mexico. The model did slightly under-predict the rainfall accumulations in this 24-hour period, compared to the observational and satellite databases.

Overall, WRF performed very well in recreating the daily precipitation events in these two scenarios. The daily precipitation plots from each WRF, PRISM, and TRMM dataset are available by request from Ramboll Environ.

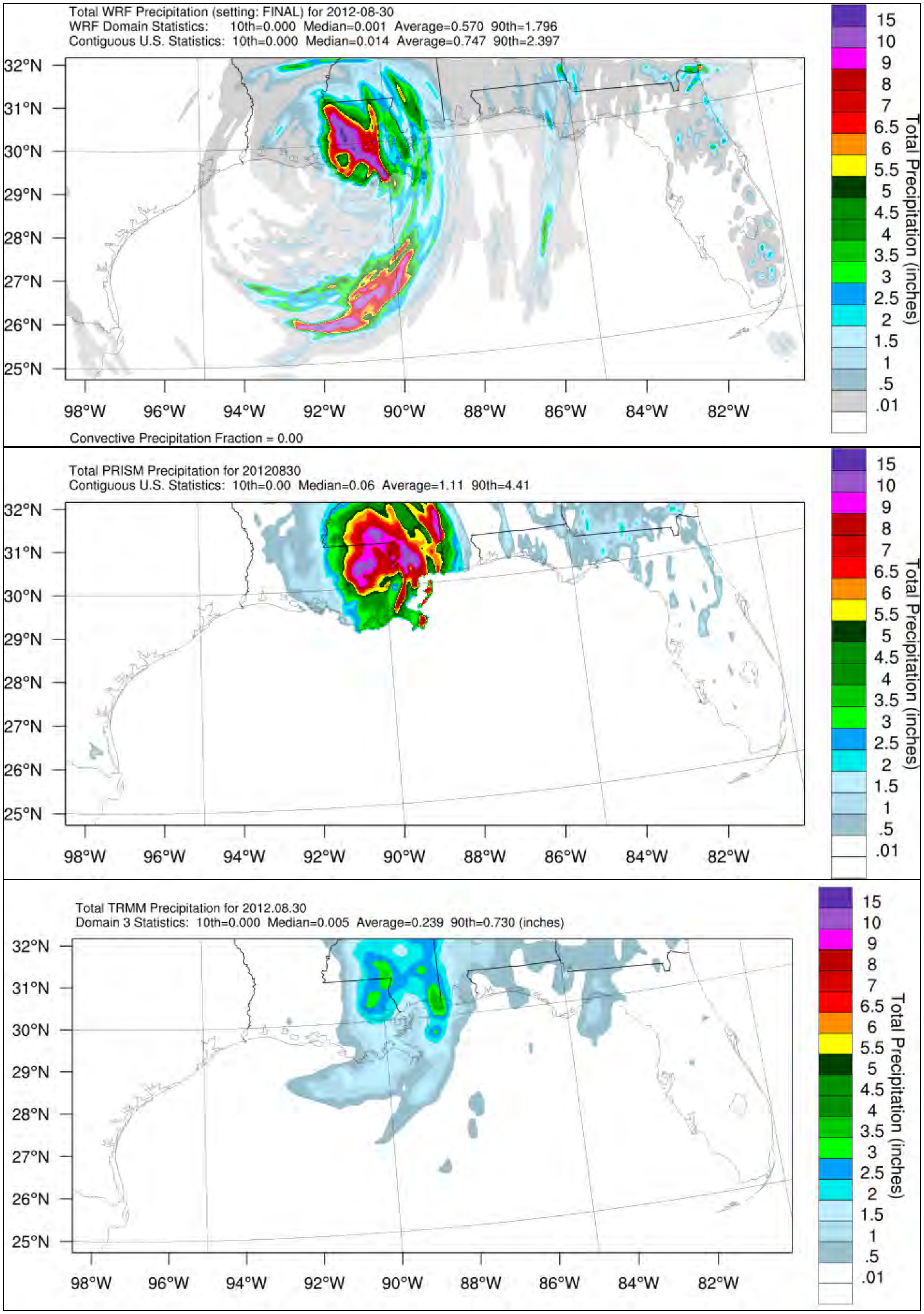


Figure B-47. Daily Precipitation Plots from WRF, PRISM, and TRMM on August 30, 2012.

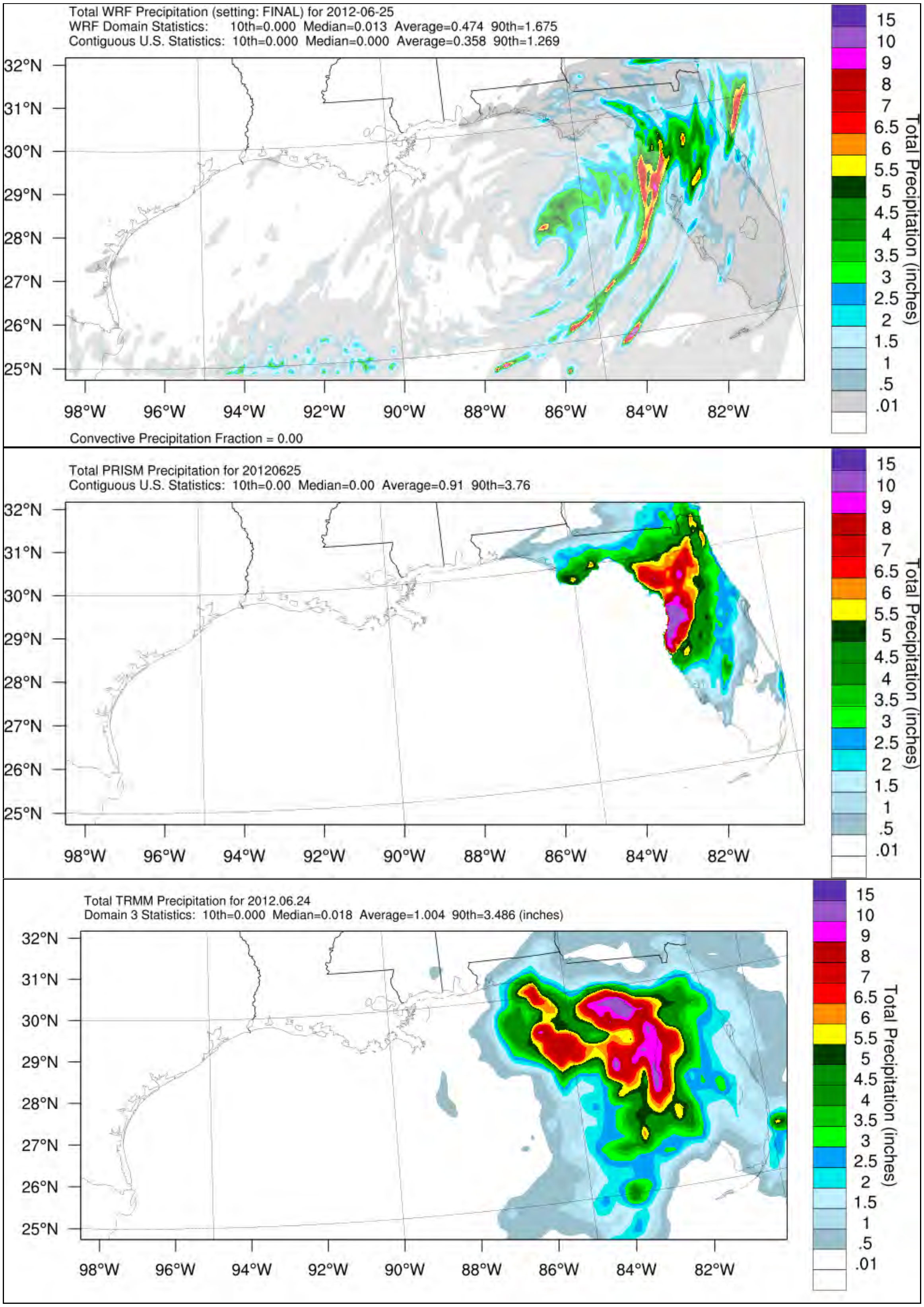


Figure B-48. Daily Precipitation Plots from WRF, PRISM, and TRMM Databases on June 25, 2012.

B.4 Summary and Conclusions

The BOEM Gulf of Mexico OCS Region WRF meteorological model simulation for January through December 2012 reproduced the observed surface and upper-air meteorological variables very well. The WRF performed exceptionally well in the onshore METSTAT analysis for the 36-km and 12-km domains and well in the onshore and offshore analysis for the 4-km domain, with a small bias in wind direction. This performance shows a very strong agreement overall between the model and surface observations.

Comparisons of selected wind roses along the Gulf Coast, which will be presented in the full WRF model evaluation, show WRF was able to forecast the offshore and onshore wind speed and wind direction very well in the 4-km domain. This suggests the model was able to accurately reproduce the land-sea breeze circulation.

Upper air performance in the 4-km (d03) domain for the two selected locations throughout the Gulf of Mexico reflects accurate predictions of the vertical atmosphere, as shown in comparisons between WRF and radiosonde data, especially in mixing layer heights and cases of surface-based temperature inversions.

The monthly precipitation analysis for the 4-km (d03) domain indicates there is a strong agreement between the model and observation-based precipitation measurements over land, including convergence zone and enhanced rainfall areas. The comparison with the 12-km (d02) WRF and satellite-based precipitation accumulations does indicate some understatement of precipitation over water, most notably in the winter months.

Based on our experience, the BOEM Gulf of Mexico OCS Region WRF modeling's superior performance throughout 2012 provides a substantial basis for developing meteorological inputs for air quality modeling in the Gulf of Mexico region.

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APPENDIX C

AIR QUALITY:
EMISSIONS FOR THE CUMULATIVE AND VISIBILITY IMPACTS

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C AIR QUALITY: EMISSIONS FOR THE CUMULATIVE AND VISIBILITY IMPACTS

C.1 INTRODUCTION

The U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) is required under the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. § 1334(a)(8)) to comply with the National Ambient Air Quality Standards (NAAQS) to the extent that Outer Continental Shelf (OCS) offshore oil and gas exploration, development, and production sources do not significantly affect the air quality of any state. The Gulf of Mexico OCS Region's OCS area of possible influence includes the States of Texas, Louisiana, Mississippi, Alabama, and Florida. BOEM's Gulf of Mexico OCS Region manages the responsible development of oil, gas, and mineral resources for the 430 million acres in the Western, Central, and Eastern Planning Areas on the OCS comprising the Gulf of Mexico OCS Region, including the areas under moratoria (shown in **Figure C-1**). The Clean Air Act Amendments (CAAA) of 1990 designate air quality authorities in the Gulf of Mexico OCS Region, giving BOEM air quality jurisdiction westward of 87°30'W. longitude and the U.S. Environmental Protection Agency (USEPA) air quality jurisdiction eastward of 87°30'W. longitude. In 2006, oil and gas leasing operations within 125 miles (201 kilometers [km]) of the Florida coastline were banned until 2022 under the Gulf of Mexico Energy Security Act (GOMESA). The GOMESA moratoria area is depicted on **Figure C-1**.

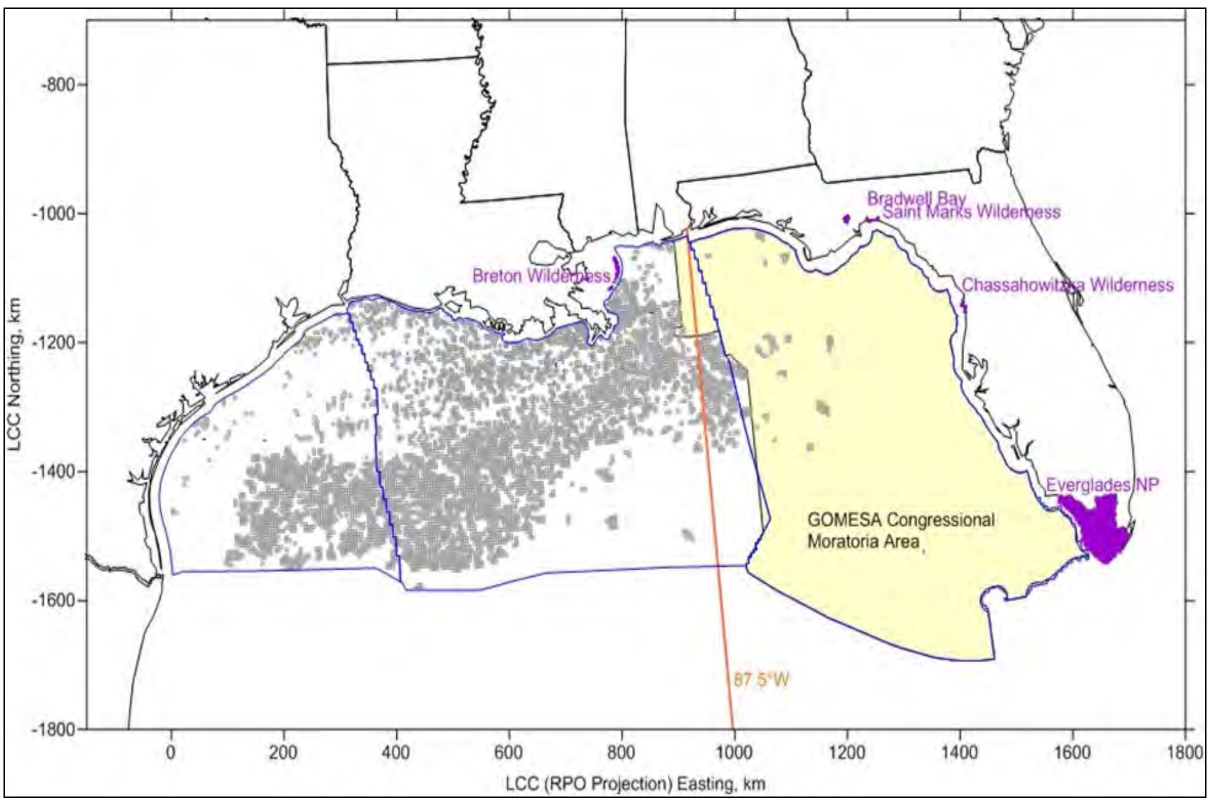

Figure C-1. Location of the "Air Quality Modeling in the Gulf of Mexico Region" Study, with Class I Areas (purple) and Platform Locations (gray dots).

The USEPA has set NAAQS for six regulated air quality pollutants: ozone; particulate matter with an aerodynamic diameter of 2.5 micrometers and smaller ($PM_{2.5}$); particulate matter with an aerodynamic diameter of 10 micrometers and smaller (PM_{10}); sulfur dioxide (SO_2); nitrogen dioxide (NO_2); carbon monoxide (CO); and lead (Pb). After promulgation of a NAAQS, the USEPA designates areas that fail to achieve the NAAQS as nonattainment areas (NAAs) and States are required to submit State Implementation Plans (SIPs) to the USEPA that contain emission control plans and a demonstration that the NAA will achieve the NAAQS by the required date. After an area comes into attainment of the NAAQS, the area can be redesignated as a maintenance area and must continue to demonstrate compliance with the NAAQS.

In 1997, the USEPA promulgated the first 8-hour ozone NAAQS with a threshold of 0.08 parts per million (ppm) (84 parts per billion [ppb]). On March 12, 2008, the USEPA promulgated a more stringent 0.075 ppm (75 ppb) 8-hour ozone NAAQS. **Figure C-2** presents the current ozone nonattainment areas in the southeastern U.S. On October 1, 2015, the USEPA strengthened the 8-hour NAAQS for ozone to 0.07 ppm (70 ppb). Under this more stringent ozone NAAQS, there may be more areas in the southeastern U.S. that will be in nonattainment. The USEPA plans to make attainment and nonattainment designations for the revised standards by late 2017, with the designations based on 2014-2016 air quality data.

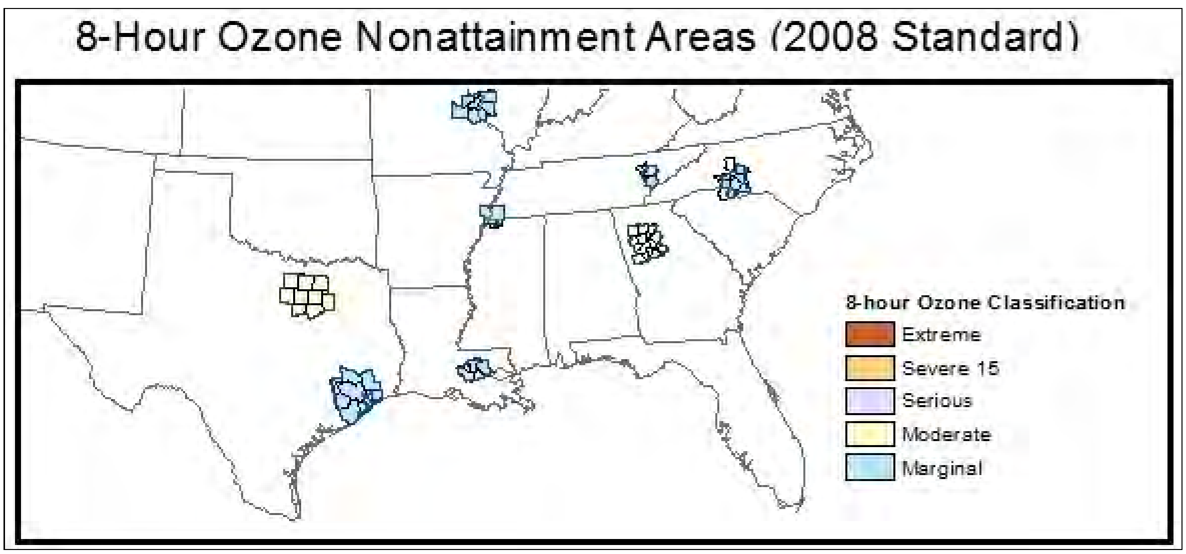

Figure C-2. Ozone Nonattainment Areas in the Southeastern U.S. (USEPA, 2016a).

On December 14, 2012, the USEPA revised the $PM_{2.5}$ primary NAAQS by lowering the annual $PM_{2.5}$ NAAQS threshold from 15.0 micrograms per cubic meter ($\mu g/m^3$) to 12.0 $\mu g/m^3$. The USEPA retained the 24-hour $PM_{2.5}$ primary NAAQS at 35 $\mu g/m^3$. The 24-hour coarse PM NAAQS (PM_{10}) was also retained at 150 $\mu g/m^3$.

In February 2010, the USEPA issued a new 1-hour NO_2 NAAQS with a threshold of 100 ppb (98th percentile daily maximum average over 3 years) and a new 1-hour SO_2 NAAQS was promulgated in June 2010 with a threshold of 75 ppb (99th percentile averaged over 3 years). The USEPA has not yet designated the nonattainment areas for the 1-hour NO_2 and 1 hour SO_2 NAAQS.

A new lead NAAQS was issued in 2008; NAAs for lead are associated with specific industrial sources. The NAAQS for carbon monoxide has remained essentially unchanged since it was originally promulgated in 1971. As of September 27, 2010, all NAAs for carbon monoxide have been redesignated as maintenance areas. **Table C-1** summarizes the nonattainment and maintenance areas in the southeastern U.S.

Table C-1. Nonattainment and Maintenance Areas in the Southeastern U.S.

State	Area	8-hr O_3 (1997)	8-hr O_3 (2008)	SO_2 (2010)	Lead (2008)
Alabama	Troy, AL				NAA[a]
Florida	Tampa, FL				NAA
	Hillsborough County, FL			NAA	
	Nassau County, FL			NAA	
Louisiana	Baton Rouge, LA	M[b]	NAA		
	St. Bernard Parish, LA			NAA	
Texas	Beaumont-Port Arthur, TX	M			
	Houston-Galveston-Brazoria, TX	NAA	NAA		
	Frisco, TX				NAA

[a] NAA = nonattainment area
[b] M = maintenance area
Blank cells indicate the area is in attainment of the NAAQS.

The CAAA designated 156 Class I areas consisting of National Parks and Wilderness Areas that are offered special protection for air quality and air quality-related values (AQRVs). The Class I areas, compared to Class II areas, have lower Prevention of Significant Deterioration (PSD) air quality increments that new sources may not exceed and are protected against excessive increases in several AQRVs including visibility impairment, acid (sulfur and nitrogen) deposition, and nitrogen eutrophication. The Regional Haze Rule (RHR) has a goal of natural visibility conditions by 2064 at Class I areas, and States must submit RHR SIPs that demonstrate progress towards that goal. **Figure C-1** displays the locations of the mandatory Class I areas (in purple) in the Gulf of Mexico OCS Region. In addition to Class I areas, Federal Land Management (FLM) agencies have designated certain other areas as sensitive Class II areas for tracking PSD increment consumption and AQRV impacts.

On August 26, 2014, BOEM contracted with Eastern Research Group, Inc. (ERG) and team members Ramboll Environ US Corporation (Ramboll Environ) and Alpine Geophysics, LLC to complete a comprehensive air quality modeling study in the Gulf of Mexico OCS Region. Under BOEM Contract Number M14PC00007, air quality photochemical grid modeling (PGM) will be conducted in the Gulf of Mexico OCS Region to assess the impacts to nearby States of OCS oil and gas exploration, development, and production as required under OCSLA. This assessment is used by BOEM in the cumulative and visibility impacts analyses of the National Environmental Policy Act (NEPA) environmental impact statements (EISs), which are the *Gulf of Mexico OCSOil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS) and this Supplemental EIS. These analyses address both current and proposed NAAQS.

Air quality modeling requires several input datasets, including meteorology, emissions inventories, and ambient pollutant concentrations. **Figure C-3** presents an overview of how these project datasets fit together for the "Air Quality Modeling in the Gulf of Mexico Region" study.

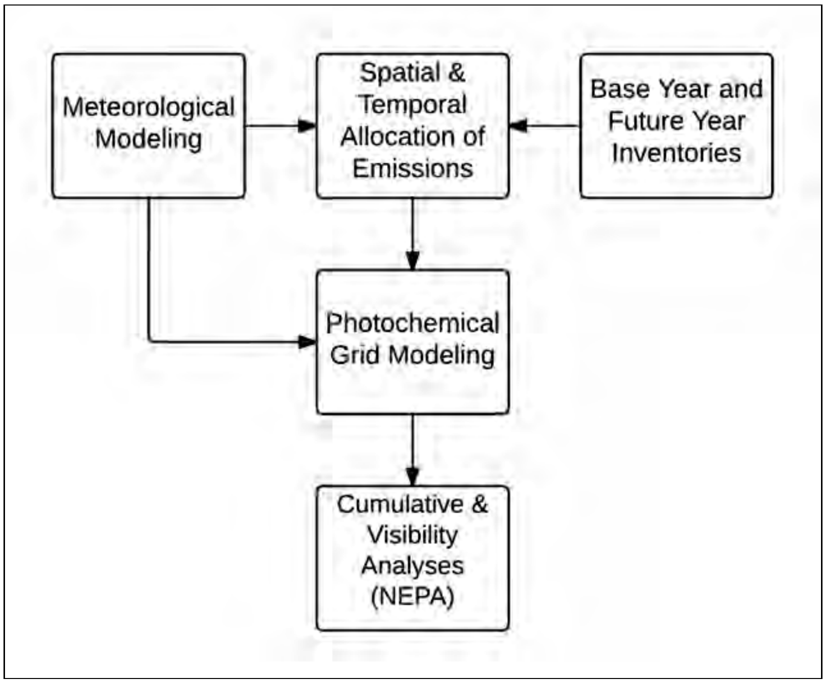

Figure C-3. Overview of the "Air Quality Modeling in the Gulf of Mexico Region" Study Tasks.

C.2 DEVELOPMENT OF EMISSION INVENTORIES

A key step in performing the "Air Quality Modeling in the Gulf of Mexico Region" study in support of the subsequent cumulative and visibility impacts analyses is development of comprehensive air emission inventories that accurately depict the base case emissions within the study area, and emissions associated with the scenario (the future year) for the 2017-2022 GOM Multisale EIS and this Supplemental EIS.

The scope of the air pollutant emissions inventory development effort for the "Air Quality Modeling in the Gulf of Mexico Region" study includes selection of: pollutants, base case year, geographical domain, sources, spatial resolution, temporal resolution, speciation, and development of the base case and future year emission estimates. These elements are described below.

C.2.1 Pollutants

Pollutants for the "Air Quality Modeling in the Gulf of Mexico Region" study consist of criteria air pollutants as defined by CAA Title I: CO; lead; NO_x (stated as equivalent mass of nitrogen dioxide [NO_2]); $PM_{2.5}$; PM_{10}; and SO_2, as well as volatile organic compounds (VOCs, which are precursors to ozone formation) and ammonia (NH_3, a precursor to PM formation).

C.2.2 Base Case Year

In determining the base case year for the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory, 2011 was initially selected based on data availability. Calendar year 2011 emissions data are readily available for most sources from the USEPA National Emissions Inventory (NEI) (USEPA, 2015a), and BOEM's *Year 2011 Gulfwide Emissions Inventory Study* (Wilson et al., 2014), hereby called the "2011 Gulfwide Inventory." However, 2011 was an unusually hot and dry year in the Gulf of Mexico OCS Region, particularly in Texas, which experienced record heat and dry conditions during the summer of 2011 and had a very high incidence of wildfires. Therefore, 2012 was selected as the base case year as more representative of "typical" conditions in the Gulf of Mexico OCS Region.

C.2.3 Geographical Domain

The domain of the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory is the area depicted in **Figure C-4**, particularly the 4-kilometer (km) domain encompassing the Gulf of Mexico OCS. This area, which includes parts of Alabama, Georgia, Louisiana, Mississippi, and Texas; all of Florida; as well as the Western, Central, and Eastern Planning Areas in the Gulf of Mexico and part of the Atlantic Ocean, are the main focus of the emissions inventory efforts. Emissions data were also required for the 36- and 12-km expanded domains depicted in **Figure C-4**, which include parts of Mexico and Canada. The outermost domain with 36-km resolution includes the entire continental U.S. and parts of Canada and Mexico, and captures synoptic-scale (storm system-scale) structures in the atmosphere. The inner 12-km regional grid covers the southeastern U.S. and is used to ensure that large-scale meteorological patterns across the region are adequately represented and to provide boundary conditions to the 4-km domain.

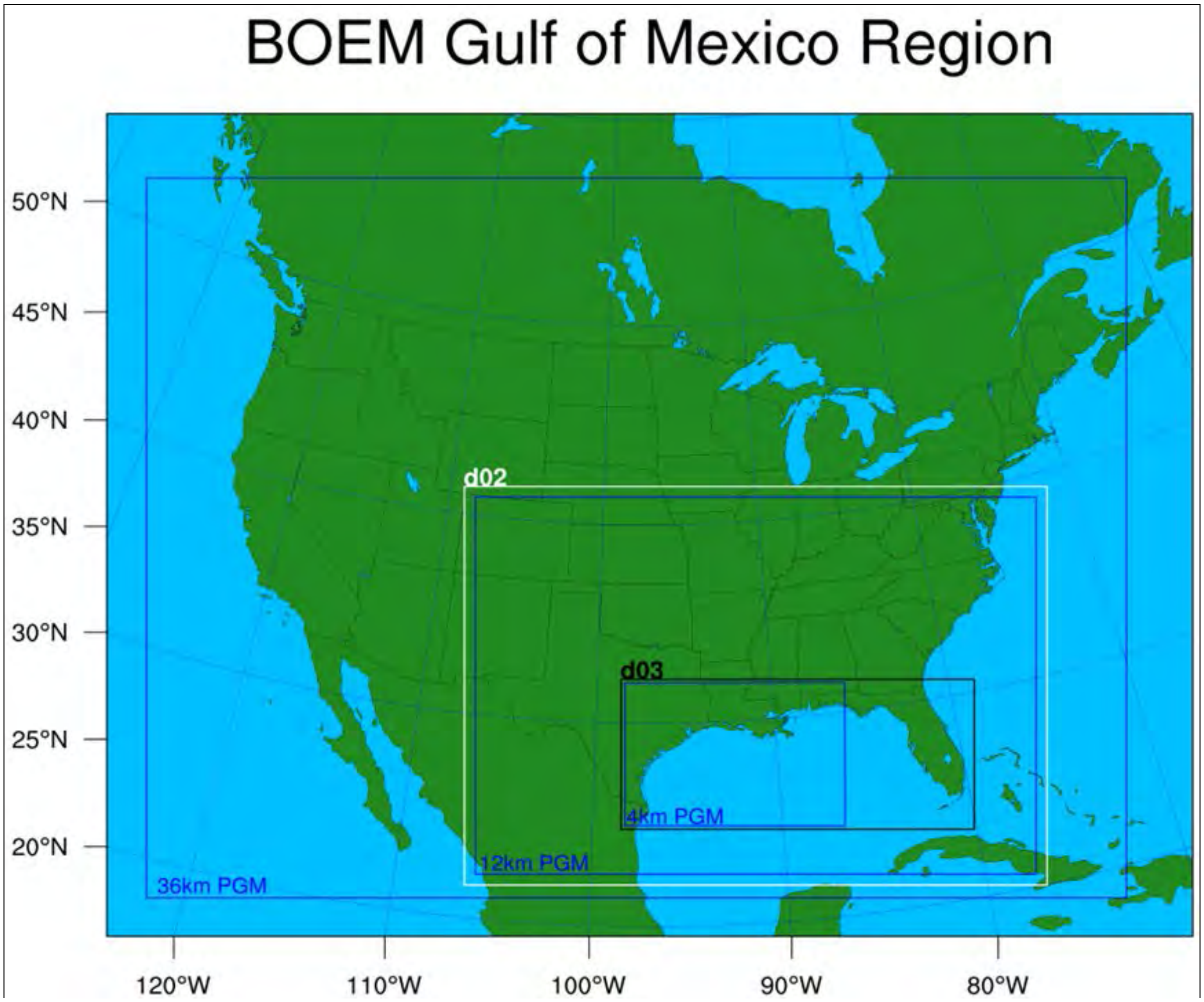

Figure C-4. WRF 36-km CONUS (d01), 12-km SE Regional (d02), and 4-km Gulf of Mexico Region (d03) Domains Along With the PGM Grids.

C.2.4 Inventory Sources

Emissions from anthropogenic (i.e., human caused) sources, including stationary point and nonpoint area sources located both onshore and offshore, onroad motor vehicles, nonroad equipment, locomotives, marine vessels and other offshore sources, and airports, were compiled for the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory. **Table C-2** lists the source groups and categories included in the emissions inventory, along with the pollutants applicable to each source, and the spatial and temporal resolution. Note that emissions from non-anthropogenic sources (i.e., biogenic and geogenic sources) are also included as part of the "Air Quality Modeling in the Gulf of Mexico Region" study cumulative and visibility analyses.

Table C-2. Gulf of Mexico Air Quality Modeling Study Source Categories.

Group	Source Category	CO	NO_x	SO_2	VOC	Pb	$PM_{2.5}$	PM_{10}	NH_3	Spatial Resolution[a]
NEI Onshore Sources	Point Sources	✓	✓	✓	✓	✓	✓	✓	✓	P
	Nonpoint Area Sources	✓	✓	✓	✓	✓	✓	✓	✓	A
	Onroad Mobile Sources	✓	✓	✓	✓		✓	✓	✓	A
	Commercial Marine Vessels	✓	✓	✓	✓	✓	✓	✓	✓	P, A[b]
	Locomotives	✓	✓	✓	✓	✓	✓	✓	✓	P, A[c]
	Aircraft and Airports	✓	✓	✓	✓	✓	✓	✓	✓	P
	Other Nonroad Mobile Sources	✓	✓	✓	✓		✓	✓	✓	A
Offshore Oil & Gas Sources	Platforms in State Waters	✓	✓	✓	✓		✓	✓		P
	Platforms in Central and Western GOM OCS Planning Areas	✓	✓	✓	✓	✓	✓	✓	✓	P
	Drilling Rigs	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Pipe-Laying Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Support Helicopters	✓	✓	✓	✓		✓	✓		LB
	Support Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Survey Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
Non-oil and Gas Offshore Vessels and Activities	Commercial Fishing Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Commercial Marine Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Louisiana Offshore Oil Port	✓	✓	✓	✓	✓	✓	✓	✓	P
	Military Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Recreational Vessels	✓	✓	✓	✓		✓	✓	✓	LB
	Vessel Lightering	✓	✓	✓	✓	✓	✓	✓	✓	P
Biogenic and Geogenic Sources	Subsurface Oil Seeps				✓					LB
	Mud Volcanoes				✓					LB
	Onshore Vegetation		✓		✓					A
	Wildfires and Prescribed Burning	✓	✓	✓	✓		✓	✓	✓	P
	Windblown Dust						✓	✓		A
	Lightning		✓							A
	Sea Salt Emissions						✓	✓		A
Sources in Mexico and Canada	Point Sources	✓	✓	✓	✓	✓	✓	✓		P
	Nonpoint Area Sources	✓	✓	✓	✓		✓	✓		A
	Mobile Sources	✓	✓	✓	✓		✓	✓		A

[a] A = Area source (modeling grid cell, spatial surrogate); P = Point source (UTM coordinates, stack parameters); LB = Offshore lease block (modeling grid cell, spatial surrogate)
[b] Larger ports and shipping will be represented as shape files; smaller ports as point sources.
[c] Rail yards will be represented as point sources; railway segments as area sources.

C.2.5 Spatial Resolution

The spatial resolution of the emissions inventory is source-specific. For example, sources such as power plants are identified based on their geographic coordinates (i.e., latitude and longitude), while other sources such as nonroad mobile sources (e.g., construction equipment) are spatially distributed using surrogates within the county in which they are reported and that are typically related to the activity distribution of the category (e.g., construction sites).

The resolution of the geographical area covered by the emissions inventory is based on the grid cell size needed for photochemical modeling. Furthermore, the photochemical model grid resolution is dependent on the grid resolution of the WRF meteorological model output used.

C.2.6 Temporal Resolution

Emissions for all sources were estimated on an annual basis (i.e., emissions generated during 2012). For electric generating units (EGUs), emissions were allocated on a sub-annual basis to reflect variations in activity using data from the USEPA.

Emissions were allocated on an hourly, daily, and seasonal basis using default temporal allocation factors provided with the Sparse Matrix Operator Kernel Emissions (SMOKE) emissions model for some sources; other temporal allocations were source-specific, and profiles were developed and applied within the SMOKE model.

C.2.7 Speciation

When applying the PGM modeling, PM emissions were allocated to individual PM species as part of the SMOKE emissions processing using PM speciation factors obtained from the USEPA's SPECIATE database (USEPA, 2014a) for each source category (as defined by the Source Classification Code). This resulted in the PM mass being broken into the mass associated with elemental carbon (EC), organic carbon (OC), and other elements, and particle-bound VOCs, such as polycyclic aromatic hydrocarbons (PAHs). The model predictions of EC will undergo further analysis and will be discussed in the "Air Quality Modeling in the Gulf of Mexico Region" study final report.

SMOKE was also used to convert VOC emissions into the photochemical mechanism-specific (e.g., CB05 or CB6r2h) model species used in air quality models.

C.3 Base Case Emission Estimates

This section presents an overview of the methodologies used to compile the base case 2012 emission estimates for all source categories in the emissions inventory.

C.3.1 Point Sources

Calendar year 2011 emissions data are available for onshore point sources from the USEPA NEI (USEPA, 2015a). In a separate modeling effort, the USEPA prepared a criteria pollutant calendar 2012 year emissions inventory for some sectors, including onshore point sources (USEPA, 2015b). The ERG obtained the USEPA 2012 point sources emissions inventory, conducted quality assurance/quality control (QA/QC) on the data, and supplemented and revised the criteria pollutant estimates, as needed. The USEPA prepared the 2012 point source emissions inventory as follows:

(1) 2012 data compiled by the USEPA from annual criteria pollutant reporting of Type A (large) sources that are submitted by responsible State and local air agencies;

(2) 2012 EGU emissions from the USEPA Clean Air Markets Division (CAMD) hourly emissions data;

(3) 2011 NEI data for other, smaller point sources that are not identified above; and

(4) 2011 airport and aircraft emission estimates developed by the USEPA updated to 2012 as needed.

Although the emissions data are likely complete for most point sources, ERG confirmed that offshore platforms within State boundaries are included in the NEI. Data from the USEPA's 2012 Toxics Release Inventory (TRI) for lead and ammonia were also used to supplement the inventory as needed (USEPA, 2015c).

C.3.2 Nonpoint Area Sources

The starting point for the 2012 nonpoint area source inventory was the data submitted by State and local agencies for the 2011 NEI. In addition, for completeness, the USEPA develops emission estimates for a number of nonpoint source categories (up to 165) for inclusion in the NEI if agencies do not provide estimates. The USEPA did not develop 2012 emission estimates for nonpoint area sources. The ERG prioritized key top-emitting source categories of NO_x, PM, SO_2, and VOCs in AL, FL, GA, LA, MS, and TX, and developed 2012 emission estimates using the USEPA nonpoint area source category tools (USEPA, 2014b). These categories are as follows: consumer products, architectural surface coatings, industrial maintenance coatings, open burning: municipal solid waste (MSW), residential and institutional/commercial/industrial (ICI) heating, upstream oil and gas, open burning, land clearing debris, paved and unpaved roads, and gasoline distribution Stage I. The ERG also conducted point source reconciliation for ICI heating, oil and gas, and gasoline distribution Stage I to verify that there are no gasoline distribution Stage II records in USEPA's nonpoint file (now reported with onroad mobile sources).

C.3.3 Mobile Sources

The onroad mobile source category includes exhaust and evaporative emissions from onroad motor vehicles (e.g., automobiles, light-duty trucks, heavy-duty trucks) and exhaust and evaporative emissions from nonroad mobile sources. The ERG team ran the MOVES2014 model for onroad sources (USEPA, 2014c), and the USEPA ran the NONROAD model for nonroad sources to develop 2012 emission estimates for these categories. Locomotive emissions in the 2011 NEI were not adjusted to represent 2012 activities because it was confirmed that the 2011 and 2012 fuel usage data from the Surface Transportation Board's R-1 Class 1 railroad annual reporting data (Surface Transportation Board, 2015) show only a slight (2%) reduction in 2012 levels from 2011 levels.

C.3.4 Offshore Helicopters

The Gulf of Mexico has more helicopter traffic than any other region of the U.S., primarily associated with offshore oil and gas support. Offshore support helicopter emission estimates were obtained from the 2011 Gulfwide inventory (Wilson et al., 2014). The estimates were supplemented with 2011 NEI helicopter data for onshore airports. The two datasets map out the full route between offshore platforms equipped with helipads and the closest onshore support facility; the NEI addresses emissions only at each airport and only for operations up to 3,000 feet of elevation (i.e., local mixing height). The two datasets were evaluated to ensure that the helicopter traffic data between the two are comparable and that there is no double counting of emissions.

C.3.5 Offshore Oil and Gas Production Sources—Western and Central/Eastern Planning Areas in the Gulf of Mexico

The starting point for offshore oil and gas production platforms in the Western and Central/Eastern Planning Areas (WPA and CPA/EPA) was the 2011 Gulfwide inventory. The ERG team supplemented the 2011 Gulfwide inventory with NH_3 and Pb emission estimates for all applicable emission sources using USEPA emission factors. The ERG team conducted research to determine if the 2011 emissions values for platform sources should be adjusted to be more representative of 2012 emissions values. Offshore oil and gas production values for 2011 and 2012 were obtained from the BOEM Part A Oil and Gas Operations Reports (OGOR) (USDOI, BOEM, 2015). The OGOR data are presented at the lease level. Production of both oil and gas (including deepwater production) decreased from 2011 to 2012; thus, the 2011 emission estimates were modeled without adjustment in order to be conservative. **Table C-3** presents the base case emission estimates for offshore oil and gas production sources in the WPA and CPA/EPA. **Figures C-5 through C-7** show the NO_x, VOC, and $PM_{2.5}$ emissions from platform sources. Platform sources include the following emission source types: amine units, boilers/heater/burners, diesel and gasoline engines, drilling equipment, combustion flares, fugitives, glycol dehydrators, losses from flashing, mud degassing, natural gas engines, natural gas turbines, pneumatic pumps, pressure/level controllers, storage tanks, and cold vents.

Table C-3. Base Case Offshore Oil and Gas Production Source Emissions Estimates for the GOM Western and Central/Eastern Planning Areas.

	NO_X (TPY)	SO_2 (TPY)	PM_{10} (TPY)	$PM_{2.5}$ (TPY)	VOC (TPY)	CO (TPY)	Pb (TPY)	NH_3 (TPY)
Platform Sources	84,128	3,197	838	835	54,724	70,339	<1	40
Non-platform Sources	232,765	22,977	8,632	8,225	7,937	41,880	701	70,139
Total	**316,893**	**26,174**	**9,470**	**9,060**	**62,661**	**112,219**	**701**	**70,179**

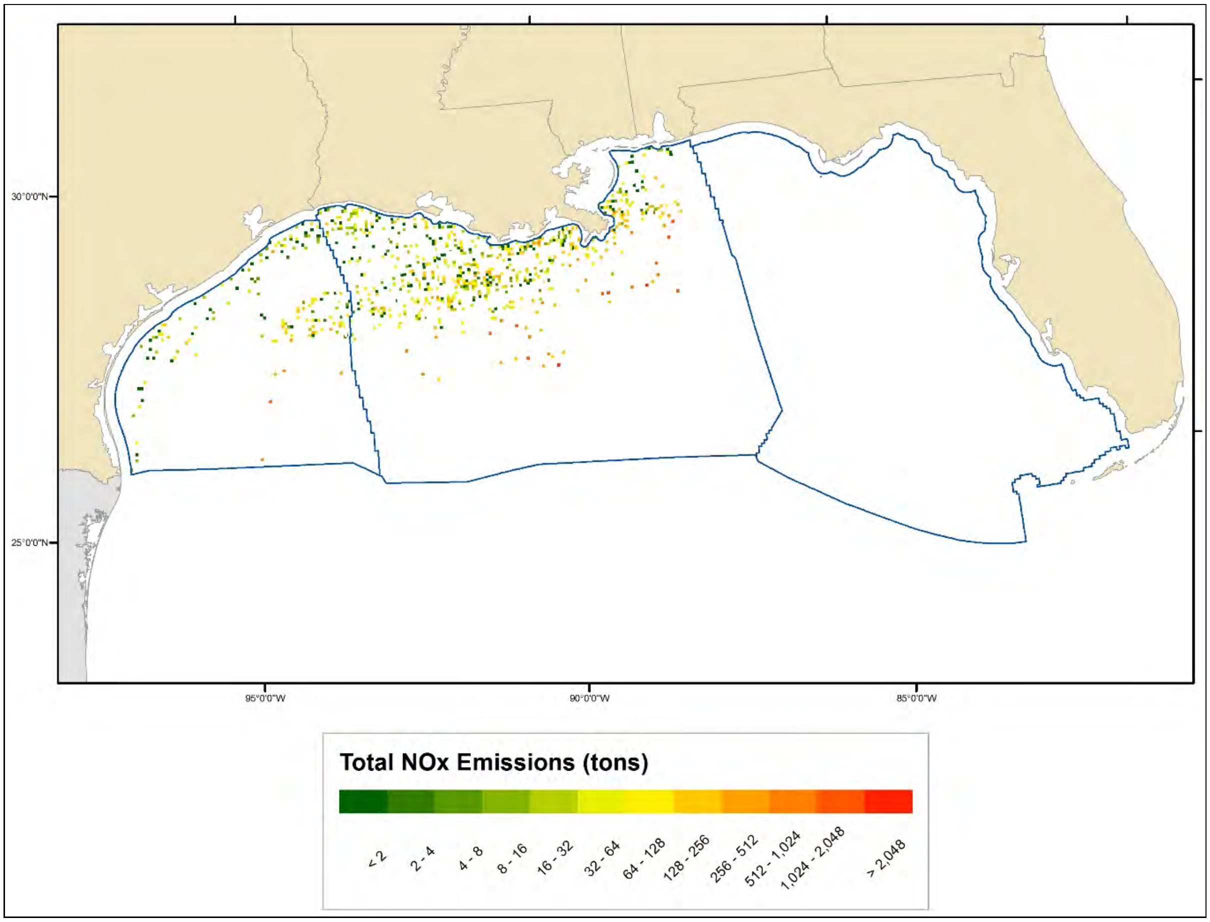

Figure C-5. 2012 Platform NO_x Emissions Aggregated by Lease Block. (Note: This figure does not indicate the platform source count, location, or emissions at the time of publication of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.)

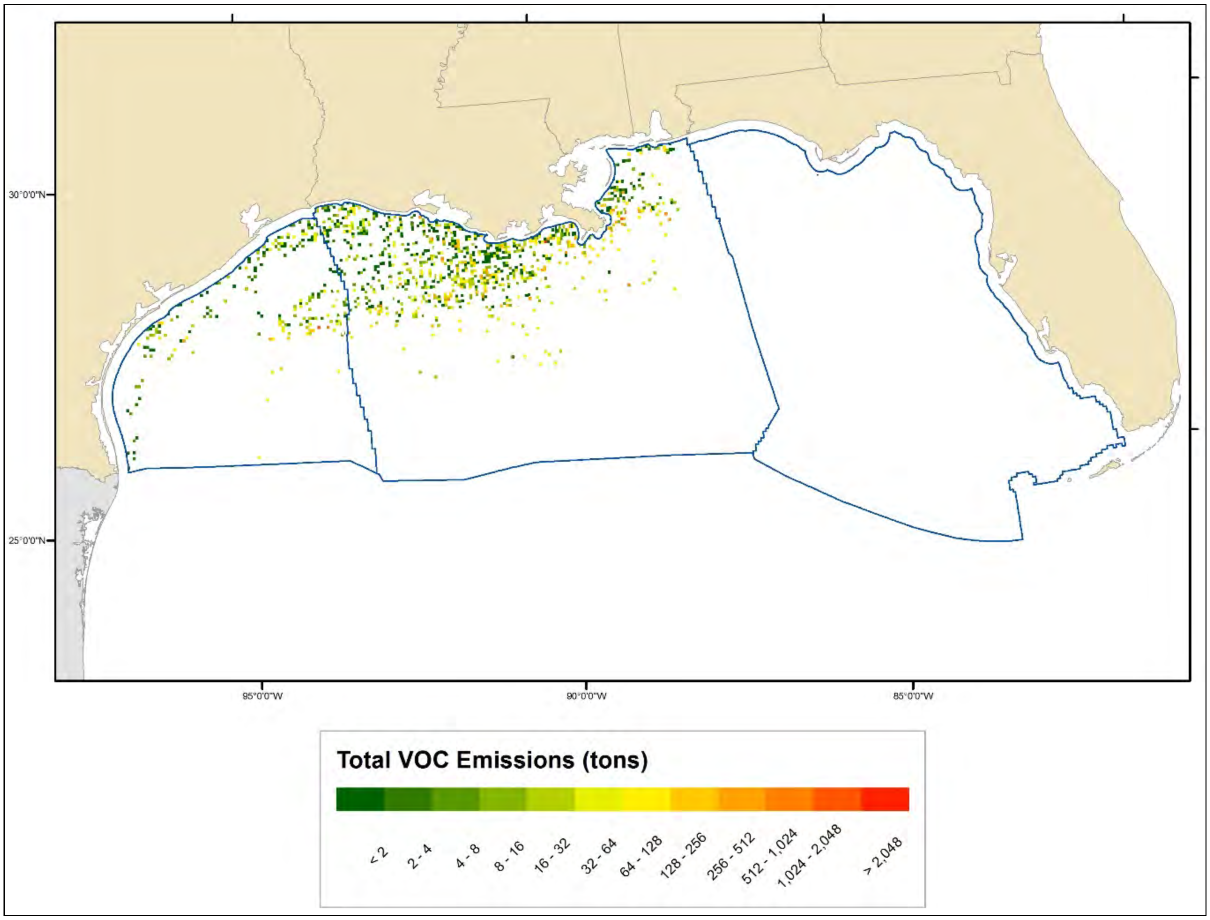

Figure C-6. 2012 Platform VOC Emissions Aggregated by Lease Block. (Note: This figure does not indicate the platform source count, location, or emissions at the time of publication of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.)

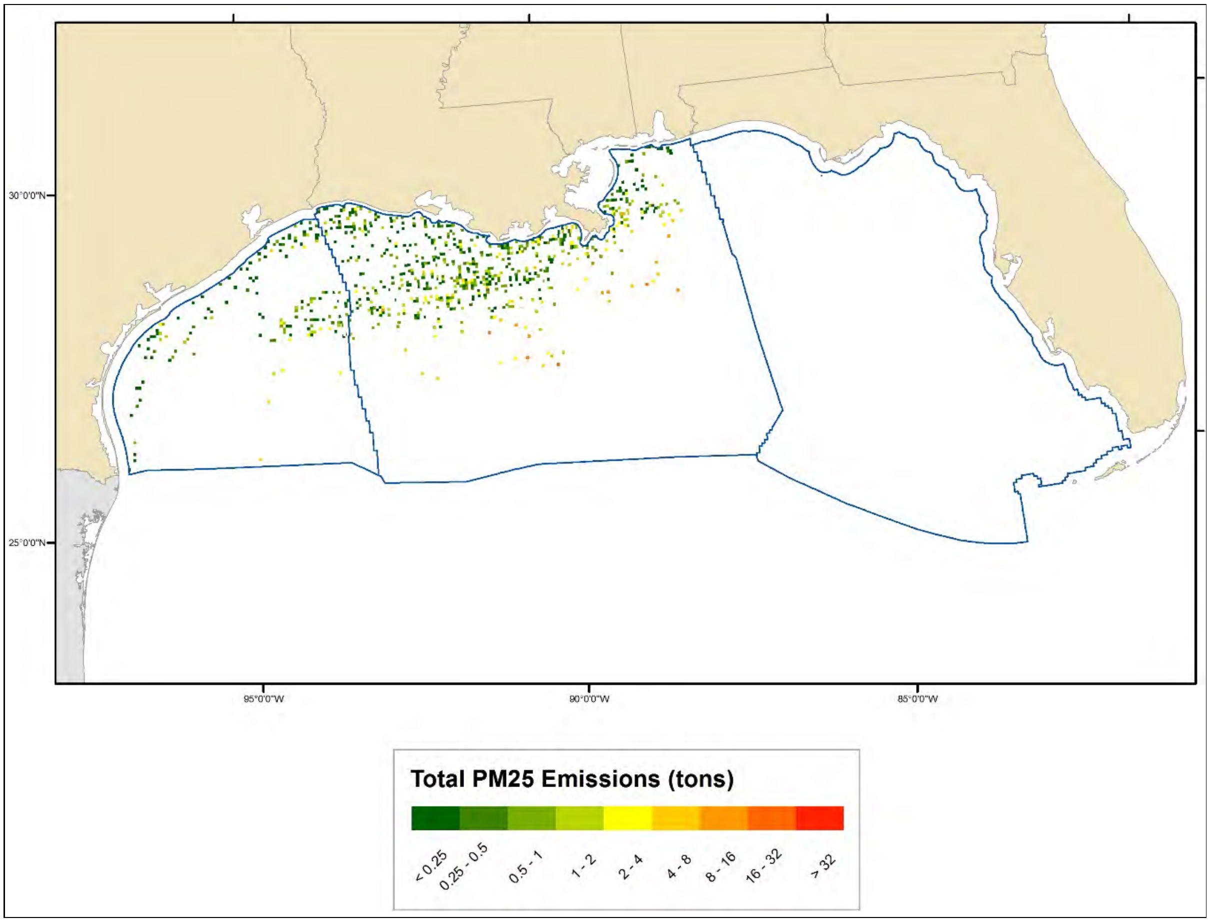

Figure C-7. 2012 Platform $PM_{2.5}$ Emissions Aggregated by Lease Block. (Note: This figure does not indicate the platform source count, location, or emissions at the time of publication of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.)

C.3.6 Offshore Vessels

Offshore vessels can be grouped into vessels that support the construction, operation, and decommissioning of oil and gas platforms; and vessels involved in other commercial, recreational, and military operations. All marine vessels included in this study operate using diesel engines. These include very large propulsion engines as well as smaller auxiliary diesel engines that provide power for electricity generation, winches, pumps, and other onboard equipment. Smaller engines tend to use distillate grade diesel fuel, while large engines are able to combust heavier residual blends.

40 CFR § 1043.109(b) created the North American Emission Control Area (ECA), which includes the Gulf of Mexico (USEPA, 2010). This regulation limits marine fuel sulfur content to 1% after August 1, 2012, for any vessel with a gross tonnage greater than 400. Vessels below this threshold tend to use distillate fuels, which are already at or below the 1% limit.

C.3.6.1 Oil and Gas Production Support Vessels

The offshore oil and gas production sector requires a wide variety of vessels to support the exploration, development, and extraction of oil and gas, including the following:

- seismic survey vessels;
- drilling vessels;
- pipe-laying vessels;
- crewboats; and
- supply vessels.

For the 2011 Gulfwide inventory, Automatic Identification System (AIS) data from PortVision were used to map spatial aspects of vessel movements (PortVision, 2012). The AIS is an automated tracking system that allows exchanges of location and contact data with other nearby ships, offshore platforms, satellites, and AIS base stations, enhancing navigation and reducing at-sea collisions.

On October 22, 2003, the U.S. harmonized the AIS mandates of the Safety of Life at Sea Convention with the Maritime Transportation Security Act of 2002 (MTSA), which requires the following vessels, including offshore support vessels, to participate in the AIS program:

(1) passenger vessels of 150 gross tonnage or more;

(2) tankers, regardless of tonnage; and

(3) vessels other than passenger vessels or tankers of 300 gross tonnage or more.

Vessels that do not meet these thresholds, such as crew boats and smaller support vessels, can still participate in AIS on a voluntary basis. The Offshore Marine Service Association (OMSA) is encouraging its membership to equip their vessels with AIS transponders, allowing for more efficient and safer ship movements in the highly congested central and western areas of the Gulf of Mexico.

The ERG team used the spatially distributed support vessel emission estimates from BOEM's 2011 Gulfwide inventory. While the USEPA 2011 NEI also includes marine vessel emission estimates for the Gulf of Mexico, the emission estimates were derived from national vessel activity data. During QA/QC of the 2011 BOEM Gulfwide estimates, ERG found and corrected an error in the vessel power rating for a number of smaller vessels.

As discussed above for offshore oil and gas production platforms, the 2011 emission estimates for these vessels were not adjusted to reflect 2012 production levels. SO_x and PM (associated with sulfates) were not adjusted to account for the introduction of low sulfur ECA compliant fuel in the last 5 months of 2012 because it was determined that most support vessels are

Category 1 or 2, which already use ECA compliant fuels. Emission estimates for NH_3 and Pb were also developed for vessels. **Table C-3** presents the base case emission estimates for drilling rigs, pipe-laying operations, support helicopters, support vessels, and survey vessels. **Figures C-8 through C-10** show the NO_x, VOC, and $PM_{2.5}$ emissions from non-platform sources.

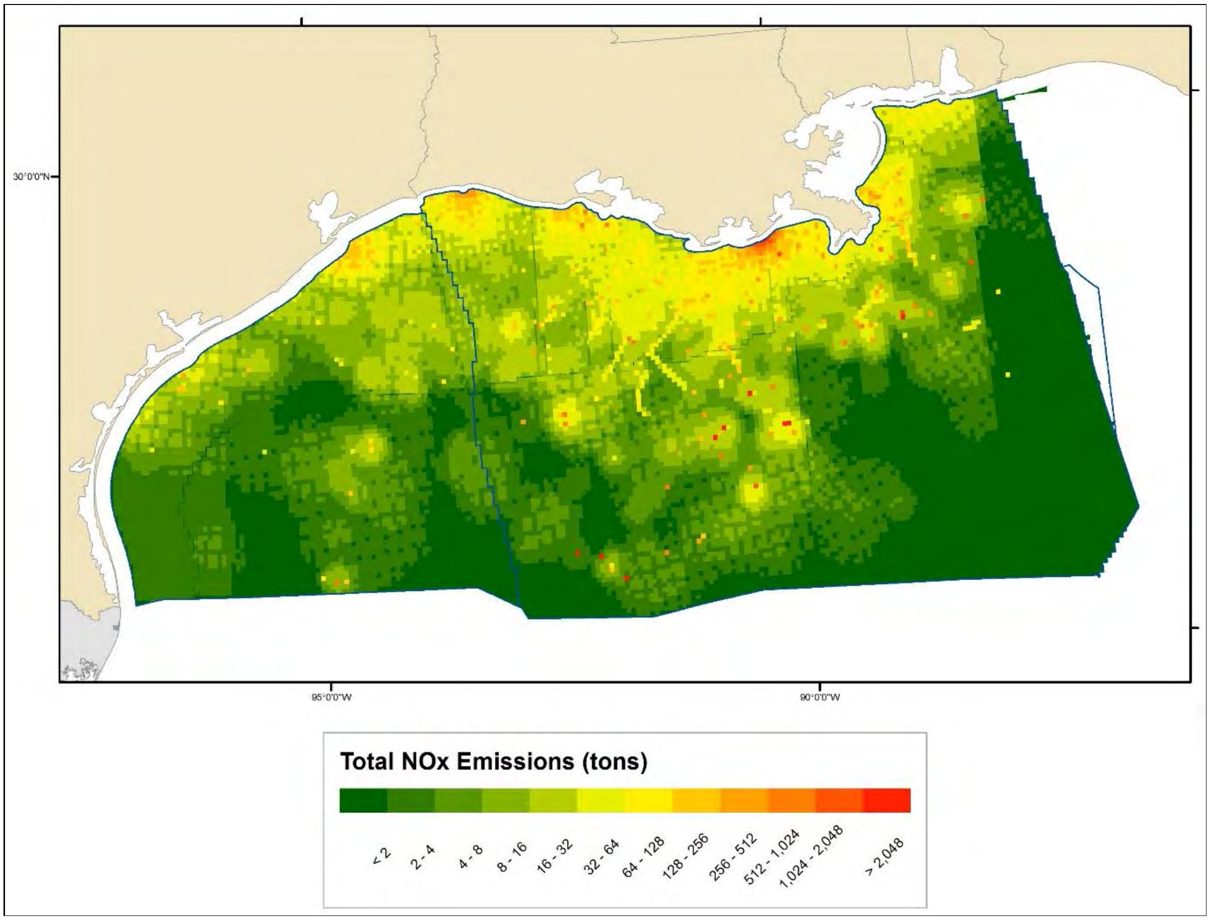

Figure C-8. 2012 Non-platform NO_x Emissions. (Note: This figure does not indicate the non-platform source count, location, or emissions at the time of publication of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.)

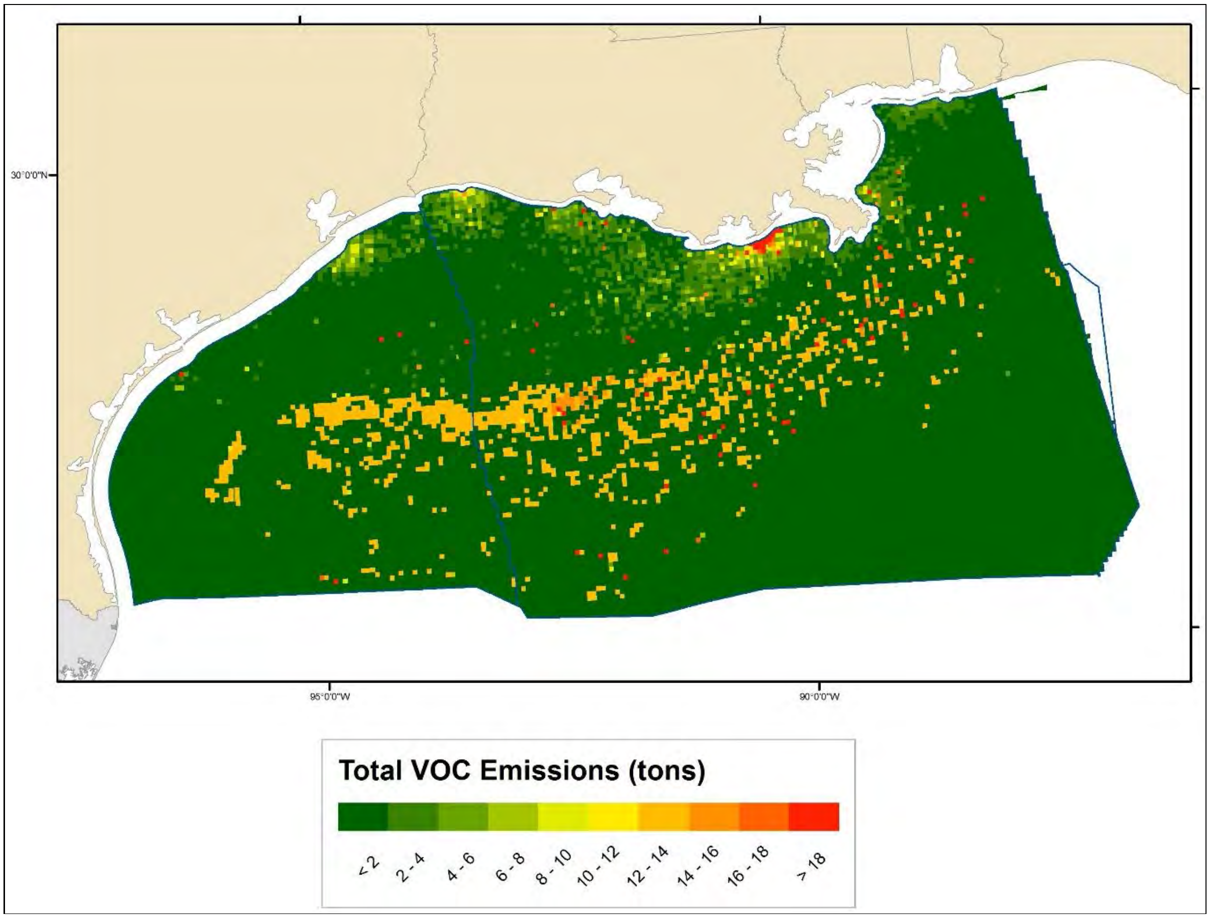

Figure C-9. 2012 Non-platform VOC Emissions. (Note: This figure does not indicate the non-platform source count, location, or emissions at the time of publication of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.)

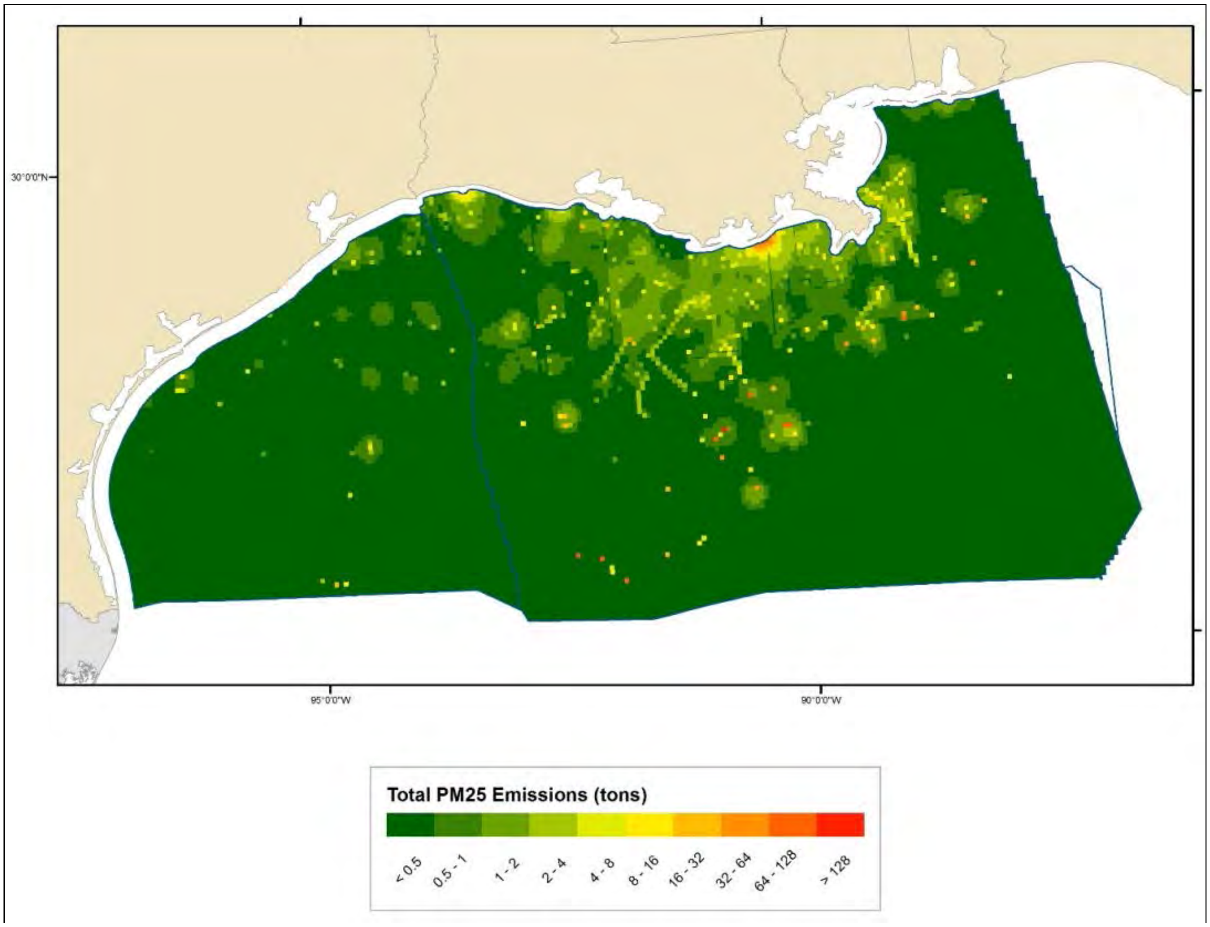

Figure C-10. 2012 Non-platform $PM_{2.5}$ Emissions. (Note: This figure does not indicate the non-platform source count, location, or emissions at the time of publication of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.)

The ERG team obtained drilling vessel data from BSEE to confirm that there was no drilling activity in the eastern Gulf of Mexico OCS region in 2012, and reviewed the permits granted by the USEPA for offshore platforms in the eastern Gulf of Mexico OCS region to confirm there were no active production platform activities in 2012.

C.3.6.2 Non-Oil and Gas Production Offshore Vessels

Vessels not directly associated with the offshore oil and gas activities include the following:

- commercial marine vessels;
- Louisiana Offshore Oil Port-associated vessels;
- commercial and recreational fishing vessels;
- ferries;
- research vessels;

- harbor craft; and
- military vessels.

Commercial marine vessels (CMVs) include large ships involved in international trade that visit coastal ports and operate in deep waters, as well as smaller general cargo ships and tugs that move barges along waterways and rivers. For the Federal waters of the central and western of the Gulf of Mexico, the ERG team used the commercial marine vessel data from the 2011 Gulfwide inventory. For completeness, for all other areas of the Gulf of Mexico, Atlantic Ocean, and State waters, the USEPA's NEI data were used (which were developed from national vessel activity data as noted above). These inventories cover different geographical areas than the BOEM inventory, as well as different vessel types. BOEM's data include large deepwater vessels as does the USEPA data beyond the Federal/State boundary, but they also include vessels such as ferries, dredging vessels, tugs, towboats, and harbor craft that tend to operate only in State waters.

The Louisiana Offshore Oil Port (LOOP) is a pumping platform for tankers to discharge imported crude oil to the mainland without having to maneuver through port traffic. Similarly, there are four offshore lightering zones in the Gulf of Mexico (i.e., Southtex, Gulfmex No. 2, Offshore Pascagoula No. 2, and South Sabine Point) where smaller shuttle tankers can move product from very large crude carriers, bringing the oil to port while the large tankers remain off the coast. Tankers that visit the LOOP or the lightering zones along with the shuttle tankers were identified in the 2011 Gulfwide inventory. The inventory also accounts for evaporative emissions from unloading and loading activities, and emissions from the operation of generators and pumps at the LOOP; adjustments were made to the 2011 LOOP emission estimates to reflect the 18% decline in crude imports in 2012.

Emissions from the operation of commercial and recreational fishing vessels are also included in the 2011 Gulfwide inventory for Federal waters. These were supplemented with the USEPA's 2011 NEI data for these fishing vessels for operations in the Eastern Planning Area in the Gulf of Mexico, Atlantic Ocean, and State waters. For military vessels, the ERG team used the 2011 Gulfwide inventory Navy and Coast Guard vessel emission estimates and the NEI's Coast Guard emission estimates for State waters, as well as Federal waters in the eastern part of the Gulf of Mexico and the Atlantic Coast. The ERG team conducted research to determine that activity levels from 2011 to 2012 were similar for the other non-oil and gas vessels (e.g., tankers, container ships, bulk, and general cargo). Based on the most recent International Maritime Organization data (IMO, 2015), fuel combustion is projected to remain constant from 2010 to 2015. Thus, no adjustments were needed to approximate activities in 2012.

The SO_2 and PM (associated with sulfates) emission estimates were adjusted for Category 3 vessels to account for the introduction of low sulfur ECA-compliant fuel in the last 5 months of 2012.

C.3.7 Biogenic and Geogenic Sources

For completeness, it is important to include non-anthropogenic emission sources in the inventory. The ERG team also estimated emissions for the sources listed below.

- Onshore vegetation (biogenic): MEGAN (version 2.1) biogenic emission model
- Wildfires, prescribed burns, and agricultural burning: USEPA's SMARTFIRE emissions inventory for the U.S.
- Windblown dust: Windblown dust (WBD) modeling using the WRF meteorological dataset
- Lightning: WRF data (preprocessor)
- Subsurface oil seeps: 2011 Gulfwide inventory
- Mud volcanoes: 2011 Gulfwide inventory
- Sea salt emissions: WRF data (preprocessor)

The ERG team used fire emission estimates from the National Center for Atmospheric Research (NCAR) Fire INventory (FINN) for Mexico and Canada.

C.3.8 Sources in Mexico

The ERG team developed the 2012 emission inventories for the portions of Mexico within the 36-km modeling inventory domain using the municipality-level emission files from the 2008 Mexico National Emissions Inventory (MNEI) (SEMARNAT, 2014) combined with projection factors for point, nonpoint area, and nonroad mobile sources. Mexico onroad motor vehicle emissions were generated using a version of the USEPA vehicle emissions model MOVES, updated to reflect conditions in Mexico. MOVES2014 was the most recent version of the model available at the time of the analysis and reflects USEPA's latest estimate of vehicle emissions and default U.S. activity data (USEPA, 2014c). The ERG also conducted research on the offshore oil production activities off the coast of Mexico. Based on a report published by the Congressional Research Service, it was determined that there was no offshore production within the 36-km modeling domain in 2012 (Seelke et al., 2015).

C.3.9 Sources in Canada

Emissions from the USEPA's most recent modeling platform (2010) were used for sources in Canada.

C.4 FUTURE YEAR MODELING SCENARIO EMISSION ESTIMATES

Emission estimates were also needed as inputs for additional modeling scenarios that will predict future impacts from implementation of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers. For modeling the future year impacts, the ERG team forecast emissions estimates based on information provided by BOEM, combined with USEPA projected emission estimates and other data for onshore sources and marine vessels and other sources outside of the GOM region. The ERG team confirmed that offshore drilling in the EPA under USEPA air quality jurisdiction is included in BOEM's *2017-2022 Outer Continental Shelf Oil and Gas Leasing: Proposed Final Program* (Five-Year Program) spreadsheets. The ERG also reviewed the USEPA's offshore oil and gas production permits to confirm that no production platforms were permitted to be constructed prior to or during 2017. Projected emission estimates were developed for anticipated offshore drilling off the coast of Mexico.

C.4.1 Western, Central, and Eastern Planning Areas OCS Offshore Oil and Gas Production Sources

The ERG team developed annual emission estimates for all categories and pollutants for each year of activity for OCS offshore oil and gas production sources associated with the Five-Year Program using BOEM's spreadsheet-based data analyses tools. BOEM provided information on the predicted levels of activity, sources, and locations (by planning area and water depth) to depict offshore oil and gas activities in the future scenario. The emissions estimates are based on a mid-price oil case scenario and cover the WPA, CPA, and EPA, which are under BOEM's jurisdiction.

After completion of the OCS offshore oil and gas production source emission estimates, the resulting cumulative emissions for each pollutant were assessed to determine which emission estimates should be selected for PGM modeling to support the cumulative and visibility impacts analyses.

Based on information provided by BOEM, it was assumed that emissions for the following sources occur during the total period of proposed activity based on the 2017-2022 GOM Multisale EIS scenario (2017-2056)[1], from which this Supplemental EIS tiers:

- exploration and delineation well drilling activities (1,671 wells drilled);
- development and production well drilling activities (1,135 wells drilled);
- platform installation activities (535 platforms installed);
- FPSO installation (1 FPSO installed);
- FPSO operation (1 FPSO operating);
- FPSO removal (1 FPSO removed);
- pipeline installation excluding State waters (7,251 km of pipeline installed);

[1] Excluding the Gulf of Mexico Energy Security Act (GOMESA) moratorium area.

- platform oil and gas production (535 platforms in operation);
- platform removal (535 platforms removed);
- support helicopters (642,000 round trips); and
- support vessels (1,062,000 operations).

The BOEM data analyses tools provide information on each of these anticipated activities by year, as well as water depth. The anticipated water depths by planning area were used to spatially allocate the emissions.

The ERG used this information to develop emission estimates for each source category based on emission estimation methods used in past Gulfwide emissions inventory studies and other data compiled for BOEM in order to determine which estimates should be selected for photochemical modeling to support the cumulative and visibility impacts analyses.

The following sections discuss the emission estimation methods that the ERG team used to estimate emissions for the BOEM oil and gas production sources in the future scenario.

C.4.1.1 Oil and Natural Gas Offshore Production Platforms

In order to develop reasonably foreseeable emission estimates for projected oil and natural gas production platforms, the emission factors presented in **Table C-4** were developed based on the 2011 Gulfwide inventory (Wilson et al., 2014). Because deepwater operations may significantly differ from conventional operations in shallower waters, are technologically more sophisticated, and produce at much higher rates, two sets of emission factors were developed and assigned to each projected platform based on water depth. Depths below 200 meters (656 feet) were assigned the shallow-water emission factors, and depths above were assigned deepwater emission factors.

Emission estimates for platform sources were developed based on platform installation and carried forward until the projected platform removal dates (provided by planning area and water depth).

Table C-4. Future Year Production Platform Emission Factors.

Pollutant	Shallow Water Emission Factors (<200 m) (tons/platform/yr)	Deepwater Emission Factors (>200 m) (tons/platform/yr)
CO	56	192
NO_x	46	582
PM_{10}-PRI	0.5	5.17
$PM_{2.5}$-PRI	0.50	5.15
SO_2	0.51	44
VOC	22	96
Pb	2.38E-05	3.79E-03
NH_3	0.0349	0.49

Source: Developed from the *Year 2011 Gulfwide Emissions Inventory* (Wilson et al., 2014).

C.4.1.2 Offshore Support Helicopters

The ERG team obtained helicopter emission factors from the Switzerland Federal Office of Civil Aviation (FOCA) Guidance on Determination of Helicopter Emissions (FOCA, 2009). However, the landing and takeoff (LTO) cycle used by FOCA was determined to be too short for typical trips taken in the Gulf of Mexico. The time-in-mode values were therefore adjusted based on the International Civil Aviation Organization (ICAO) test cycles, which are considered to be appropriate for offshore operations in the Gulf of Mexico. Because the future fleet mix is unknown, ERG weighted the emission factors using fleet profile data from the Helicopter Safety Advisory Conference (HSAC, 2015). The VOC emission factors were developed by converting the hydrocarbon (HC) emission factors using data from the USEPA's Procedures for Emission Inventory Preparation Volume IV: Mobile Sources (USEPA, 1992). The aggregated general aviation conversion factor of 1.0631 for turbine engines was used because the GOM support helicopter fleet is primarily equipped with turbine engines. The $PM_{2.5}$ emission factors were speciated from PM_{10} factors using USEPA aircraft speciation data, and the SO_2 emission factors were developed based on a typical jet fuel sulfur concentration of 0.05% (UNEP, 2012).

C.4.1.3 Oil and Gas Production Offshore Support Vessels

Four components are needed to estimate future offshore vessel emissions:

- vessel characteristics (engine power and speed);
- engine operating load (percent of maximum engine power);
- hours of operation (typically determined by the distance the vessel travels divided by the vessel speed); and
- appropriate emission factors (grams per kW-hr).

Because there is uncertainty about the location of future activities, it was assumed that a typical vessel trip is 200 nautical miles, which is the round-trip distance from shore to the mid-point of Federal waters.

In projecting future year activity, it is not always possible to identify specific vessels that will be used. Therefore, the use of larger vessels that represent the upper bound of each vessel type was assumed, such that actual future year emissions should be similar to or lower than emission estimates developed using this fleet profile. These vessels were identified based on data compiled from the Information Handling Service (IHS) Register of Ships (IHS, 2015). Vessels from the global fleet were used because these larger ships move internationally based on local demand. It should also be noted that these larger vessels tend to be involved in deepwater activities because they are designed for extended open-water operations. As trends to develop deeper water locations in the Gulf of Mexico continue into the future, it is likely that these larger or similar vessels will support future year activities.

The selected vessels and their characteristics are presented in **Table C-5**. In order to correctly match the vessel to the appropriate emission factors, the vessel engine category is required. The USEPA vessel category was determined by calculating the cylinder volume based on the stroke length and diameter of the cylinder. The USEPA categories are defined by the following cylinder volumes:

- Category 1: Cylinder displacement less than 5 liters;
- Category 2: Cylinder displacement from 5 to 30 liters; and
- Category 3: Cylinder displacement greater than 30 liters.

If a vessel's cylinder volume was unknown, it was assumed that the vessel was powered by a Category 3 propulsion engine. It should also be noted that all of the selected vessels are foreign flagged, but it is assumed that they refuel using U.S.-regulated marine fuels as they shift equipment and supplies from nearby U.S. ports.

Table C-5. Summary of Vessel Characteristics.

Vessel Type	Total Main Power (kW)	Vessel Name	Propulsion Engine Category	Speed (knots)
Drillship	48,666	Rowan Renaissance	3	12
Jackup	12,485	Bob Palmer	2	
(auxiliary)	Not self-propelled			
Platform Rig	8,100	Nabors Mods 087	2	
(auxiliary)	Not self-propelled			
Semisubmersible	22,371	ENSCO 7500	2	3.5
Submersible	3,691	Hercules 78	2	
(auxiliary)	Not self-propelled			
FPSO	14,110[1]	Terra Nova FPSO	2	12.0
FSO	51,519	Africa	3	16.5
Stimulation Vessel	15,840	Norshore Atlantic	2	14
Oil Tanker	13,369	SPT Explorer	3	15
Anchor Handling Vessel	27,000	KL Sandefjord	3	17
Crew Boat	11,520	R. J. Coco Mccall	3	23
Supply Vessel	18,000	Aleksey Chirikov	3	15
Tug Boat	19,990	Yury Topchev	3	15
Pipe-Laying Vessel	67,200	Castorone	3	14

[1] Only distillate oil main engine kW included (430 kW & 2 x 6840 kW). Topside emissions are included in the deepwater production platform estimates.

A vessel's engine power varies relative to the type of operation that is implemented. While cruising in open waters, the propulsion engine load is typically 84% of maximum load; during maneuvering, it can be 60% or lower; and when stationary,. it can be 10% or lower. **Table C-6** presents the aggregated load factors that will be used in this Study for propulsion and auxiliary engines.

Table C-6. Load Factors to be Used in the Future Year Projections.

Vessel Type	Load Factor
Propulsion Cruising	0.8-0.85
Propulsion Idle	0.1
Propulsion Crew/Supply Boat	0.45
Propulsion Drill Ship and Semi-Submersible	0.83
Propulsion Pipe-Laying Vessel	0.16
Propulsion Tug	0.68
Auxiliary Emergency Generator	0.75
Drilling Equipment	1

The future year emission factors were developed in terms of grams of pollutant emitted per load-adjusted engine kW-hours based on the emission factors used in the USEPA's 2014 NEI (**Table C-7**). The factors presented below are applicable for foreign-flagged vessels that are not required to comply with USEPA exhaust standards but that must comply with international Emission Control Area (ECA) standards. These future year factors account for the reduction in fuel sulfur level associated with the ECA. Because Category 2 foreign-flagged offshore support vessels will be refueling at U.S. ports, it was anticipated that these vessels will use low sulfur compliant U.S. fuels. Also, the NO_x emission factors were adjusted to account for the 2016 ECA Tier III standard that requires high efficiency, after-treatment technology, and is applicable for U.S. and foreign-flagged vessels. The Category 3 PM emission factors were not adjusted to account for reductions in PM as sulfate compounds because the USEPA's adjustment equation provided a PM factor lower than the PM emission factor for Category 2 powered vessels.

Table C-7. Marine Vessel Emission Factors (g/kW-hr).

Engine Category	NO_x	SO_2	PM_{10}	$PM_{2.5}$	VOC	CO	HC	NH_3	Pb
2	3.4	0.006	0.320	0.310	0.141	2.48	0.13	0.005	0.00003
3	3.4	0.362	0.450	0.437	0.632	1.40	0.60	0.003	0.00003

Source: USEPA, 2016b.

C.4.1.4 Future Year Emission Estimates and Selection of Future Modeling Year

The emission estimates developed for the future BOEM oil and gas production sources were reviewed to determine the most suitable future year emissions to model. The PGM modeling for the cumulative and visibility impacts analysis was conducted based on the emissions anticipated to have the greatest impact on the air quality of any state. This was determined based on the estimated annual emission trends. The future highest NO_x emission year for all activities in all planning areas coincided with the highest PM, CO, NH_3, and Pb emissions. These emissions are driven by support vessel activity for the most part. The future highest VOC emission year for all activities in all planning areas coincided with the highest SO_2 emissions and is driven by production platform emissions. **Table C-8** presents the resulting emission estimates, and **Figure C-11** presents a graphical depiction of the annual emission estimates for all pollutants. **Figures C-12 through C-14** present graphical depictions of the annual emission estimates for NO_x, VOC, and $PM_{2.5}$ by source category.

It was concluded that BOEM would model the activity data and resulting emission estimates for year 2033 for non-platform sources, and year 2036 activity data and resulting emission estimates for platform sources.

Table C-8. Emission Estimates for the Western, Central, and Eastern Planning Areas, All Depths, By Year and Pollutant.

Year	NO_x (TPY)	SO_2 (TPY)	PM_{10} (TPY)	$PM_{2.5}$ (TPY)	VOC (TPY)	CO (TPY)	Pb (TPY)	NH_3 (TPY)
2017	3,693	40	360	349	200	2,591	0.03	10
2018	19,328	118	1,813	1,759	1,213	14,058	0.17	80
2019	34,958	158	3,199	3,104	2,150	25,462	0.30	98
2020	46,119	268	4,124	4,001	3,042	33,293	0.39	111
2021	50,126	379	4,368	4,238	3,807	35,937	0.42	125
2022	54,328	446	4,605	4,469	4,535	38,906	0.45	139
2023	57,639	527	4,888	4,743	5,311	41,426	0.48	154
2024	59,979	484	5,030	4,881	5,872	43,637	0.49	170
2025	64,527	523	5,413	5,252	6,543	47,198	0.53	189
2026	70,601	598	5,870	5,696	7,510	51,762	0.57	209
2027	76,146	704	6,305	6,118	8,419	55,747	0.61	228
2028	79,863	742	6,609	6,414	9,125	58,701	0.64	244
2029	85,277	803	7,012	6,805	10,034	62,750	0.68	262
2030	90,332	876	7,381	7,163	11,010	66,523	0.72	280
2031	97,123	984	7,860	7,628	12,185	71,365	0.77	298
2032	100,564	1,022	8,057	7,820	13,228	74,107	0.79	315
2033	**108,447**[1]	1,199	**8,590**	**8,338**	14,709	**79,486**	**0.85**	**334**
2034	101,673	1,193	7,919	7,687	14,939	74,742	0.79	329
2035	102,443	1,253	7,923	7,691	15,484	75,167	0.79	327
2036	103,354	**1,395**	7,865	7,635	**15,940**	75,096	0.79	318
2037	96,715	1,343	7,274	7,062	15,254	70,088	0.74	298
2038	92,539	1,327	6,935	6,732	14,560	66,732	0.71	283
2039	84,787	1,280	6,269	6,087	13,443	60,725	0.65	247
2040	79,475	1,235	5,841	5,672	12,317	56,455	0.61	226
2041	77,705	1,294	5,652	5,488	11,544	54,267	0.60	209
2042	71,710	1,292	5,110	4,962	10,485	49,266	0.55	187

Table C-8. Emission Estimates for the Western, Central, and Eastern Planning Areas, All Depths, By Year and Pollutant (continued).

Year	NO_x (TPY)	SO_2 (TPY)	PM_{10} (TPY)	$PM_{2.5}$ (TPY)	VOC (TPY)	CO (TPY)	Pb (TPY)	NH_3 (TPY)
2043	51,254	1,094	3,390	3,293	8,643	34,736	0.38	157
2044	46,692	1,077	3,018	2,932	7,842	31,076	0.35	143
2045	42,933	1,009	2,752	2,673	7,115	28,358	0.32	128
2046	39,227	974	2,433	2,364	6,492	25,503	0.29	117
2047	37,540	965	2,313	2,247	6,006	24,050	0.28	108
2048	34,738	954	2,083	2,024	5,495	21,808	0.26	98
2049	32,995	904	1,995	1,939	5,020	20,615	0.25	90
2050	28,873	849	1,688	1,640	4,403	17,665	0.22	82
2051	26,286	796	1,524	1,481	3,872	15,834	0.20	73
2052	24,303	747	1,406	1,367	3,475	14,510	0.18	67
2053	15,585	598	757	737	2,610	8,716	0.11	23
2054	13,131	592	542	527	2,333	6,838	0.09	17
2055	12,062	502	548	533	2,010	6,479	0.09	16
2056	10,119	453	434	422	1,615	5,185	0.07	12
2057	9,083	450	340	331	1,528	4,407	0.06	9
2058	8,519	405	344	335	1,321	4,185	0.06	8
2059	7,182	316	321	313	1,031	3,653	0.05	7
2060	6,052	314	215	209	984	2,829	0.04	5
2061	5,765	270	237	231	877	2,852	0.04	5
2062	5,075	268	180	176	760	2,305	0.04	4
2063	4,614	224	186	181	646	2,201	0.03	3
2064	3,524	136	183	178	433	1,872	0.03	2
2065	1,906	46	130	126	175	1,157	0.02	1
2066	1,392	46	81	79	153	782	0.01	1

[1] Bold numbers are the highest emissions per year per pollutant. These were the amounts modeled.

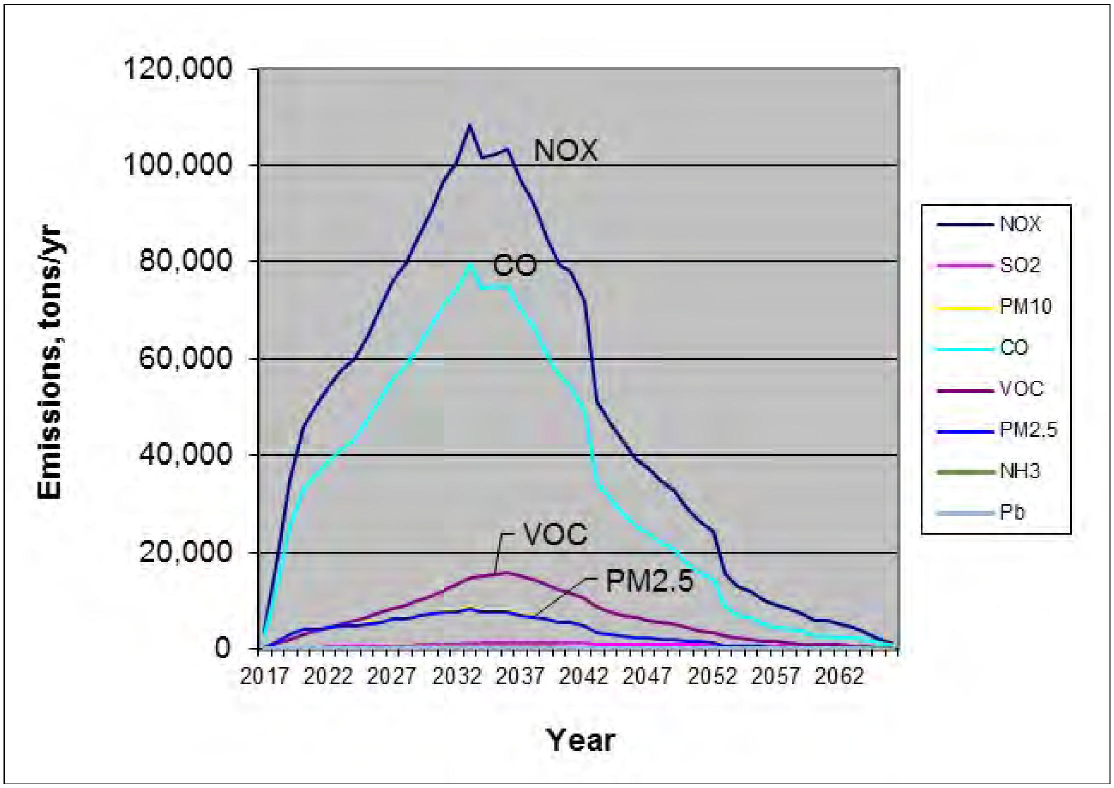

Figure C-11.   Emission Estimates for all Planning Areas and Future Activities.

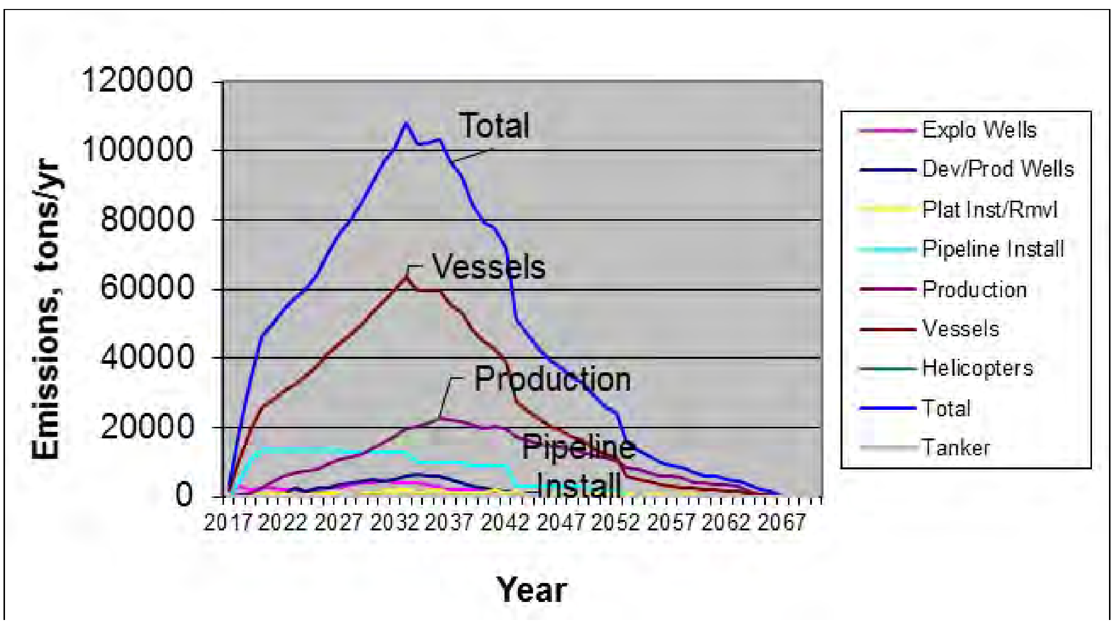

Figure C-12.   Combined Annual NO_x Emissions.

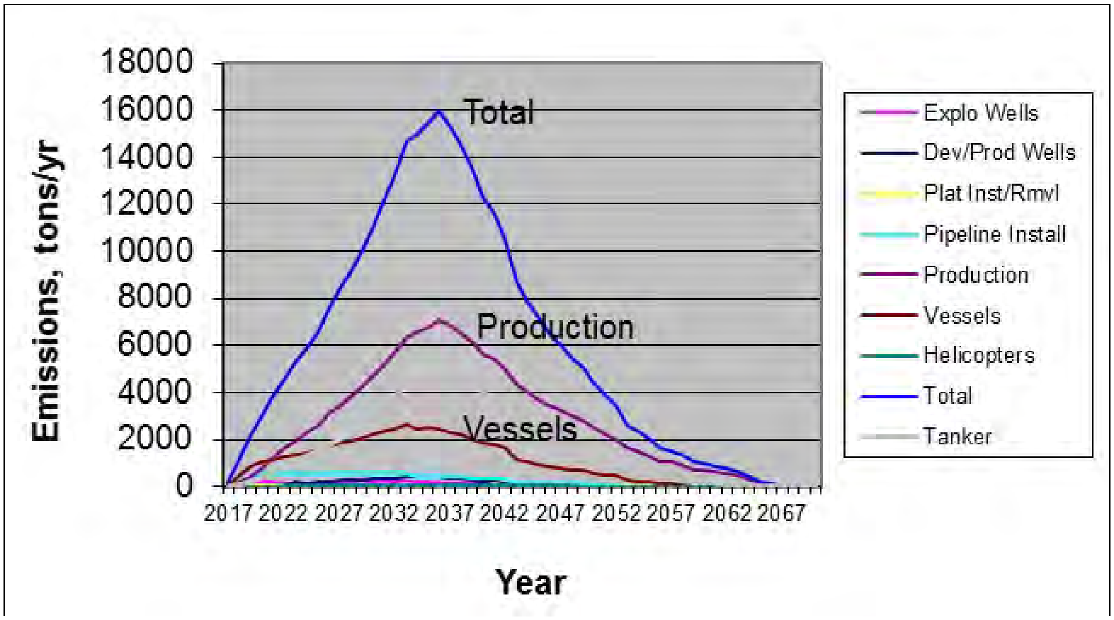

Figure C-13. Combined Annual VOC Emissions.

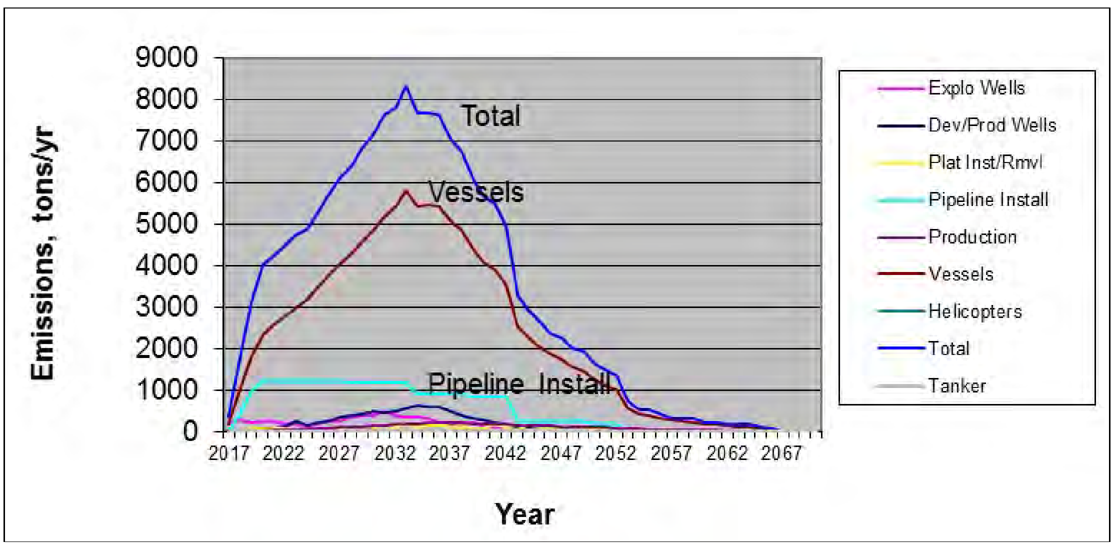

Figure C-14. Combined Annual $PM_{2.5}$ Emissions.

C.4.1.5 Spatial Allocation

The estimated emissions were allocated by planning area (WPA vs. CPA/EPA) and water depth (i.e., 0-60 m, 60-200 m, 200-800 m, 800-1,600 m, 1,600-2,400 m, and >2,400 m). **Figure C-15** depicts the planning area boundaries and water depth contours. (Note that the GOMESA Congressional Moratoria Area is not indicated in **Figure C-15**.) Emissions were not allocated to the GOMESA. The emission estimates were allocated spatially based on the anticipated future year activities provided by BOEM. Because helicopters, support vessels, and tankers transit multiple water depths, their emissions were allocated across multiple water depth contours based on assumed installed platform locations.

For some sources, emissions were assigned to unleased blocks in each area (i.e., WPA and CPA/EPA) relative to the water depth where the activity is anticipated to occur. These categories include the following:

- exploratory drilling vessels;
- development/production drilling vessels; and
- production platforms.

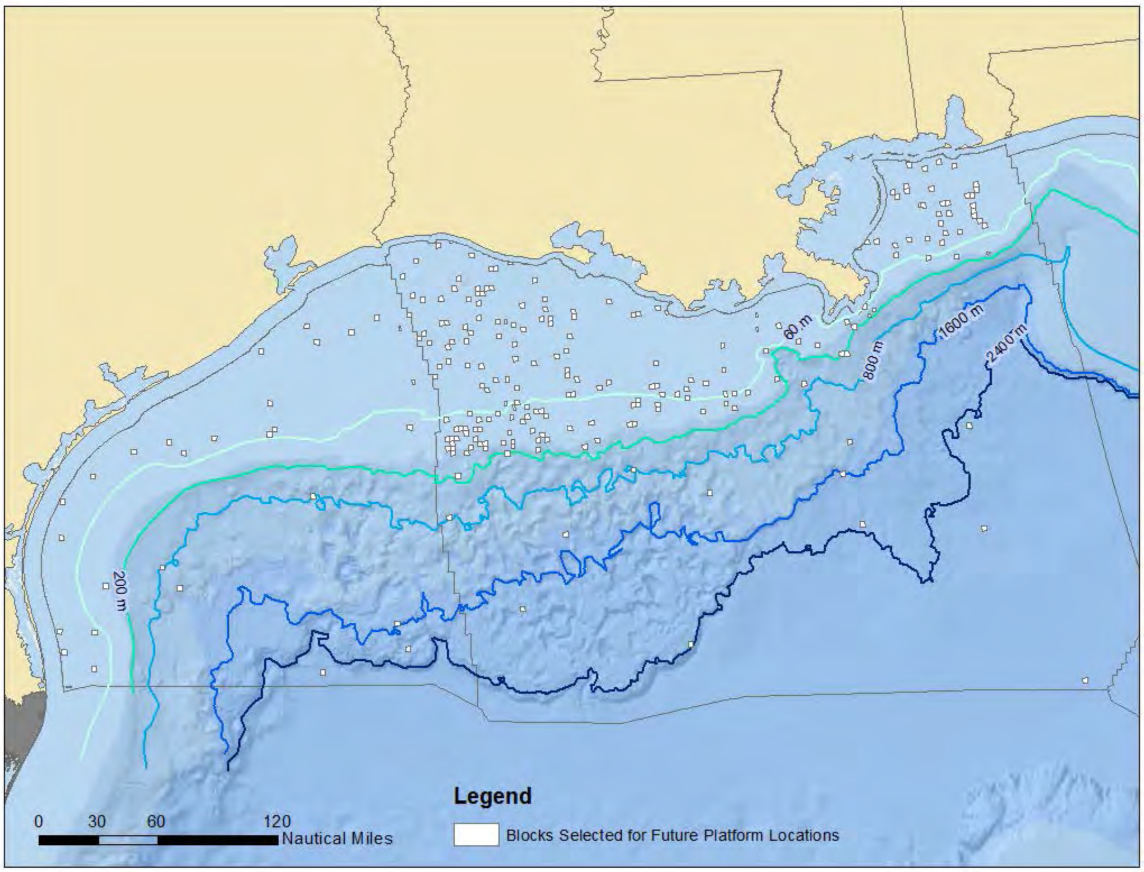

Figure C-15. BOEM OCS Planning Areas and Water Depths.

Production platforms were located as point sources with randomly selected locations. Using GIS, each lease block in the Gulf of Mexico was assigned to a water depth bin. Blocks with an active lease and that have contained a platform were then removed. Blocks that have had a platform suggest that they were leased at some point in time, and therefore are less desirable for future exploration. Once the inactive blocks with no history of production were identified, random blocks were selected throughout each water depth for each future platform as depicted in **Figure C-15**. Each platform was placed in a separate block at the centroid. Pipe-laying vessel activities were assigned to leased and unleased blocks as their operations were not limited to just the unleased blocks.

Emissions associated with BOEM's existing OCS oil and gas production sources were held constant at 2012 levels.

C.4.2 Onshore Sources and Marine Vessels

In support of the proposed ozone NAAQS revisions, the USEPA released the 2011 air quality modeling platform (2011v6.1), with projections to 2018 and 2025, for point, nonpoint area, and mobile sources in the United States (USEPA, 2014d). In addition, the USEPA released the 2011 air quality modeling platform (2011v6.2), with projections to 2017, to support ozone transport modeling for the 2008 NAAQS as well as the 2015 ozone NAAQS (USEPA, 2015d). In early October, 2015, the USEPA also released the 2011v6.2 calendar year 2025 projected inventory (USEPA, 2015d). The ERG team used the 2011v6.2 platform for calendar year 2017, primarily because the platform is based on the most recent version of the NEI (2011v.2). Calendar year 2017 data were selected rather than 2025 data because there is less uncertainty associated with the 2017 estimated emissions because most of the controls factored in by the USEPA are already "on the books" and not speculative. The *Technical Support Document (TSD) Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform* (USEPA, 2015d) provides details on the development of the 2011v6.2 future year modeling platforms.

C.4.3 Other Sources

For sources in Mexico, the USEPA air quality modeling platform 2011v6.2 includes projected 2018 emissions for onshore sources. The USEPA held emissions constant for sources in Canada.

For completeness, projected emissions estimates were also developed for platforms off the coast of Mexico; the ERG team researched the impacts of the restructuring of the energy sector in Mexico, which is predicted to include deepwater drilling within the modeling domain. Emissions were estimated based on projected deepwater production (PEMEX, 2012) and using production-based emission factors developed from the 2011 Gulfwide Inventory (Wilson et al., 2014).

For the LOOP and vessel lightering, emissions were held at 2012 levels because of uncertainties in future crude oil imports, which involve the very large crude carriers that visit the LOOP and lightering zones. The ERG team also investigated the need to include a liquefied natural gas (LNG) port to be located in Federal waters and originally expected to be operational in 2019. On September 18, 2015, however, the Maritime Administration (MARAD) and the U.S. Coast Guard stopped the permit application process, as Delphin LNG, LLC is amending the application. This potential source was not included in the future scenario given this uncertainty.

C.5 SOURCE APPORTIONMENT

Source apportionment, as applied in PGM modeling, provides a means of assessing the contributions of specified sources or source groups to predicted ozone and PM concentrations under the air quality conditions being simulated. Source contributions can be calculated for ozone and for PM using ozone or PM source apportionment routines included in the CAMx PGM modeling. In this Study, the primary receptor locations of interest for examining source contributions lie both along the shoreline and the State seaward boundary, although the PGM source apportionment output is for the entire modeling domain. Source apportionment analyses with the PGM will be applied to the future year scenario in order to analyze the pre- and postlease OCS oil and gas impacts to short-term and annual NAAQS. This will afford BOEM the opportunity to discern which source groups have the largest impacts and potentially need to be examined for control strategies. BOEM selected the following source groups for source apportionment:

- fires (U.S., Canada, and Mexico);
- biogenic and other natural sources (e.g., lighting NO_x and sea salt);
- additional BOEM OCS oil and gas production platforms associated with the Five-Year Program;
- additional BOEM oil and gas production support vessels and helicopters associated with the Five-Year Program;
- BOEM OCS oil and gas production platforms, support vessels, and helicopters under No Action (base case) alternative;
- all other marine vessel activity in the Gulf of Mexico;
- other anthropogenic U.S. sources;
- Mexican and Canadian anthropogenic sources; and
- initial and boundary conditions (IC and BC).

These source groups aggregate similar sources based on jurisdiction (i.e., sources under BOEM control versus other Federal agencies) and sources beyond control (e.g., natural emission sources and foreign sources). This is helpful in showing whether BOEM's sources are significantly contributing to any modeled air quality issues onshore and at the State seaward boundary, or if a source category regulated by another Federal agency is the more likely the problem source.

Having the additional OCS oil and gas production platforms, support vessels, and helicopters associated with the scenarios for the 2017-2022 GOM Multisale EIS and this Supplemental EIS as separate source groups allows BOEM to quantify the impact of these sources on the onshore air quality and at the State seaward boundary.

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APPENDIX D

AIR QUALITY:
CUMULATIVE AND VISIBILITY IMPACTS

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ABBREVIATIONS AND ACRONYMS

ANC	acid neutralizing capacity
AQRV	air quality related value(s)
BLM	Bureau of Land Management (U.S. Department of the Interior)
CAMx	Comprehensive Air quality Model with eXtensions
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
DAT	Deposition Analysis Threshold
dv	deciview
DVB	design value for base year
DVC	design value for current (base) year
DVF	design value for future year
FLAG	Federal Land Managers' Air Quality Related Values Workgroup
GHG	greenhouse gas
HAP(s)	hazardous air pollutant(s)
hp	horsepower
hr	hour(s)
IMPROVE	Interagency Monitoring of Protected Visual Environments
kg/ha-yr	kilogram(s) per hectare - year
km	kilometer(s)
m	meter(s)
MATS	Modeled Attainment Test Software
mcf	Thousand cubic feet
MDA_8	Annual 4th highest daily maximum running 8-hour average (concentration)
Mm^{-1}	inverse megameters
N_2O	Nitrous oxide
NAAQS	National Ambient Air Quality Standards
NO_2	nitrogen dioxide
NO_x	total oxides of nitrogen
O_3	ozone
$PM_{2.5}$	fine particulate matter (less than 2.5 microns in effective diameter)
PM_{10}	inhalable particulate matter (less than 10 microns in effective diameter)
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Deterioration
RRF	Relative Reduction Factor
SO_2	sulfur dioxide
tpy	tons per year
UAA	Unmonitored Area Analysis

USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
VOC	volatile organic compounds
WRF	Weather Research and Forecasting model
yr	year
μeq/l	microequivalent(s) per liter
$\mu g/m^3$	microgram(s) per cubic meter

D AIR QUALITY: CUMULATIVE AND VISIBILITY IMPACTS

D.1 INTRODUCTION

The U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) is required under the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. § 1334(a)(8)) to comply with the National Ambient Air Quality Standards (NAAQS) to the extent that Outer Continental Shelf (OCS) offshore oil and gas exploration, development, and production sources do not significantly affect the air quality of any state. The Gulf of Mexico OCS Region's area of possible influence includes the States of Texas, Louisiana, Mississippi, Alabama, and Florida. BOEM's Gulf of Mexico OCS Region manages the responsible development of oil, gas, and mineral resources for the 430 million acres in the Western, Central, and Eastern Planning Areas (WPA, CPA, and EPA) on the OCS comprising the Gulf of Mexico region, including the areas under moratoria (shown in **Figure D-1**). The Clean Air Act Amendments (CAAA) of 1990 designate air quality authorities in the Gulf of Mexico OCS Region, giving BOEM air quality jurisdiction westward of 87°30'W. longitude and the U.S. Environmental Protection Agency (USEPA) air quality jurisdiction eastward of 87°30'W. longitude. In 2006, oil and gas leasing operations within 125 miles (201 kilometers [km]) off the Florida coastline were placed under moratoria until 2022 under the Gulf of Mexico Energy Security Act (GOMESA). The GOMESA moratoria area is depicted on **Figure D-1**.

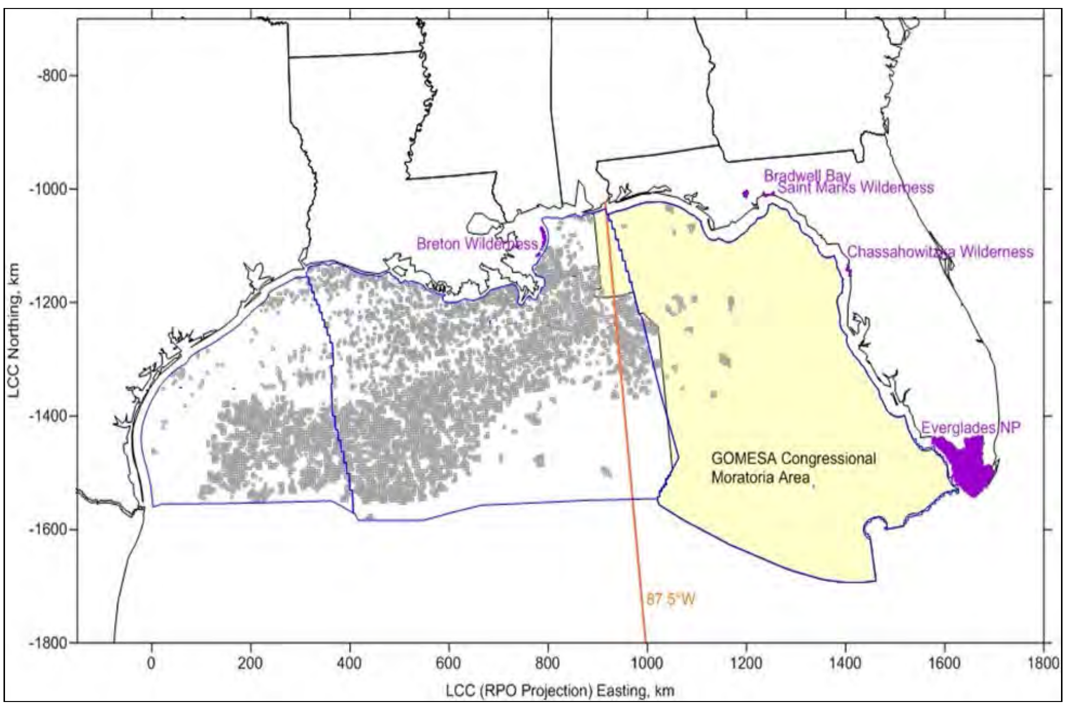


Figure D-1. Location of the "Air Quality Modeling in the Gulf of Mexico Region" Study, with Class I Areas (purple).

BOEM published the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261—Final Multisale Environmental Impact Statement* (2017-2022 GOM Multisale EIS) and is currently developing the *Gulf of Mexico OCS Oil and Gas Lease Sales: 2018-2022; Gulf of Mexico Lease Sales 250, 251,* *252, 253, 254, 256, 257, 259, and 261—Draft Supplemental Environmental Impact Statement* (2018-2022 GOM Supplemental EIS) for oil and gas resources under its jurisdiction within the Gulf of Mexico's WPA, CPA, and EPA (the Proposed Action).

On August 26, 2014, BOEM contracted with Eastern Research Group, Inc. (ERG) and team members Ramboll Environ US Corporation (Ramboll Environ) and Alpine Geophysics, LLC (Alpine) to complete a comprehensive air quality modeling study in the Gulf of Mexico OCS region. Under BOEM Contract Number M14PC00007, "Air Quality Modeling in the Gulf of Mexico Region," photochemical air quality modeling was conducted to assess impacts to nearby states of OCS oil and gas exploration, development, and production as required under OCSLA. This assessment was used by BOEM to disclose potential incremental and cumulative air quality impacts of a proposed action in the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers. This Technical Support Document (TSD) provides a detailed description of the data, modeling procedures, and results of the Air Quality Impact Analysis (AQIA). BOEM used this information to complete its analysis of potential impacts of a proposed action on air quality in the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers.

D.1.1 Background on Air Quality Impact Analyses and Thresholds

This analysis examines the potential impacts of the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers, with respect to the following:

- the NAAQS for the criteria pollutants ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), fine particulate matter with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) and fine plus coarse particulate matter with aerodynamic diameters less than 10 μm (PM_{10});
- air quality related values (AQRV), including visibility and acid deposition (sulfur and nitrogen) in nearby Class I and sensitive Class II areas (as defined below); and
- incremental impacts of Prevention of Significant Deterioration (PSD) pollutants (NO_2, PM_{10}, $PM_{2.5}$) with respect to PSD Class I and Class II increments.

Note that the PSD increments are provided here for information purposes, but this analysis does not constitute a regulatory PSD increment consumption analysis as would be required for major sources subject to the New Source Review (NSR) program requirements of the Clean Air Act.

Results of each impact analysis are compared with applicable "thresholds of concern," which have typically been used in air quality impact evaluations of other Federal actions, including onshore oil and gas leasing programs. The applicable comparison thresholds for criteria pollutant impacts are the corresponding NAAQS. For acid (i.e., sulfur and nitrogen) deposition impacts, thresholds are based on (a) incremental impacts considered sufficiently small as to have no consequential effect on the receiving ecosystems, i.e., Deposition Analysis Thresholds, and (b) critical load levels above which cumulative ecosystem effects are likely to or have been observed. For visibility impacts, thresholds are based on incremental changes in light extinction below the level at which they would be noticeable to the average human observer. Additional information about these various thresholds is provided in relevant sections in the remainder of this appendix.

D.1.1.1 Ambient Air Quality Standards

The USEPA has set NAAQS for six regulated air quality pollutants: ozone, particle pollution ($PM_{2.5}$ and PM_{10}), SO_2, NO_2, CO, and lead (Pb). After promulgation of a NAAQS, the USEPA designates areas that fail to achieve the NAAQS as nonattainment areas (NAAs), and States are required to submit State Implementation Plans (SIPs) to the USEPA that contain emission control plans and a demonstration that the NAA will achieve the NAAQS by the required date. After an area comes into attainment of the NAAQS, the area can be redesignated as a maintenance area and must continue to demonstrate compliance with the NAAQS.

In 1997, the USEPA promulgated the first 8-hour ozone NAAQS with a threshold of 0.08 parts per million (ppm) (84 parts per billion [ppb]). On March 12, 2008, the USEPA promulgated a more stringent 0.075 ppm (75 ppb) 8-hour ozone NAAQS. **Figure D-2** presents the current ozone nonattainment areas in the southeastern U.S. On October 1, 2015, the USEPA strengthened the 8-hour NAAQS for ozone to 0.07 ppm (70 ppb). Under this more stringent ozone NAAQS, there may be more areas in the southeastern U.S. that will be in nonattainment. The USEPA plans to make attainment and nonattainment designations for the revised standards by October 2017, with the designations based on 2014-2016 air quality data.

On December 14, 2012, the USEPA revised the $PM_{2.5}$ primary NAAQS by lowering the annual $PM_{2.5}$ NAAQS threshold from 15.0 micrograms per cubic meter ($\mu g/m^3$) to 12.0 $\mu g/m^3$. The USEPA retained the 24-hour $PM_{2.5}$ primary NAAQS at 35 $\mu g/m^3$. The 24-hour course PM NAAQS (PM_{10}) was also retained at 150 $\mu g/m^3$.

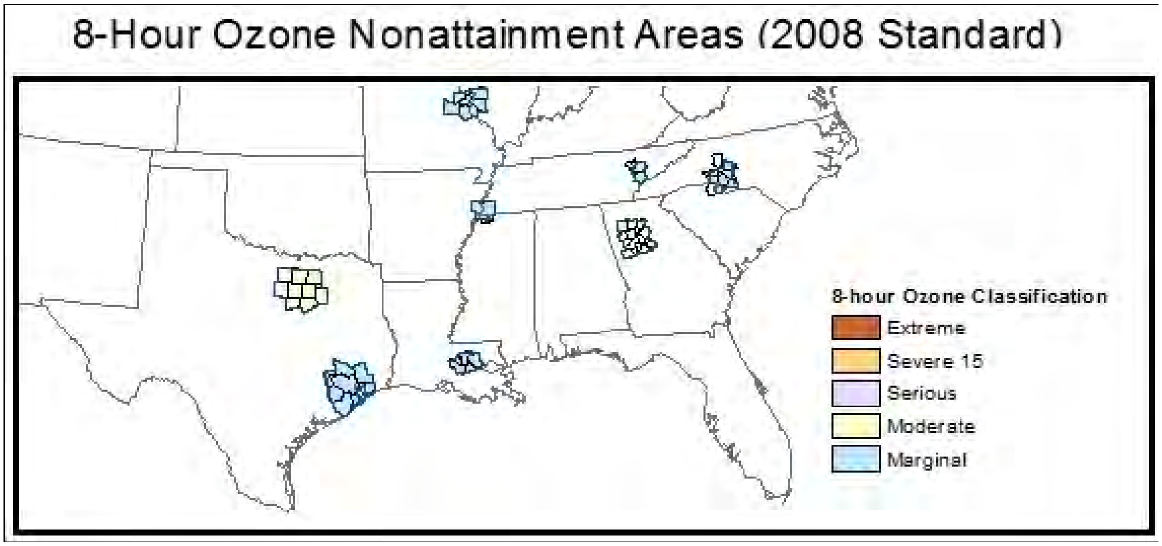


Figure D-2. Ozone Nonattainment Areas in the Southeastern U.S. (Source: USEPA, 2016; https://www3.epa.gov/airquality/greenbook/map8hr_2008.html).

In February 2010, the USEPA issued a new 1-hour NO_2 NAAQS with a threshold of 100 ppb (98th percentile daily maximum 1-hour average averaged over 3 years) and a new 1-hour SO_2 NAAQS was promulgated in June 2010 with a threshold of 75 ppb (99th percentile daily maximum 1-hour average averaged over 3 years). No areas are currently in nonattainment of either the annual or 1-hour NO_2 NAAQS. On July 25, 2013, the USEPA designated 29 areas in 16 states as nonattainment for the 1-hour SO_2 standard.[1] In June 2016, four additional areas were designated as nonattainment (Madison and Williamson Counties in southern Illinois, Anne Arundel-Baltimore Counties in Maryland and St. Clair County in Michigan).[2] The USEPA is currently in the process of gathering more information needed to complete designation of remaining unclassifiable areas with respect to the 1-hour SO_2 NAAQS.

A new lead NAAQS was issued in 2008; NAAs for lead are associated with specific industrial sources. As oil and gas sources in the Gulf of Mexico OCS region produce negligible amounts of lead emissions and to be consistent with onshore oil and gas analysis, which does not include lead, lead emissions were calculated but lead was not included in the air quality analysis. The NAAQS for carbon monoxide has remained essentially unchanged since it was originally promulgated in 1971. As of September 27, 2010, all NAAs for carbon monoxide have been redesignated as maintenance areas.

Table D-1 summarizes the nonattainment and maintenance areas in the southeastern U.S. SO_2 and lead NAAs are focused around specific large industrial sources of SO_2 or lead emissions,

[1] https://www.epa.gov/sites/production/files/2016-03/documents/20130725fs.pdf
[2] https://www.epa.gov/sites/production/files/2016-06/documents/so2d-r2-area-list.pdf

whereas ozone nonattainment areas are more regional in nature, reflecting the formation of ozone as a secondary pollutant from emissions of NO_x and VOC precursors from a wide range of sources.

Table D-1. Nonattainment and Maintenance Areas in the Southeastern U.S.

State	Area	8-hr O_3 (1997)	8-hr O_3 (2008)	SO_2 (2010)	CO (1971)	Lead (2008)
Alabama	Troy, AL					NAA[a]
Florida	Tampa, FL					NAA
	Hillsborough County, FL			NAA		
	Nassau County, FL			NAA		
Louisiana	Baton Rouge, LA	M[b]	NAA			
	St. Bernard Parish, LA			NAA		
Texas	Beaumont-Port Arthur, TX	M				
	Houston-Galveston-Brazoria, TX	NAA	NAA			
	Frisco, TX					NAA

[a] NAA = nonattainment area.
[b] M = maintenance area.
Blank cells indicate the area is in attainment of the NAAQS.

D.1.1.2 Air Quality-Related Values

The CAAA designated 156 Class I areas consisting of National Parks and Wilderness Areas that are offered special protection for air quality and AQRVs. The Class I areas, compared to Class II areas, have lower PSD increments that new sources may not exceed and are protected against excessive increases in several AQRVs including visibility impairment, acid (sulfur and nitrogen) deposition, and nitrogen eutrophication. The Regional Haze Rule (RHR) specifies a goal of achieving “natural” visibility conditions by 2064 in Class I areas, and States must submit RHR SIPs that demonstrate progress towards that goal. **Figure D-1** displays the locations of the mandatory Class I areas (in purple) in the Gulf of Mexico OCS region.

In addition to the Class I areas described above, Federal Land Management (FLM) agencies have designated certain other areas as Class II sensitive areas for tracking PSD increment consumption and AQRV impacts. Sensitive Class II areas in the southeastern U.S. study region are shown in **Figure D-3**.

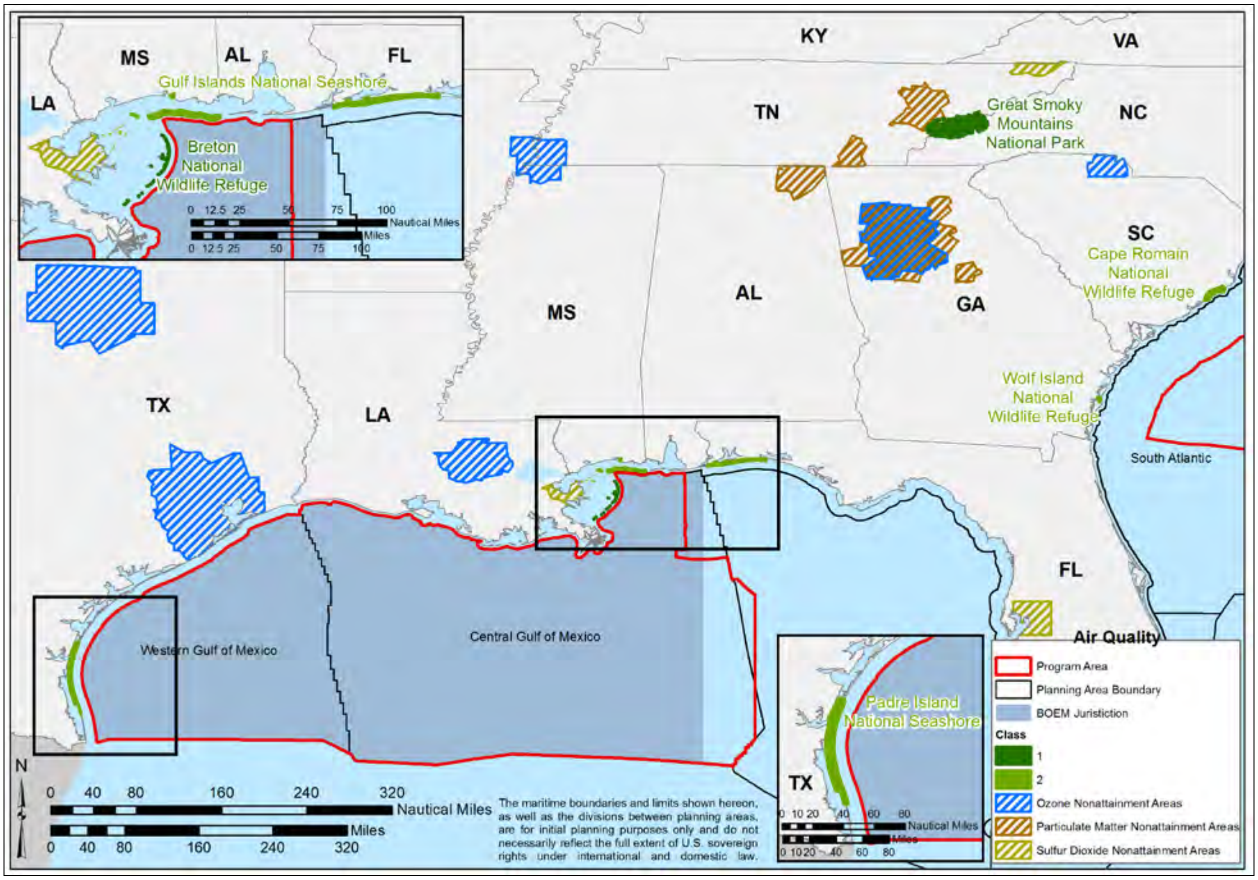


Figure D-3. Class I and Sensitive Class II Areas in the Study Region. (Note: The South Atlantic Planning Area was removed from the Five-Year Program.)

D.1.2 Overview of Approach

The Comprehensive Air-quality Model with extensions (CAMx; www.camx.com) and Community Multiscale Air Quality (CMAQ; https://www.cmascenter.org/cmaq/) Photochemical Grid Models (PGMs) were used to simulate the dispersion and chemical transformation of pollutants over the Study area. Similar to other air quality models, CAMx/CMAQ require several input datasets, including meteorology and an emissions inventory. **Figure D-4** presents an overview of how these project datasets fit together for the "Air Quality Modeling in the Gulf of Mexico OCS Region" study. Preparation of the required meteorological and emissions data is described briefly in this TSD, along with references to more detailed reports.

Photochemical modeling was conducted for two emission scenarios:

- a base case scenario using the 2012 base year (BY) emissions inventory described in **Section D.3** was used to evaluate model performance and to define current baseline air quality conditions; and
- a future year development scenario (FY) using an emissions inventory that includes potential new sources associated with the 2017-2022 GOM Multisale

EIS, from which this Supplemental EIS tiers, and projections of emissions to 2017 for all other sources as described in **Section D.3** was used to estimate the cumulative and incremental air quality and AQRV impacts of the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers.

Note that both scenarios used the same meteorological dataset and the same photochemical model configuration.

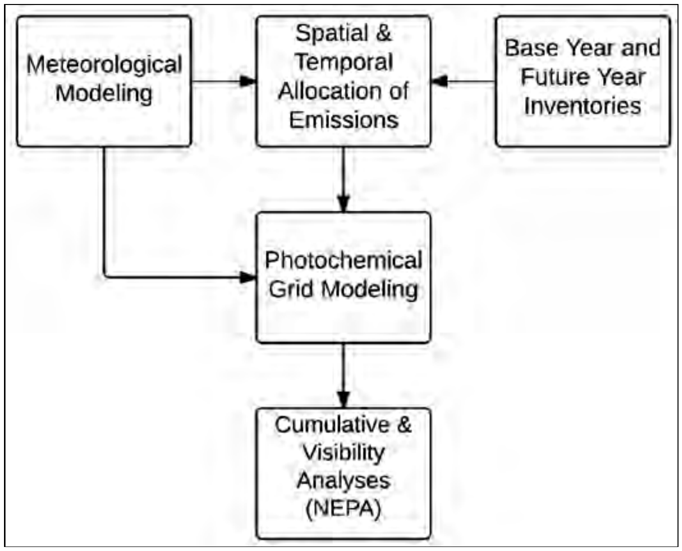


Figure D-4. Overview of the "Air Quality Modeling in the Gulf of Mexico Region" Study Tasks (note that the meteorological model takes meteorological observations as inputs).

D.2 METEOROLOGY

Meteorological datasets required to determine the rate that pollutants disperse and react in the atmosphere include spatially and temporally varying parameters such as wind speed, wind direction, air temperature, and humidity, among others. Sources of meteorological information include datasets of measurements gathered at various locations within the Gulf of Mexico OCS Region domain. However, the spatial coverage of measurements is insufficient to describe the three-dimensional structure of the atmosphere away from measurement locations. Using measurement data as inputs, gridded meteorological models capable of simulating the fluid dynamics of the atmospheric can be used to estimate meteorological conditions over a complete modeling domain—including regions far from measurement sites—in a physically consistent fashion. Results of these meteorological models provide the inputs needed to exercise the photochemical grid air quality dispersion models used in this Study. For this "Air Quality Modeling in the Gulf of Mexico Region" study, the Advanced Research version of the Weather and Research Forecasting (WRF) model (version 3.7) was applied over a system of nested modeling grids. **Figure D-5** shows the WRF modeling grids at horizontal resolutions of 36, 12, and 4 km. All WRF grids were defined on a Lambert Conformal Conic (LCC) projection centered at 40°N. latitude, 97°W. longitude with true latitudes at 33°N. and 45°N. (the "standard RPO" projection). The outermost domain (outer box) with 36-km resolution includes the entire continental U.S. and parts of Canada and Mexico, and captures synoptic-scale (storm system-scale) structures in the atmosphere. The inner 12-km regional grid (d02) covers the southeastern U.S. and is used to ensure that large-scale meteorological patterns across the region are adequately represented and to provide boundary conditions to the 4-km domain. The 4-km domain (d03) is centered on the coastal areas of the southeastern U.S. and over-water portions of the Gulf of Mexico.

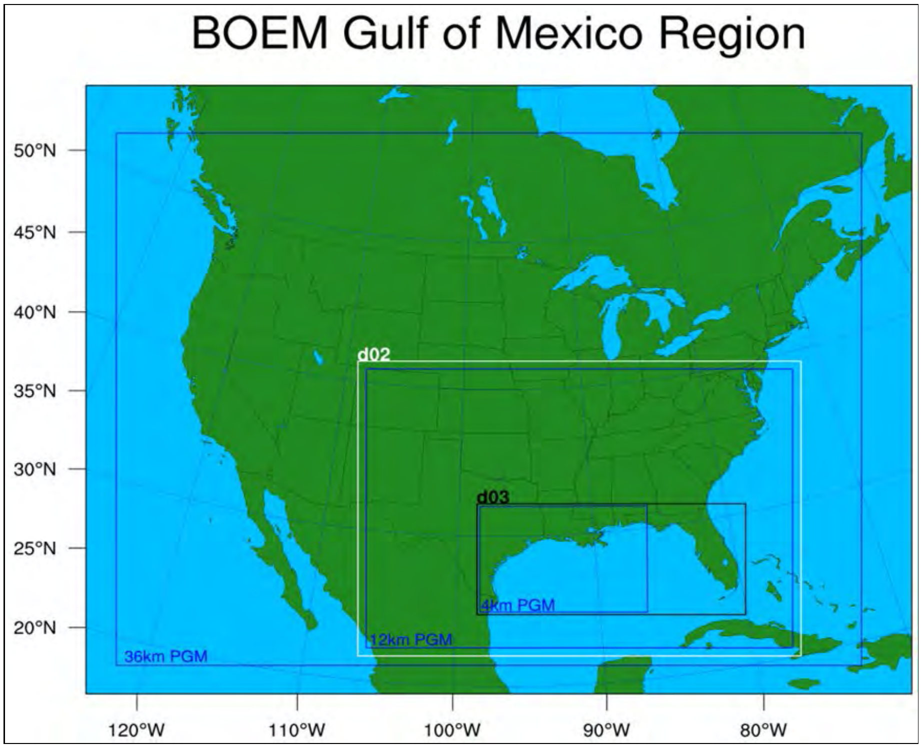


Figure D-5. Meteorological (WRF model) and PGM Modeling Domains Including the 36-km Horizontal Grid Resolution CONUS WRF Domain (outer box), 12-km Resolution Southeast Regional WRF (white) and PGM (blue) Domains (d02), and 4-km Resolution Gulf of Mexico OCS Region WRF (black) and PGM (blue) Domains (d03).

The WRF ran the 36-, 12- and 4-km grids simultaneously with one-way nesting, meaning that meteorological information flows down-scale via boundary conditions introduced from the respective coarser to finer grids without feedback from the finer to coarser grids. The WRF modeling domain was defined to be slightly larger than the CAMx/CMAQ PGM modeling domains to eliminate boundary artifacts in the meteorological fields. Such boundary artifacts occur for both numerical reason (the 3:1 grid spacing ratio) and because the imposed boundary conditions require some time/space to come into dynamic balance with WRF's atmospheric equations. All meteorological modeling domains, techniques, inputs, vertical resolution, parameters, nudging, physics options, and application strategy, along with quantitative and qualitative evaluation procedures and statistical benchmarks, are discussed in **Appendix B**.

D.3 EMISSIONS

Analysis of the cumulative air quality impacts of the 2017-2022 GOM Multisale EIS scenario required development of both a contemporary base year emissions inventory for the base case analysis and a projected future year inventory that includes emissions from all cumulative sources, as well as additional emissions anticipated to occur under the 2017-2022 GOM OCS Multisale EIS alternatives in which additional exploratory drilling and construction of new shallow-water and deepwater platforms to support oil and gas production would occur. Both the base case and future year cumulative source inventories represent comprehensive compilations of pollutant emissions from all human activities, as well as emissions from biogenic and geogenic sources. This Supplemental EIS tiers from the 2017-2022 GOM Multisale EIS and uses the scenario and alternatives analyzed in the 2017-2022 GOM Multisale EIS.

The scope of the air pollutant emissions inventory for the "Air Quality Modeling in the Gulf of Mexico Region" study is defined in terms of: pollutants, representative time periods for the base case and future year analysis, geographical domain, and sources to be included.

D.3.1 Pollutants

Pollutants included in the inventories were selected to support analysis of air quality impacts in terms of impacts on attainment of NAAQS and on AQRVs, including acid deposition and visibility. The selected pollutants are: CO, NO_x (which includes NO and NO_2 and is stated in terms of equivalent mass of NO_2), $PM_{2.5}$, fine plus coarse PM (PM_{10}), SO_2, volatile organic compounds (VOCs, which are precursors to formation of ozone and organic particulates), and ammonia (NH_3, a precursor to particulate matter formation). Note that lead emissions were calculated since lead is a criteria pollutant, but since oil and gas sources have negligible lead emissions, it was not modeled in the air quality analysis.

While the cumulative air quality impact analysis did not focus specifically on air toxics, compilation of VOC emissions by source type together with VOC speciation profiles by source type provides a mechanism for estimating emissions of individual air toxic species.

D.3.2 Base Year

In determining the base case (base year) for the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory, 2011 was initially selected based on data availability. Calendar year 2011 emissions data are readily available for most sources from the USEPA's National Emissions Inventory (NEI) (USEPA, 2015a) and BOEM's *Year 2011 Gulfwide Emissions Inventory Study* (Wilson et al., 2014). However, 2011 was an unusually hot and dry year in the Gulf of Mexico OCS region, particularly in Texas, which experienced record heat and dry conditions during the summer of 2011 and had a very high incidence of wildfires. Therefore, 2012 was selected as the base year as more representative of "typical" conditions in the Gulf of Mexico OCS region.

D.3.3 Geographical Domain

Modeling domains used for the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory are depicted in **Figure D-5**. Emissions were spatially allocated over the three PGM modeling domains: an outer 36-km horizontal grid resolution domain covering all of the U.S. and parts of Mexico and Canada; a regional 12-km resolution domain covering the southeastern U.S.; and an inner 4-km domain encompassing the CPA and WPA. The influences of global emissions on the study area are accounted for by the use of a global air quality model to specify domain boundary conditions.

D.3.4 Inventory Sources

A comprehensive inventory of emissions from anthropogenic (i.e., human caused) sources, including stationary point and nonpoint area sources located both onshore and offshore, on-road motor vehicles, nonroad equipment, locomotives, marine vessels and other offshore sources, and airports, were compiled for the "Air Quality Modeling in the Gulf of Mexico Region" study emissions inventory. **Table D-2** lists the source categories included in the emissions inventory, along with the pollutants applicable to each category, and the source type (area source, point source, offshore lease block). Note that emissions from non-anthropogenic sources (biogenic and geogenic sources) were developed in conjunction with the emissions modeling procedures described in **Section D.3.9**.

Table D-2. Gulf of Mexico OCS Region Air Quality Modeling Study Source Categories.

Group and Source Category		CO	NO_x	SO_2	VOC	Pb	$PM_{2.5}$	PM_{10}	NH_3	Source Type[a]
NEI Onshore Sources	Point Sources	✓	✓	✓	✓	✓	✓	✓	✓	P
	Nonpoint Area Sources	✓	✓	✓	✓	✓	✓	✓	✓	A
	Onroad Mobile Sources	✓	✓	✓	✓		✓	✓	✓	A
	Commercial Marine Vessels	✓	✓	✓	✓	✓	✓	✓	✓	P, A[b]
	Locomotives	✓	✓	✓	✓	✓	✓	✓	✓	P, A[c]
	Aircraft and Airports	✓	✓	✓	✓	✓	✓	✓	✓	P
	Other Nonroad Mobile Sources	✓	✓	✓	✓		✓	✓	✓	A
Offshore Oil and Gas Sources	Platforms in State Waters	✓	✓	✓	✓		✓	✓		P
	Platforms in the CPA and WPA	✓	✓	✓	✓	✓	✓	✓	✓	P
	Drilling Rigs	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Pipelaying Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Support Helicopters	✓	✓	✓	✓		✓	✓	✓	LB

Group and Source Category		CO	NO_x	SO_2	VOC	Pb	$PM_{2.5}$	PM_{10}	NH_3	Source Type[a]
	Support Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Survey Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
Non-oil and Gas Offshore Vessels and Activities	Commercial Fishing Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Commercial Marine Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Louisiana Offshore Oil Port	✓	✓	✓	✓	✓	✓	✓	✓	P
	Military Vessels	✓	✓	✓	✓	✓	✓	✓	✓	LB
	Recreational Vessels	✓	✓	✓	✓		✓	✓	✓	LB
	Vessel Lightering	✓	✓	✓	✓	✓	✓	✓	✓	P
Biogenic and Geogenic Sources	Subsurface Oil Seeps				✓					LB
	Mud Volcanoes				✓					LB
	Onshore Vegetation		✓		✓					A
	Wildfires and Prescribed Burning	✓	✓	✓	✓		✓	✓	✓	P
	Windblown Dust						✓	✓		A
	Lightning		✓							A
	Sea Salt Emissions						✓	✓		A
Sources in Mexico and Canada	Point Sources	✓	✓	✓	✓		✓	✓	✓	P
	Nonpoint Area Sources	✓	✓	✓	✓		✓	✓		A
	Mobile Sources	✓	✓	✓	✓		✓	✓		A

[a] A = area source (requires spatial surrogate); P = point source (requires UTM coordinates, stack parameters); LB = offshore lease block (requires GIS shape file).
[b] Larger ports and shipping represented as shape files; smaller ports as point sources.
[c] Rail yards represented as point sources; railway segments as area sources.

D.3.5 Spatial Resolution

The spatial resolution of the emissions inventory is source specific. For example, sources such as power plants are identified based on their geographic coordinates (i.e., latitude and longitude), while other sources such as nonroad mobile sources (e.g., construction equipment) are spatially distributed using surrogates within the county in which they are reported and that are typically related to the activity distribution of the category (e.g., construction sites).

The resolution of the geographical area covered by the emissions inventory is based on the grid cell size needed for photochemical and dispersion modeling. Furthermore, the photochemical model grid resolution is dependent on the grid resolution of the WRF meteorological model output used. This is described further in **Section D.3.9**.

D.3.6 Temporal Resolution

Emissions for all sources were estimated on an annual basis (i.e., emissions generated during 2012). For electric generating units (EGUs), emissions were allocated on a sub-annual basis to reflect variations in activity using data from the USEPA. Emissions were allocated on an hourly, daily, and seasonal basis during the emissions modeling process (**Section D.3.9**) using default temporal allocation factors provided with the Sparse Matrix Operator Kernel Emissions model (SMOKE) emissions model for some sources; other temporal allocations were source specific; and profiles were developed and applied within the SMOKE model.

D.3.7 Speciation

When applying the photochemical grid modeling, PM emissions were allocated to individual PM species as part of the SMOKE emissions processing using PM speciation factors obtained from the USEPA's SPECIATE database for each source category (as defined by the Source Classification Code). This resulted in the PM mass being broken into the mass associated with elemental carbon (EC), organic aerosol (OA), primary sulfate (SO_4) and nitrate (NO_3) and other elements, and particle-bound VOCs, such as polycyclic aromatic hydrocarbon (PAHs). The model predictions of EC will undergo for further analysis and discussed in the "Air Quality Modeling in the Gulf of Mexico Region" study final report.

SMOKE was also used to convert VOC emissions into the photochemical mechanism-specific (e.g., CB05 or CB6r2h) model species used in air quality models as described in **Section D.3.9**. The CB6r2h chemical mechanism used in CAMx also models excess methane (ECH_4) from local sources that is added to the background methane value (1.75 ppm) in the chemical mechanism. The excess methane species is calculated as part of the speciation of the VOC emissions that are first adjusted to total organic gases (TOG) before calculating the CB6 chemical species. Thus, the excess methane species only includes methane emissions from local VOC sources (e.g., oil and gas) and will not include methane emissions not associated with VOC sources.

D.3.8 Base Year and Future Year Emission Estimates

Details on the development of the base year and future year emission estimates are presented in **Appendix C**.

D.3.9 Emissions Processing for Preparation of Model-Ready Emissions

D.3.9.1 Smoke Processing

Anthropogenic emissions inventories discussed in the previous section and other data were used to prepare PGM model-ready emission files using the Sparse Matrix Operator Kernel Emissions (SMOKE) system version 3.6 and other methods as described below. The inventories were processed through SMOKE to develop hourly, gridded, and speciated emissions required for input to the PGM models at 36-, 12-, and 4-km grid resolutions. During emissions processing, annual emissions inventories were speciated to model species, temporally allocated to hourly emissions, and spatially allocated to grid cells.

The latest Carbon Bond 6 revision 2h (CB6r2h) photochemical mechanism with active local methane emissions and halogen chemistry was used for the CAMx modeling, whereas the Carbon Bond 5 (CB05) with updated toluene and chlorine chemistry photochemical mechanism was used for the CMAQ modeling, and emissions were processed accordingly. CMAQ versions 5.0 and later contain a thermodynamic equilibrium aerosol mechanism (ISORRPIA v2) that requires detailed speciation of $PM_{2.5}$. This involves splitting PMFINE into additional elemental components.

The SMOKE emissions model was used to perform the following tasks:

- Spatial Allocation: Spatial surrogates contained in the USEPA 2011v6.2 modeling platform[3] were used to spatially distribute emissions to modeling grid cells. Spatial surrogates are generated by overlaying the PGM modeling grid on maps of geospatial indicators appropriate to each source category (e.g., housing units). The Surrogate Tool[4], a component of USEPA's Spatial Allocator system, is used to calculate the fraction of geospatial indicator coverage in each model grid cell.
- Temporal Allocation: Air quality modeling systems, such as CMAQ and CAMx, require hourly emissions input data. With the exception of a few source types (i.e., Continuous Emissions Monitoring data, biogenic emissions, and some fire inventories), most inventory data are estimated in the form of annual or daily emissions. SMOKE was used to allocate annual emissions to months and across the diurnal cycle to account for seasonal, day-of-week and hour-of-day effects. Temporal profiles and SCC cross references from the 2011v6.2 modeling platform were used to incorporate seasonal and monthly variations into the development of the PGM model-ready emissions.
- Chemical Speciation: The emissions inventories for the "Air Quality Modeling in the Gulf of Mexico OCS Region" study included the following pollutants: CO, NO_x, VOC, NH_3, SO_2, PM_{10}, and $PM_{2.5}$. Ramboll Environ used SMOKE to convert inventoried VOC emissions into the CB6r2 photochemical mechanism model species. Chemical speciation profiles were assigned to inventory sources using cross-referencing data that match the profiles and inventory sources using country/state/county (FIPS) and source classification codes (SCCs). Ramboll Environ used NO_x, VOC, and PM speciation profiles from the 2011v6.2 platform for SMOKE processing. In the 2011v6.2 platform, USEPA-generated emissions

[3] http://www.epa.gov/ttn/chief/emch/index.html#2011
[4] https://www.cmascenter.org/sa-tools/documentation/4.2/html/srgtool/SurrogateToolUserGuide_4_2.pdf

for Carbon Bond version 6 revision 2 (CB6r2) chemical mechanism used by CAMx. In addition, this platform generates the $PM_{2.5}$ model species associated with the CMAQ Aerosol Module, version 6 (AE6). SMOKE also applied source-specific speciation profiles to convert inventoried NO_x emissions to NO, NO_2, and HONO components. After SMOKE processing, Ramboll Environ applied necessary species mapping to prepare CMAQ-ready emissions in CB05/AE6 terms and CAMx-ready emissions in CB6r2/CF terms. Note that CB6r2 chemistry also models local excess methane (ECH_4) above background concentrations. Sea salt and halogen emissions from the Gulf of Mexico and other ocean portions of the modeling domain were also generated for CAMx as described below.

D.3.9.2 Biogenic Emissions

Biogenic emissions were generated using the MEGAN version 2.1 biogenics model developed at the National Center for Atmospheric Research (Guenther et al., 2012; Sakulyanontvittaya et al., 2008).

Biogenic emissions depend critically upon landuse/landcover input data. Biogenic VOC and NO emissions vary considerably on spatial scales ranging from a few meters to thousands of kilometers. The MEGAN model accounts for this variability with high-resolution estimates of vegetation type and quantity. The MEGAN landcover variables include total Leaf Area Index (LAI), tree fraction, and plant species composition. These variables are determined based primarily on satellite observations, such as 2003 1 km^2 Moderate Resolution Imaging Spectroradiometer (MODIS) and 30-m resolution LANDSAT data (Guenther et al., 2006; Sakulyanontvittaya et al., 2008). MEGAN driving variables include weather data, LAI, plant functional type (PFT) cover, and compound-specific emission factors that are based on plant species composition. All of these variables are available at various temporal scales and are provided in a geo-referenced gridded database in several formats (e.g., netcdf, ESRI GRID). The MEGAN database has global coverage at 30 sec (approximately 1 km) spatial resolution.

The MEGAN model was applied using the specific daily meteorology (e.g., temperature and solar radiation) extracted from the 2012 WRF model outputs to generate day-specific biogenic emissions for the 2012 calendar year in the 36-, 12-, and 4-km PGM modeling domains.

D.3.9.3 Fire Emissions

Forest fire emissions are highly episodic and very location specific. Using annual average fire emissions and temporally and spatially allocating these emissions using generic allocation schemes would result in significant inaccuracies. In this modeling study, Ramboll Environ used day-specific wild and prescribed fire (together called wildland fires [WLFs]) emission estimates developed by the USEPA for calendar year 2012.[5] The emission estimates are based on the SMARTFIRE2 (SF2) framework and the BlueSky models.[6] The USEPA fire inventory was processed through SMOKE in separate processing streams for CMAQ and CAMx. The CMAQ model-ready emissions were developed in "in-line" point format. The term "in-line" means that the plume rise calculations are done inside the CMAQ model instead of being computed by SMOKE. To prepare CAMx model-ready emissions using a plume rise algorithm that is consistent with the algorithms in CMAQ, plume rise calculation was done in SMOKE and 3-D emissions files were prepared that were converted into a CAMx "PTSOURCE" type file where each grid cell centroid represents one virtual stack. The cmaq2uam program was used to convert 3-D fire emissions from SMOKE into CAMx format. **Table D-3** shows total annual criteria air pollutant emissions by fire type for all U.S. wildland fires within each of BOEM's PGM modeling domains.

Table D-3. 2012 Fire Criteria Air Pollutant Emissions Summary by Fire Type for BOEM's 36-, 12-, and 4-km Domains.

Fire Type (SCC)	Domain	CO (TPY)	NO_x (TPY)	PM_{10} (TPY)	$PM_{2.5}$ (TPY)	SO_2 (TPY)	VOC (TPY)
Wildfires (2810001000)	36 km	59,794	613	5,901	5,001	387	14,050
	12 km	6,568	74	654	554	44	1,545
	4 km	1,087	6	103	87	6	254
Prescribed fires (2810015000)	36 km	27,331	391	2,796	2,370	211	6,453
	12 km	20,126	308	2,077	1,760	161	4,757
	4 km	7,020	58	680	577	41	1,646
Total	36 km	87,125	1,003	8,698	7,371	598	20,503
	12 km	26,694	382	2,731	2,314	206	6,302
	4 km	8,107	64	783	664	47	1,900

As noted above, the USEPA wildland fires inventory is restricted to fire sources within the lower 48 states and thus does not cover the portions of Canada and Mexico lying within the 36-, 12-, and 4-km PGM domains. To fill this gap, we used 2012 day-specific Fire INventory from NCAR (FINN) for Canada and Mexico. The FINN provides daily, 1-km resolution, global estimates of the trace gas and particle emissions from open burning of biomass, which includes wildfire, agricultural fires, and prescribed burning exclusive of biofuel combustion and trash burning. Each fire record was treated as a point source and emissions were distributed vertically into multiple model layers to better represent each fire plume. The day-specific FINN fire emissions in Canada and Mexico were processed to develop elevated "point sources" of fire emissions using plume rise estimates as a function of fire size based on the Western Regional Air Partnership (WRAP) 2002 fire plume rise approach (Mavko and Morris, 2013). The chemical speciation profile for the MODIS fire emissions were derived from a study on biomass burning (Karl et al., 2007).

[5] ftp://ftp.epa.gov/EmisInventory/fires/
[6] http://www.airfire.org/smartfire/

D.3.9.4 Sea Salt and Halogen Emissions

Ramboll Environ used an emissions processor that integrates published sea spray flux algorithms to estimate sea salt PM emissions for input to CAMx. The gridded data for input to the sea salt emissions model is a land-water mask file that identifies each modeling domain grid cell as open ocean, surf zone, or land. Additional details on the development and evaluation of the sea salt emissions processor that was used for the "Air Quality Modeling in the Gulf of Mexico Region" study are available in the WestJumpAQMS Sea Salt and Lightning memo (Morris et al., 2012). The CAMx sea salt emissions processor was used with the 2012 WRF data to generate sea salt emissions for the 36-, 12-, and 4-km modeling domains. The sea salt emissions processor has recently been updated to also generate emissions for halogen compounds from the ocean (Yarwood et al., 2014). Gridded chlorophyll data is obtained from satellite data is used as input and the processor generated gridded hourly emissions of chlorine, bromine, and iodine. Halogen chemistry over the ocean depletes ozone concentrations near the surface so is especially important in the Gulf of Mexico OCS region.

The CMAQ model includes inline calculation of sea-salt emissions from the open ocean and coastal surf zone so no pre-processing of sea salt emissions is needed. The CMAQ does not treat halogen chemistry except for chlorine.

D.3.9.5 Lightning NO_x Emissions

The NO_x is formed in lightning channels as the heat released by the electrical discharge causes the conversion of nitrogen (N_2) and oxygen (O_2) to NO. Modeling of lightning and its emissions is an area of active research. For example, the mechanism for the buildup of electric potential within clouds is not well understood, and modeling the production, transport, and fate of emissions from lighting is complicated by the fact that the cumulus towers where lightning occurs may be sub-grid scale depending on the resolution of the model. Given the importance of lightning NO_x in the tropospheric NO_x budget and in understanding its effect on upper tropospheric ozone and OH-, lightning NO_x is typically incorporated in global modeling (e.g., Tost et al., 2007; Sauvage et al., 2007; Emmons et al., 2010) and has also been integrated into many regional modeling studies (e.g., Allen et al., 2012; Koo et al., 2010).

For the CMAQ modeling, Ramboll Environ used in-line lightning NO_x emissions derived from the convective precipitation rate provided in the MCIP files. Since the CMAQ model includes inline calculation of lightening NO_x emissions, no pre-processing of lightening NO_x is needed. The CAMx model requires pre-calculated lightening emissions for input. To better facilitate comparisons with CMAQ, lightening NO_x emissions from the CMAQ modeling were output and converted into a format suitable for use in CAMx.

D.3.9.6 Windblown Dust

Windblown dust emissions are calculated in-line in the CMAQ model based on wind speed and soil moisture parameters passed to CMAQ from the WRF model. Spatially and temporally resolved CMAQ windblown dust emissions were output for use in CAMx.

D.3.9.7 QA/QC of Processed Emissions

Emissions were processed by major source category in several different processing "streams" to simplify the emissions modeling process and facilitate the QA/QC of results. SMOKE includes QA and reporting features to keep track of the adjustments at each step of emissions processing and to ensure that data integrity is not compromised. Ramboll Environ carefully reviewed the SMOKE log files for significant error messages and ensure that appropriate source profiles are being used. In addition, SMOKE output summary reports were reviewed and compared with input emission totals.

D.3.9.8 Development of Model-Ready Emissions

Since the "Air Quality Modeling in the Gulf of Mexico Region" study involved application of both the CAMx and CMAQ photochemical grid models, the emissions processing procedure included development of emissions ready for input to CMAQ, as well as for input to CAMx. Each SMOKE processing stream generates a set of pre-merged model-ready emissions in CMAQ input format (netCDF). As specified in the chemical speciation section, species mapping was applied to convert SMOKE generated model species to the appropriate input for CMAQ. SMOKE modeling generated VOC model species for CB6 chemical mechanism, which were converted into CB05 model species for CMAQ. All pre-merged gridded emissions inputs were merged together to generate the final CMAQ-ready, two-dimensional gridded low-level (layer 1) and point source emissions inputs. Since CMAQ provides the option to specify point source emissions separately from the gridded emissions from other sources, only distributed sources (mobile sources, area sources, natural emissions) were merged in developing the CMAQ-ready emissions files.

The CAMx requires two types of emissions files, as described below, for every episode day; both of the emission files are UAM-based Fortran binary files.

(1) Surface-level 2D emissions: This file contains two-dimensional gridded fields of low-level (i.e., surface) emissions rates for all emitted species to be modeled.

(2) Elevated point source emissions: The elevated point source emissions file contains stack parameters and emissions rates for all elevated point sources and emitted species to be modeled.

The merged two-dimensional gridded anthropogenic emissions, which were originally output in CMAQ format, were converted into CAMx format using the CMAQ2CAMX program[7]. Ramboll Environ then merged natural source categories – sea salt, biogenic, fires, lightning and windblown dust with the surface-level emissions using the MRGUAM processor to develop CAMx model-ready emissions. Ramboll Environ first converted model species from CMAQ to CAMx compatible form and then converted CMAQ 2-D and in-line point emissions files to CAMx area-/point-source emissions files using the CMAQ2CAMx interface program. The point source emissions files in UAM-based binary format were merged together to develop the final CAMx-ready point-source emissions. The elevated point source file is independent of the modeling grid because it contains horizontal (X, Y) coordinates for each point source, and so one file includes all point sources in the 12- and 4-km BOEM modeling grids. In addition, CAMx requires separate emissions inputs for source groups being tracked in the source apportionment modeling performed for the future year scenario.

D.3.9.9 Summary of Processed Emissions

This section presents 2012 base case and future year scenario emissions summaries for the BOEM 12- and 4-km domains. The summary is organized by state and by source category.

Table D-4 summarizes NO_x, VOC, SO_2, and $PM_{2.5}$ air pollutant emissions in short tons per year for the states that border the Gulf of Mexico (i.e., Texas, Louisiana, Alabama, Mississippi, and Florida). The summary data are based on 12-km SMOKE processing of 2012 base case and future year inventories as described above. With the exception of fugitive dust and biogenic sources, emissions are summarized from the SMOKE reports generated by the SMKMRG program. Fugitive dust emissions were adjusted after SMOKE processing to account for fugitive dust correction factors derived from the Biogenic Emission Landuse Database version 3 (BELD3). Application of these dust transport correction factors accounts for suppression of grid-scale dust emissions via deposition on proximate vegetation surfaces such as roadside trees and bushes. As noted above, biogenic emissions were generated using the MEGAN model outside of SMOKE and so are generated directly on the 36/12/4-km grids rather than by state/county. Across the 5-state region, NO_x emissions were projected to go down 4% but VOC emissions are expected to increase by 3%, with $PM_{2.5}$ emissions increasing by 10%. The largest change in emissions between the current and future year is for SO_2 that is projected to go down by 39%.

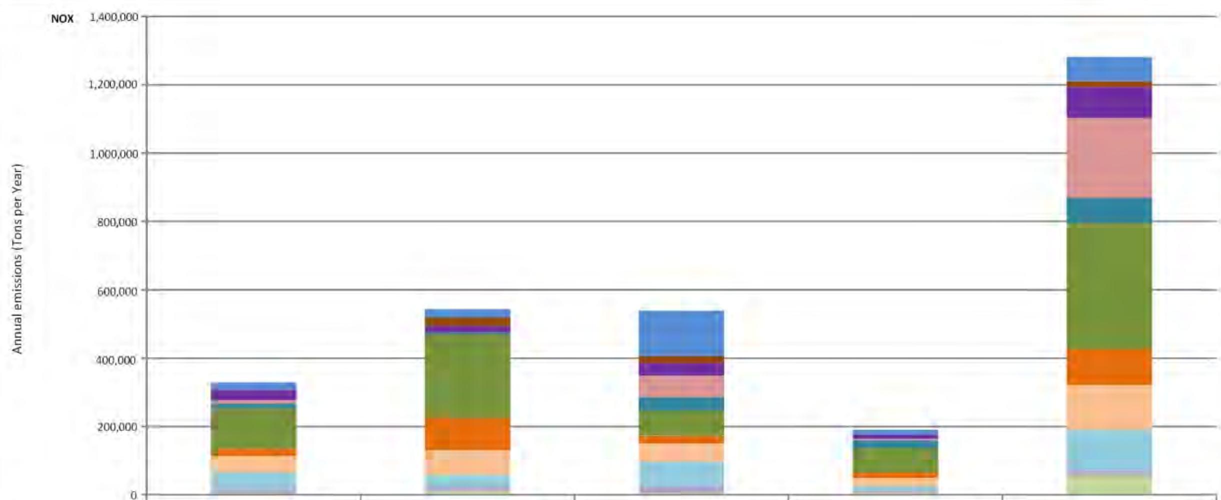
[7] http://www.camx.com/download/support-software.aspx

Table D-4. 2012 Base Case and Future Year Emissions Summary by State for BOEM'S 12-km Domain (only Gulf Coast States: Alabama, Florida, Louisiana, Mississippi, and Texas).

States	2012 Base Year				Future Year Scenario			
	NO_x (TPY)	$PM_{2.5}$ (TPY)	SO_2 (TPY)	VOC (TPY)	NO_X (TPY)	$PM_{2.5}$ (TPY)	SO_2 (TPY)	VOC (TPY)
Alabama	210,701	183,321	201,810	1,763,216	178,015	208,531	104,688	1,744,057
Florida	299,738	182,492	144,640	1,754,031	263,778	201,117	127,170	1,690,680
Louisiana	464,962	299,510	203,154	2,030,042	406,421	301,052	127,260	2,007,720
Mississippi	119,430	216,950	57,466	1,622,369	98,334	277,025	32,403	1,610,893
Texas	911,470	683,209	451,018	5,155,944	970,493	739,791	257,073	5,588,049

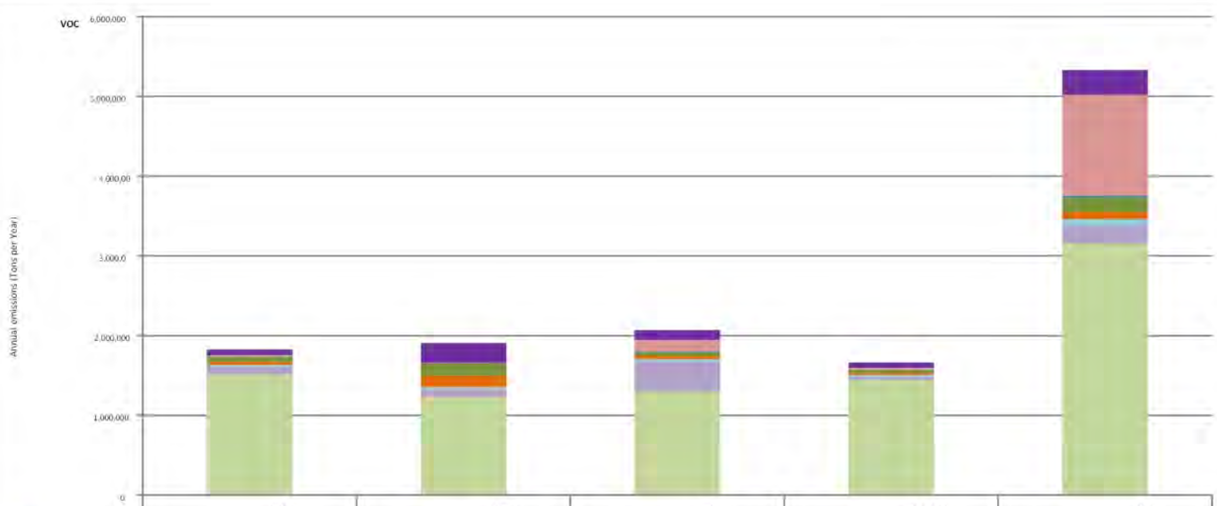
Figures D-6 through D-9 present stacked bar chart summaries for the 2012 base case emissions that show BOEM 12-km domain anthropogenic, fire, and biogenic emissions by source category and pollutants for Alabama, Florida, Louisiana, Mississippi, and Texas. Note that these emission summaries are only for the states (and State waters) that border the Gulf of Mexico. Similarly, **Figures D-10 through D-13** present stacked bar chart summaries for the future year scenario in short tons per year for the Gulf Coast States. Emission categories used in these summaries are defined below:

Source Category	Description
ALM	Aircraft, locomotive and smaller commercial marine vessels
Fugitive Dust	Anthropogenic fugitive dust from paved and unpaved roads, agricultural, construction, and mining sources
C3 CMV	Commercial marine vessels with Category 3 (C3) main engines
Nonpoint	Stationary non-point sources
Area Oil and Gas	Non-point oil and gas sector onshore sources
Point Oil and Gas	Point oil and gas sector onshore sources
Onroad	Motorized vehicles that are normally operated on public roadways (passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses
Nonroad	Off-road equipment included in USEPA's nonroad model
EGU Point	Electric Generating Unit point sources
NonEGU Point	NEI point sources that are not in the EGU or Point oil and gas sectors
Fires	Agricultural fires, wildfires and prescribed burning
Biogenic	Vegetation and soils throughout domain
BOEM OCS Support Vessel with Action (State waters only)	All BOEM OCS oil and gas support vessels and helicopter under the 2017-2022 GOM Multisale EIS's "Proposed Action" scenario, from which this Supplemental EIS tiers



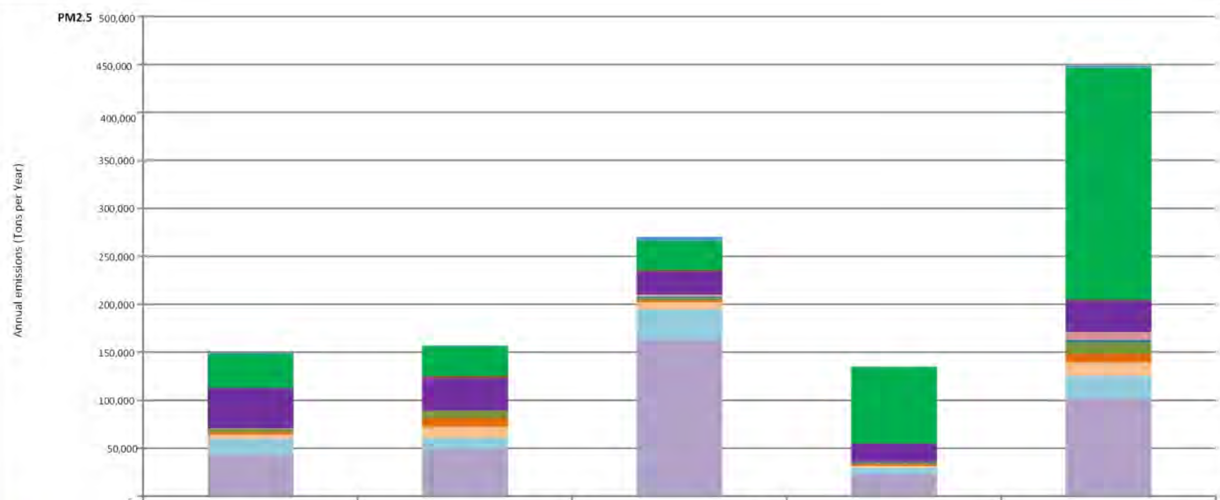
	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	22,187	24,680	132,587	14,043	70,977
Fugitive Dust	-	-	-	-	-
C3 CMV	971	24,823	20,265	1,067	15,637
Nonpoint	29,583	19,810	37,279	12,713	91,593
Area O&G	10,207	75	63,115	3,126	234,192
Point O&G	13,338	5,303	39,071	23,337	73,067
Onroad	118,611	243,612	73,345	70,922	369,305
Nonroad	21,563	94,187	22,506	16,326	104,704
EGU Point	47,247	72,708	52,585	23,088	131,820
NonEGU Point	49,997	35,207	73,726	13,257	117,052
Fires	10,105	12,139	17,307	6,294	14,474
Biogenic	5,503	10,804	6,521	6,178	57,955

Figure D-6. BOEM's 12-km 2012 Base Case NO_x Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



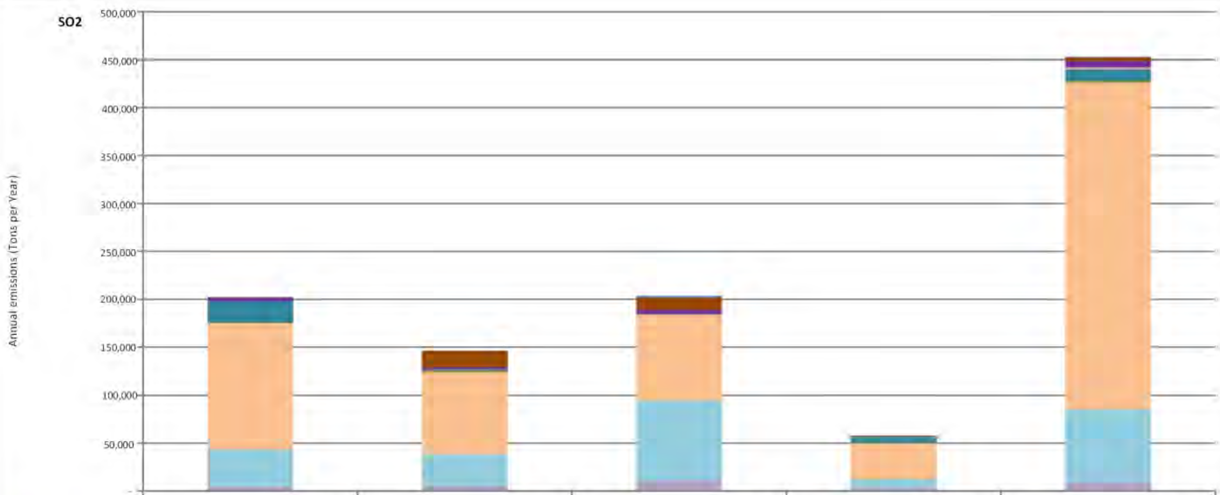
	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	943	774	3,319	514	3,605
Fugitive Dust	-	-	-	-	-
C3 CMV	36	833	737	37	628
Nonpoint	66,912	248,371	119,530	65,800	309,395
Area O&G	22,960	2,726	147,466	21,091	1,268,897
Point O&G	1,866	558	11,263	3,366	22,395
Onroad	60,863	152,419	39,325	37,769	176,615
Nonroad	39,070	146,351	43,583	27,100	89,663
EGU Point	1,293	3,649	1,377	572	3,410
NonEGU Point	25,570	21,884	38,954	23,034	80,784
Fires	88,593	97,281	360,560	40,655	220,751
Biogenic	1,515,975	1,231,604	1,303,252	1,440,201	3,156,416

Figure D-7. BOEM 12-km 2012 Base Case VOC Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



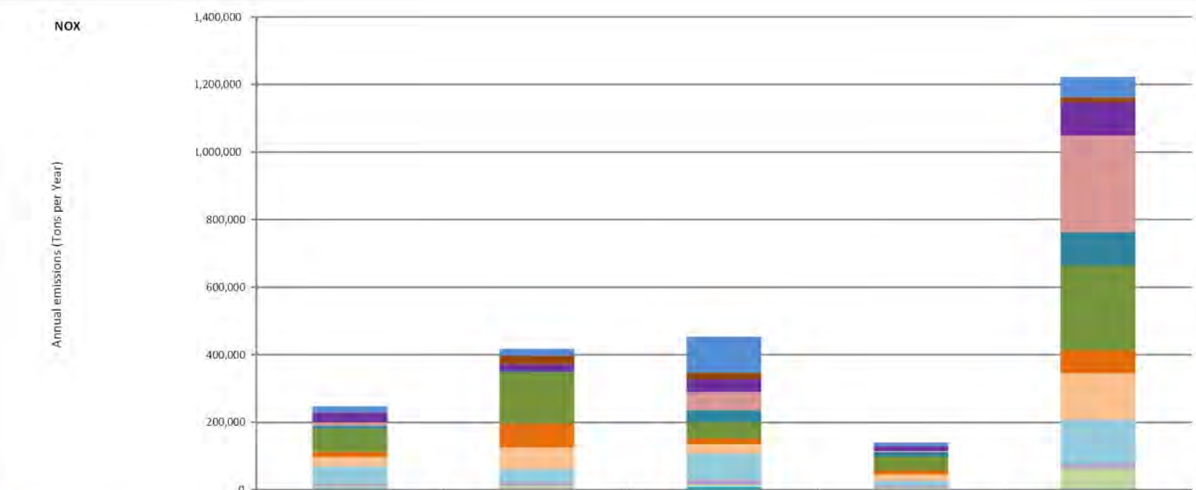
	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	700	766	4,222	430	2,054
Fugitive Dust	35,334	31,200	30,530	79,263	241,756
C3 CMV	74	2,027	1,534	82	497
Nonpoint	42,167	33,881	23,829	19,757	33,391
Area O&G	260	2	1,982	88	7,855
Point O&G	338	108	1,715	364	2,931
Onroad	3,637	7,729	2,345	2,014	11,615
Nonroad	2,223	9,141	2,181	1,626	9,119
EGU Point	4,133	11,413	7,244	1,692	13,886
NonEGU Point	16,674	11,908	32,024	7,296	23,346
Fires	43,385	48,951	162,728	22,455	102,046
Biogenic	-	-	-	-	-

Figure D-8. BOEM 12-km 2012 Base Case $PM_{2.5}$ Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



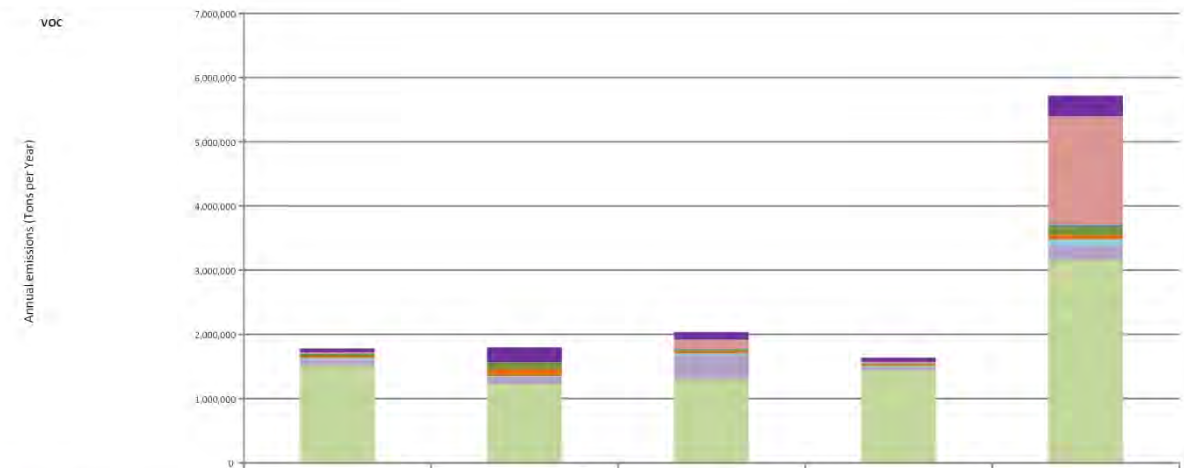
	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	242	280	1,603	153	713
Fugitive Dust	-	-	-	-	-
C3 CMV	635	17,141	13,061	740	4,404
Nonpoint	3,643	2,388	4,302	894	6,240
Area O&G	46	2	173	31	2,304
Point O&G	21,967	943	488	5,825	11,304
Onroad	592	1,842	441	352	2,259
Nonroad	47	194	47	32	188
EGU Point	131,903	85,483	89,045	37,279	340,995
NonEGU Point	38,663	32,528	83,318	9,544	76,365
Fires	4,664	5,680	11,117	2,968	8,505
Biogenic	-	-	-	-	-

Figure D-9. BOEM 12-km 2012 Base Case SO_2 Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



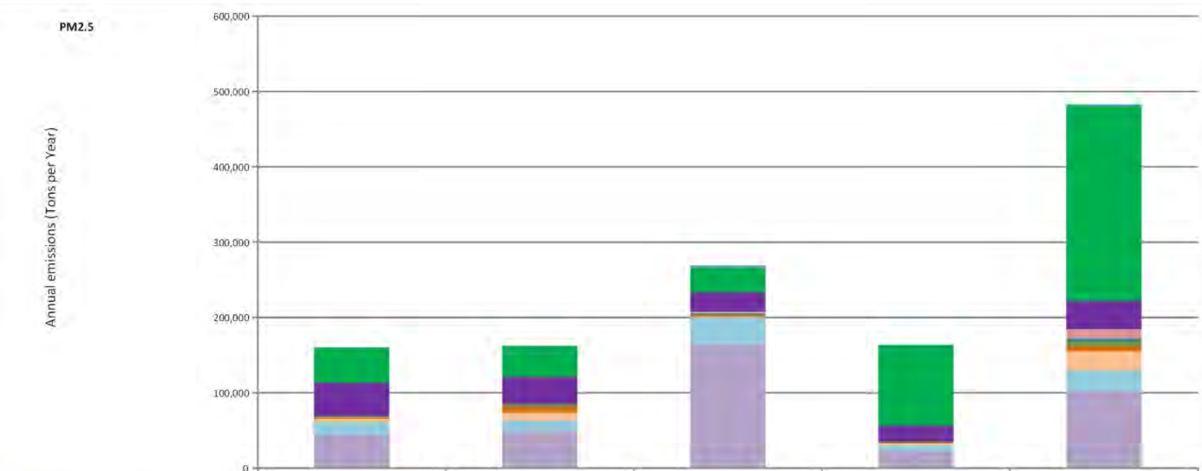
	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	18,589	20,338	106,694	11,650	60,228
Fugitive Dust	-	-	-	-	-
C3 CMV	919	25,472	19,184	1,010	14,803
Nonpoint	28,479	20,023	38,619	13,162	98,650
Area O&G	9,791	54	52,941	2,460	286,144
Point O&G	7,941	2,619	36,784	13,217	98,642
Onroad	69,174	153,294	47,154	42,091	251,443
Nonroad	15,534	69,617	16,923	11,908	68,038
EGU Point	27,727	64,970	27,347	17,909	135,803
NonEGU Point	49,478	37,742	75,646	14,545	131,876
Fires	10,105	12,139	17,307	6,294	14,474
Biogenic	5,503	10,804	6,521	6,178	57,955
BOEM OCS Sup. Vessel w/Action	3,949	0	8,454	0	3,881

Figure D-10. BOEM 12-km Future Year NO_x Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



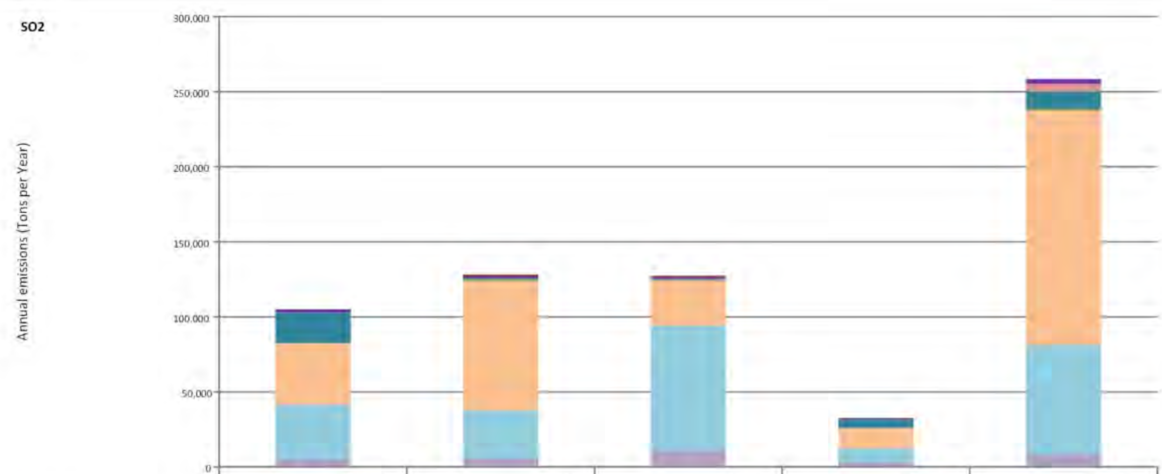
	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	661	587	2,630	369	2,475
Fugitive Dust	-	-	-	-	-
C3 CMV	43	1,071	874	44	746
Nonpoint	62,324	227,349	113,678	61,502	319,263
Area O&G	20,611	2,264	143,332	21,786	1,691,300
Point O&G	1,394	435	11,250	3,475	27,984
Onroad	35,193	107,225	26,348	22,906	128,671
Nonroad	27,959	103,374	30,468	19,306	63,715
EGU Point	1,043	2,313	850	574	5,106
NonEGU Point	25,286	24,403	39,403	22,982	100,121
Fires	88,593	97,281	360,560	40,655	220,751
Biogenic	1,515,975	1,231,604	1,303,252	1,440,201	3,156,416
BOEM OCS Sup. Vessel w/Action	169	0	1,421	0	171

Figure D-11. BOEM 12-km Future Year VOC Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	508	555	3,011	311	1,501
Fugitive Dust	46,649	40,813	32,621	107,592	259,416
C3 CMV	13	386	271	14	88
Nonpoint	43,916	35,751	25,230	20,839	37,578
Area O&G	215	2	1,868	76	12,271
Point O&G	304	66	1,767	240	3,744
Onroad	2,001	4,592	1,395	1,170	7,128
Nonroad	1,618	6,841	1,544	1,140	6,155
EGU Point	4,613	10,062	1,395	2,097	25,048
NonEGU Point	16,623	14,396	36,271	7,899	27,414
Fires	43,385	48,951	162,728	22,455	102,046
Biogenic	-	-	-	-	-
BOEM OCS Sup. Vessel w/Action	360	0	777	0	354

Figure D-12. BOEM 12-km Future Year $PM_{2.5}$ Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).



	Alabama	Florida	Louisiana	Mississippi	Texas
ALM	18	34	240	15	34
Fugitive Dust	-	-	-	-	-
C3 CMV	29	846	595	34	201
Nonpoint	2,004	1,510	1,492	873	2,924
Area O&G	23	2	214	37	5,125
Point O&G	20,298	853	576	5,513	11,291
Onroad	301	933	235	182	1,223
Nonroad	25	94	24	17	92
EGU Point	40,732	86,015	29,990	13,422	155,982
NonEGU Point	36,887	32,135	82,976	9,525	72,910
Fires	4,664	5,680	11,117	2,968	8,505
Biogenic	-	-	-	-	-
BOEM OCS Sup. Vessel w/Action	8	0	36	0	10

Figure D-13. BOEM 12-km Future Year SO_2 Emissions Summary in Tons per Year by Source Category and State (Alabama, Florida, Louisiana, Mississippi, and Texas).

Table D-5 summarizes NO_x, VOC, SO_2, and $PM_{2.5}$ emissions within the 4-km domain in short tons for the 2012 base year and the 2017 future year scenario, and **Table D-6** summarizes the changes in emissions between the base and future year scenarios by major source category.

Table D-5. 2012 Base Case and Future Year Emissions Summary by Source Category for BOEM's 4-km Domain.

Sectors	2012 Base Year (TPY)				Future Year Scenario (TPY)			
	NO_x	$PM_{2.5}$	SO_2	VOC	NO_x	$PM_{2.5}$	SO_2	VOC
Fugitive Dust	0	70,526	0	0	0	78,179	0	0
Agricultural	0	0	0	0	0	0	0	0
Fires	50,781	493,750	34,939	1,112,486	50,781	493,750	34,939	1,112,486
ALM	171,436	5,416	2,039	4,896	278,052	7,752	560	7,520
C3 CMV	68,857	3,650	36,339	2,466	108,654	2,666	25,892	4,769
Biogenic	19,015	0	0	3,140,424	19,015	0	0	3,140,424
Nonpoint	81,918	54,561	7,390	296,267	86,014	58,937	3,165	294,728
Nonroad	76,345	6,994	153	112,683	105,272	9,653	159	157,559
Area Oil and Gas	69,331	1,991	530	506,972	148,131	5,535	2,134	1,283,385
Onroad	270,364	8,467	1,731	145,061	183,305	7,124	940	106,904

Sectors	2012 Base Year (TPY)				Future Year Scenario (TPY)			
	NO_x	$PM_{2.5}$	SO_2	VOC	NO_x	$PM_{2.5}$	SO_2	VOC
Non-U.S. Fugitive Dust	0	0	0	0	0	0	0	0
Non-U.S. Area	38,832	4,361	719	15,208	35,625	4,429	502	16,787
BOEM Gulfwide	186,636	6,337	26,968	7,310	129,814	4,117	31,839	36,109
Non-U.S. Onroad	13,894	438	73	6,217	9,097	447	27	4,041
Non-U.S. Point (with GOM offshore platforms)	106,344	2,663	7,795	57,361	32,045	2,181	4,646	11,337
Point Oil and Gas	101,530	4,587	50,861	39,192	95,052	4,961	47,086	42,884
EGU Point	137,932	17,943	306,031	3,545	117,518	21,802	136,784	4,371
Non-EGU Point	319,924	105,264	271,961	208,773	344,080	120,826	269,191	240,212
BOEM OCS Platform No Action	0	0	0	0	84,351	837	3,205	54,449
BOEM OCS Platform w/Action	0	0	0	0	22,973	223	1,037	7,015
BOEM OCS Support Vessel No Action	0	0	0	0	234,796	8,296	23,089	8,093
BOEM OCS Support Vessel w/Action	0	0	0	0	106,163	9,749	396	10,238

Table D-6. Changes in Emissions between the 2012 Base Case and Future Year Emissions (short tons per year) by Source Category for BOEM's 4-km Domain.

Sector	Future Year - Base Year (TPY)				Future Year - Base Year (%)			
	NO_x	$PM_{2.5}$	SO_2	VOC	NO_x	$PM_{2.5}$	SO_2	VOC
Fugitive Dust	0	7,653	0	0	--	11%	--	--
Agricultural	0	0	0	0	--	--	--	--
Fires	0	0	0	0	0%	0%	0%	0%
ALM	106,616	2,336	(1,479)	2,624	62%	43%	-73%	54%
C3 CMV	39,797	(984)	(10,447)	2,303	58%	-27%	-29%	93%
Biogenic	0	0	0	0	0%	--	--	0%
Nonpoint	4,096	4,376	(4,225)	(1,539)	5%	8%	-57%	-1%
Nonroad	28,927	2,659	6	44,876	38%	38%	4%	40%
Area Oil and Gas	78,800	3,544	1,604	776,413	114%	178%	303%	153%
Onroad	(87,059)	(1,343)	(791)	(38,157)	-32%	-16%	-46%	-26%

Sector	Future Year - Base Year (TPY)				Future Year - Base Year (%)			
	NO_x	$PM_{2.5}$	SO_2	VOC	NO_x	$PM_{2.5}$	SO_2	VOC
Non-U.S. Fugitive Dust	0	0	0	0	--	--	--	--
Non-U.S. Area	(3,207)	68	(217)	1,579	-8%	2%	-30%	10%
BOEM Gulfwide	(56,822)	(2,220)	4,871	28,799	-30%	-35%	18%	394%
Non-U.S. Onroad	(4,797)	9	(46)	(2,176)	-35%	2%	-63%	-35%
Non-U.S. Point (with GOM offshore platforms)	(74,299)	(482)	(3,149)	(46,024)	-70%	-18%	-40%	-80%
Point Oil and Gas	(6,478)	374	(3,775)	3,692	-6%	8%	-7%	9%
EGU Point	(20,414)	3,859	(169,247)	826	-15%	22%	-55%	23%
Non-EGU Point	24,156	15,562	(2,770)	31,439	8%	15%	-1%	15%

Figure D-14 presents spatial plots of future year scenario NO_x, VOC, $PM_{2.5}$, and SO_2 emissions in short tons per year within the 4-km domain for the Bureau of Ocean Energy Management's OCS oil and gas production platforms under the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers. Note that the deepwater platforms have higher annual emissions than the shallow-water platforms. **Figure D-15** presents 4-km spatial plots for the same pollutants and future year scenario in short tons per year for BOEM's OCS oil and gas support vessels and helicopters under the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers. **Figure D-16** shows emissions for the Bureau of Ocean Energy Management's OCS oil and gas platforms, support vessels, and helicopters under the No Action alternative, which are the existing sources. **Figure D-17** shows emissions for all other marine vessel activity in the Gulf of Mexico. **Figure D-18** shows emissions for all other anthropogenic U.S. sources.

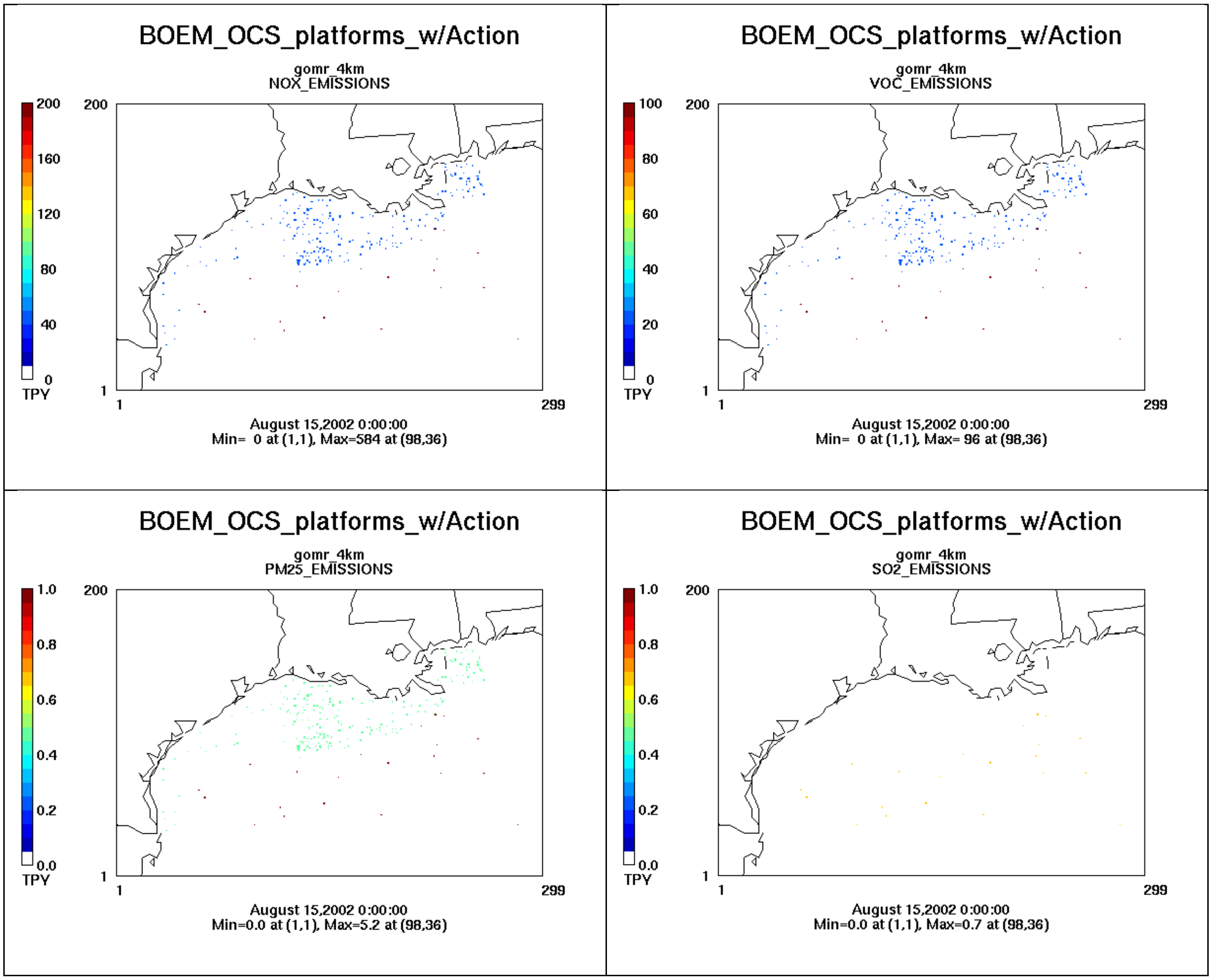


Figure D-14. Spatial Distribution of (clockwise starting from top left) NO_x, VOC, SO_2, and $PM_{2.5}$ Emissions (tons per year) from New OCS Oil and Gas Production Platforms under the Proposed Action.

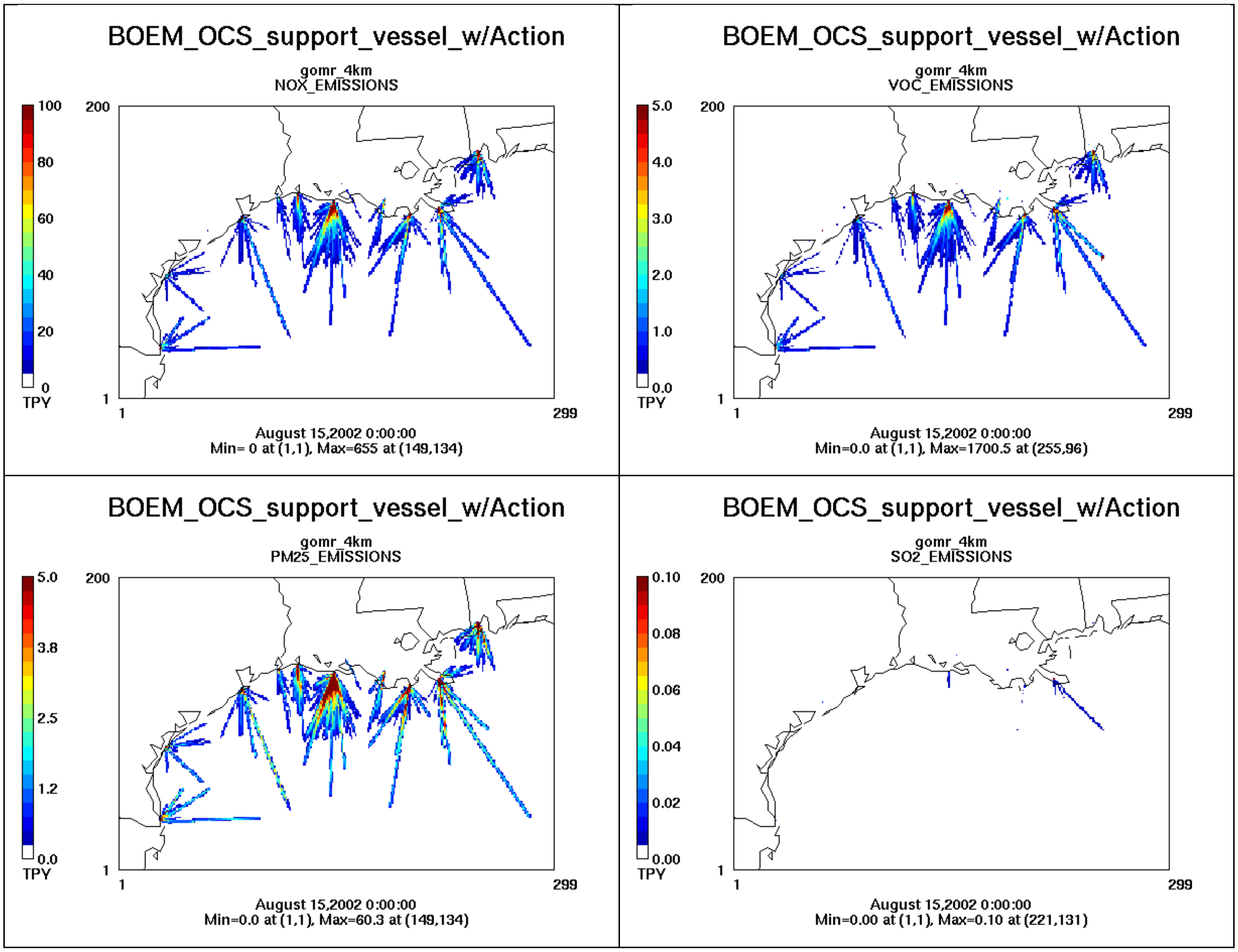


Figure D-15. Spatial Distribution of Emissions (tons per year) of (clockwise starting from top left) NO_x, VOC, SO_2, and $PM_{2.5}$ from BOEM's OCS Additional Oil and Gas Support Vessels and Helicopters under the Proposed Action Scenario.

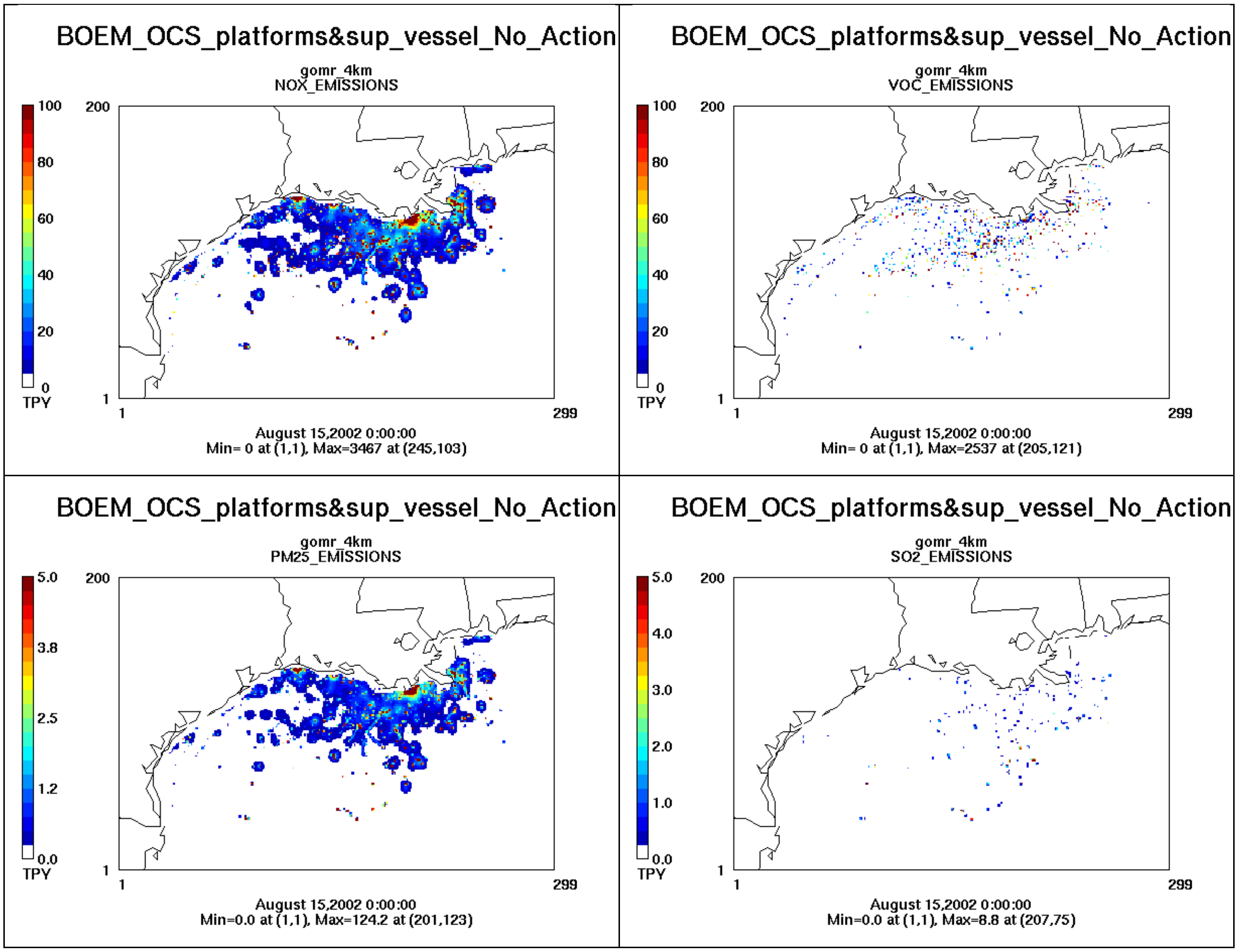


Figure D-16. Spatial Distribution of (clockwise starting from top left) NO_x, VOC, SO_2, and $PM_{2.5}$ Emissions (tons per year) from BOEM's OCS Oil and Gas Platforms, Support Vessels, and Helicopters under the No Action Alternative in BOEM's 4-km Domain.

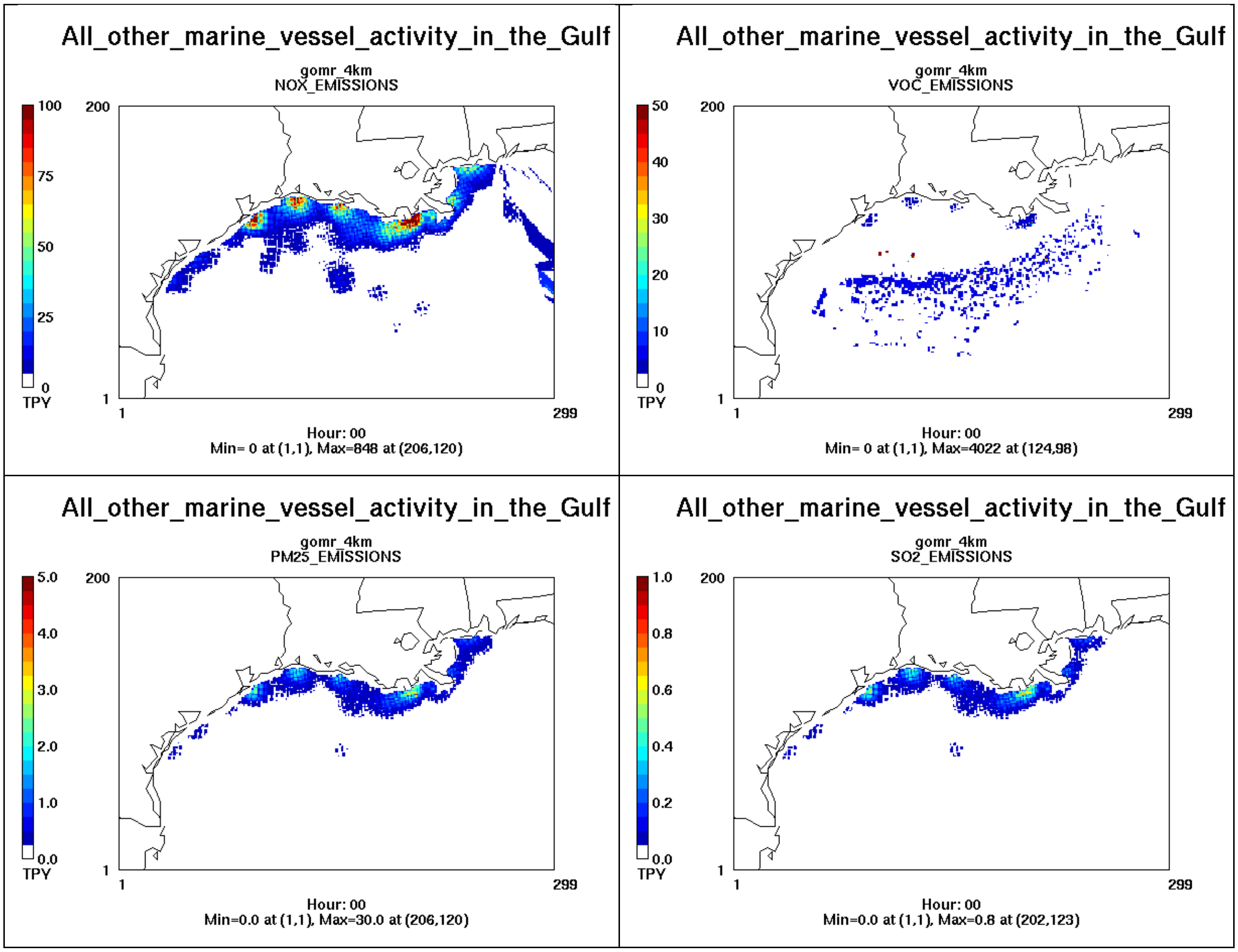


Figure D-17. Spatial Distribution of (clockwise starting from top left) NO_x, VOC, SO_2, and $PM_{2.5}$ Emissions (tons per year) from All Other Marine Vessel Activity in the Gulf of Mexico under the Future Year Scenario in BOEM's 4-km Domain.

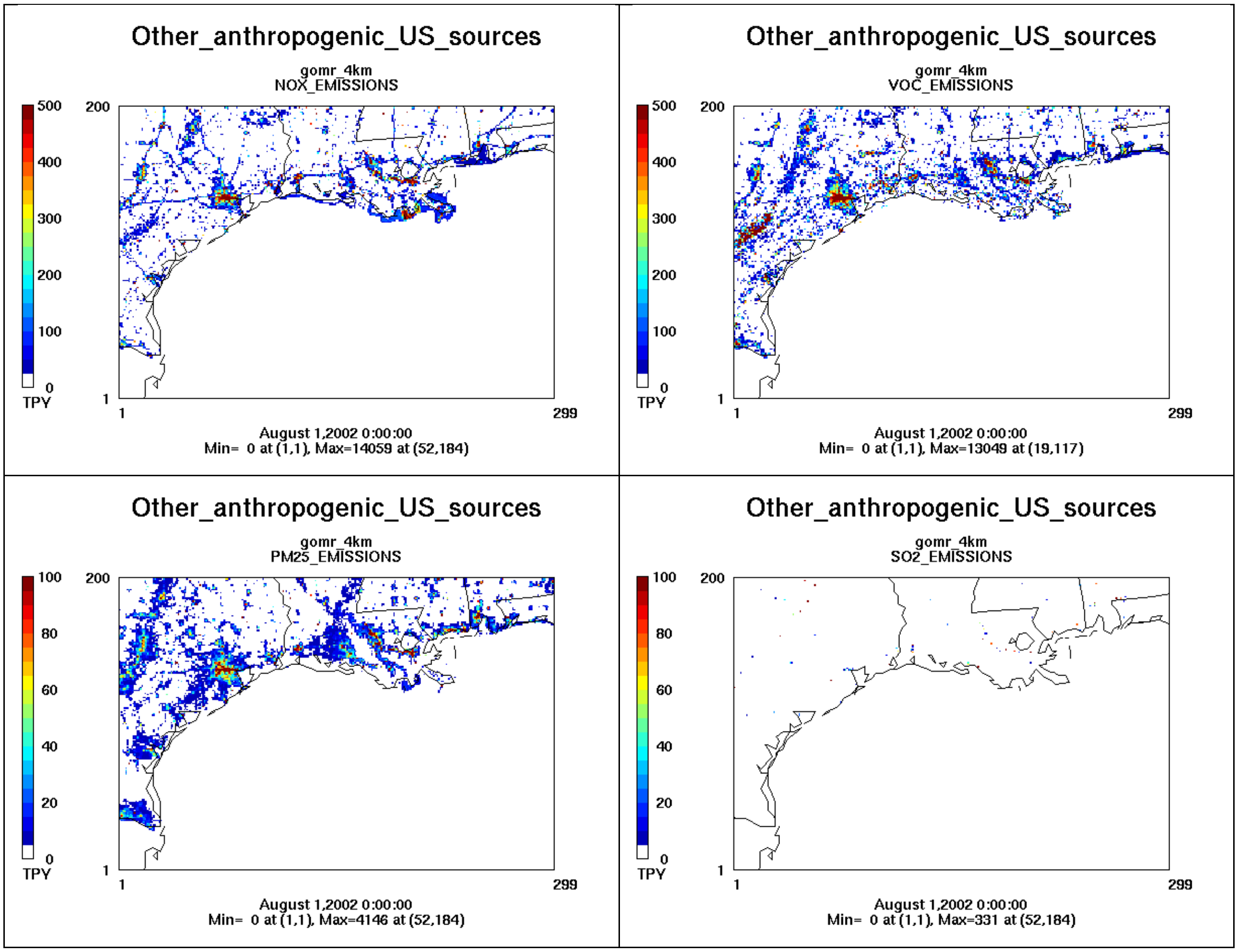


Figure D-18. Spatial Distribution of (clockwise starting from top left) NO_x, VOC, SO_2, and $PM_{2.5}$ Emissions (tons per year) from Other Anthropogenic U.S. Sources for the Future Year Scenario within BOEM's 4-km Domain.

D.3.10 Source Apportionment Design

Source apportionment, as applied in CAMx, provides a means of assessing the contributions of specified sources or categories of sources to predicted ozone and PM concentrations under the air quality conditions being simulated. Source contributions can be calculated for ozone and for PM using ozone or PM source apportionment routines included in CAMx. Source apportionment analyses were applied to the future year scenario in order to analyze the pre- and postlease OCS oil and gas impacts to short-term and annual NAAQS, AQRVs, and PSD increments. BOEM selected a set of nine source categories for source apportionment as listed in **Table D-7**.

Table D-7. Source Categories for Source Apportionment Calculations.

Category ID	Sources
SC1	Fires (U.S., Canada, and Mexico)
SC2	Biogenic and other natural sources (e.g., lighting NO_x and sea salt)
SC3	Additional BOEM OCS oil and gas production platforms associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers (w/Action)
SC4	Additional BOEM oil and gas production support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers (w/Action)
SC5	BOEM's OCS oil and gas production platforms, support vessels, and helicopters under the base case (No Action) alternative
SC6	All other marine vessel activity in the Gulf of Mexico, not associated with OCS oil and gas activities
SC7	Other anthropogenic U.S. sources[8]
SC8	Mexican and Canadian anthropogenic sources[9]
SC9	Initial Conditions (IC)
SC10	Boundary Conditions (BC)

These source categories aggregate similar sources based on jurisdiction (i.e., sources under BOEM's jurisdiction versus other Federal agencies) and sources beyond direct domestic regulatory control (e.g., natural emission sources and foreign sources). Additional OCS oil and gas production platforms and additional support vessel and helicopter trips associated with the 2017-2022 GOM Multisale EIS are included as a separate source category, thus providing estimates of the impacts of these new sources, which are projected to occur under the future year scenario associated with the 2017-2022 GOM Multisale EIS. Platforms and support vessels and helicopters projected for the future year scenario under the base case (No Action) scenario are also included as a separate source apportionment category. This Supplemental EIS tiers from the 2017-2022 GOM Multisale EIS and uses the scenario and alternatives analyzed in the 2017-2022 GOM Multisale EIS.

Isolating fires and biogenic emissions shows the component of the air quality concentrations that are typically beyond the control of Federal agencies and states. Similarly, the Mexican and Canadian anthropogenic emissions are beyond the control of U.S. regulators.

D.4 BASE CASE PHOTOCHEMICAL GRID MODELING

D.4.1 Overview

The CAMx Photochemical Grid Model (PGM) was applied on a set of nested domains with horizontal resolutions of 36, 12 and 4 km centered on the Gulf of Mexico OCS Region (**Figure D-5**). For the 2012 base case analysis, CAMx was run with the 2012 base case emissions described in

[8] Includes onshore oil and gas production sources and oil and gas production sources in State waters.
[9] Also includes oil and gas production sources.

Section D.3. Meteorological fields required by CAMx were obtained from the WRF meteorological model results for 2012, which were developed as described in **Section D.2**. Modeling procedures were based on the USEPA's current and revised draft modeling guidance procedures (USEPA, 2007 and 2014). Additional features of the modeling approach are listed below.

- Anthropogenic and non-anthropogenic model-ready emissions for the 2012 base case were developed as described in the emission inventory TSD.
- Photochemical grid modeling was based on CAMx version 6.20 with the Carbon Bond 6 revision 2h (CB6r2h) photochemical mechanism, including active excess methane emissions and halogen chemistry.
- Day-specific boundary conditions (BCs) for the lateral boundaries of the 36-km modeling domain were based on 2012 GEOS-Chem global chemistry model (GCM) output.
- A model performance evaluation was conducted for the initial 2012 base case simulation using all available aerometric data within the modeling domain. Based on these initial results, a number of potential issues with model inputs were identified and appropriate modifications tested to confirm that the extent to which the modifications resolved the identified issues and resulted in improved model performance. These initial results and test results are described in **Section D.5**. Revised inputs were then used in the final model simulations and revised model performance metrics based on the final model runs were prepared. Results of the final model performance evaluation are also presented in **Section D.5**.

D.4.2 Model Grid Configuration

The PGM domain configuration is comprised of a system of nested grids with 36-, 12-, and 4-km horizontal resolution as shown in **Figure D-5**. **Table D-8** provides the modeling grid definitions for the WRF and CAMx simulations. Since a large portion of the eastern GOM is under Congressional moratoria (GOMESA), the 4-km PGM domain excluded this area to limit the grid dimension to allow for a more manageable size for computation efficiency.

Table D-8. Domain Grid Definitions for the WRF and CAMx/CMAQ Modeling.

Modeling Grid	WRF		CAMx	
	Origin[1] Coordinates (x, y) (km)	Grid Dimension (column × row)	Origin[1] Coordinates (x, y) (km)	Grid Dimension (column × row)
36-km grid	(-2592, -2304)	(164 × 128)	(-2736, -2088)	(148 × 112)
12-km grid	(-1008, -2016)	(264 × 186)	(-948, -1956)	(254 × 176)
4-km grid	(-156, -1704)	(480 × 210)	(-136, -1684)	(299 × 200)

[1] Southwest corner of each domain grid.

For CAMx, BCs for the 12-km domain were extracted from the 36-km simulation results, and the 12-and 4-km grids were modeled using 2-way nesting (allowing interactions between the two grids in both directions). Specification of the CAMx vertical domain structure depends on the definition of the WRF vertical layers structure. The WRF simulation was run with 33 vertical layer interfaces (which is equivalent to 32 vertical layers) from the surface up to 50 mbar (approximately 20 km above mean sea level [AMSL]). The WRF model employs a terrain following coordinate system called eta (η) coordinate, which is defined by relative pressure differences between layers. As shown in **Table D-9**, the WRF levels are more finely stratified near the surface in an attempt to improve simulation of the atmospheric boundary layer structure and processes. A layer collapsing scheme is adopted for the CAMx simulations whereby multiple WRF layers are combined into single CAMx layers to improve the PGM computational efficiency. **Table D-9** also shows the layer collapsing from the 32 WRF layers to 28 PGM layers. The mixing heights over the study domain are typically below 2 km. Therefore, the WRF modeling layers up to the 16th layer (approximately 2 km) are directly mapped to the PGM layers (no layer-collapsing) to better simulate the stable thermal stratification of the boundary layer and avoid errors potentially introduced by layer collapsing. Above the 20th WRF layer, two WRF layers were combined into a single PGM layer up to the 50 hPa region top.

Table D-9. Vertical Layer Interface Definition for WRF Simulations (left-most columns) and the Layer-collapsing Scheme for the CAMx/CMAQ Layers (right columns).

WRF					CAMx/CMAQ		
Layer Interface	Eta (η)	Pressure (mbar)	Height (m)	Thickness (m)	Layer	Layer Top Height (m)	Thickness (m)
33	0.0	50	19,594.2	2,090.8	24	19,594.2	3,972.6
32	0.027	76	17,503.4	1,881.8			
31	0.06	107	15,621.6	1,754.7	23	15,621.6	3,484.9
30	0.1	145	13,866.9	1,730.1			
29	0.15	193	12,136.7	1,412.6	22	12,136.7	2,614.2
28	0.2	240	10,724.1	1,201.6			
27	0.25	288	9,522.5	1,050.2	21	9,522.5	1,986.1
26	0.3	335	8,472.3	935.8			
25	0.35	383	7,536.4	846	20	7,536.4	1,693.2
24	0.4	430	6,690.5	847.3			
23	0.455	482	5,843.2	910.3	19	5,843.2	1,679.1
22	0.52	544	4,932.9	768.8			
21	0.58	601	4,164.1	711.8	18	4,164.1	1,375.4
20	0.64	658	3,452.2	663.5			
19	0.7	715	2,788.7	418.9	17	2,788.7	821.1
18	0.74	753	2,369.8	402.1			
17	0.78	791	1,967.6	386.8	16	1,967.6	386.8
16	0.82	829	1,580.8	280.8	15	1,580.8	280.7
15	0.85	858	1,300.1	273.3	14	1,300.1	273.4
14	0.88	886	1,026.7	178.3	13	1,026.7	178.2
13	0.9	905	848.5	131.7	12	848.5	131.8
12	0.915	919	716.7	130.1	11	716.7	130.1
11	0.93	934	586.6	85.8	10	586.6	85.8
10	0.94	943	500.8	85.1	9	500.8	85.1

WRF					CAMx/CMAQ		
Layer Interface	Eta (η)	Pressure (mbar)	Height (m)	Thickness (m)	Layer	Layer Top Height (m)	Thickness (m)
9	0.95	953	415.7	84.5	8	415.7	84.5
8	0.96	962	331.2	83.8	7	331.2	83.8
7	0.97	972	247.4	83.1	6	247.4	83.1
6	0.98	981	164.3	57.8	5	164.3	57.8
5	0.987	988	106.5	41.1	4	106.5	41.1
4	0.992	992	65.4	24.6	3	65.4	24.6
3	0.995	995	40.8	20.4	2	40.8	20.4
2	0.9975	998	20.4	20.4	1	20.4	20.4
1	1.0	1,000	0	--	--	--	--

D.4.3 Meteorology

Given the objectives of the air quality analysis and the availability of full annual WRF simulations for 2009 through 2013, the CAMx model was exercised for a full calendar year. The decision to model for an entire calendar year rather than just a single season is consistent with the need to address ozone, $PM_{2.5}$, visibility and annual deposition. Given the extremely hot, dry, and smoky conditions during 2011, the 2012 calendar year was selected for the base year, base case modeling.

Meteorological inputs for CAMx were generated by processing the WRF outputs using appropriate meteorological input preprocessors. The WRFCAMx Version 4.3 was used to translate WRF output meteorological fields to daily CAMx meteorological inputs. For a single day, 25 hours of meteorology must be present (midnight through midnight, inclusive) as these fields represent hourly instantaneous conditions and CAMx internally time-interpolates these fields to each model time step. Precipitation fields are not time-interpolated but rather time-accumulated, so cloud/precipitation files contain one less hour than other meteorological files (e.g., 24 hours of clouds/precipitation vs. 25 hours for other meteorology fields).

Several methodologies are available in WRFCAMx to derive vertical diffusivity (Kv) fields from WRF output. For this modeling, a method consistent with the Yonsei University (YSU) bulk boundary layer scheme (Hong and Noh, 2006; this is the default option in WRF) was used to generate the Kv profile. The lower bound Kv value is set based on the land-use type for each grid cell. Another issue is deep cumulus convection, which is difficult to simulate in a grid model because of the small horizontal spatial scale of the cumulus tower. Inadequate characterization of this convective mixing can cause ozone and precursor species to be overestimated in the boundary layer. To address this issue, a patch was developed that increases transport of air from the planetary boundary layer into the free troposphere and up to the cloud top within cloudy grid cells (ENVIRON, 2012). This patch was shown to improve surface layer ozone in a recent modeling study in Texas (Kemball-Cook et al., 2015), and thus was also employed in this modeling study.

The WRFCAMx provides an option to process sub-grid cloud data from WRF fields. Selecting the "DIAG" sub-grid cloud method diagnoses sub-grid cloud fields from WRF gridded thermodynamic fields. The DIAG option is generally selected for the 36- and 12-km WRF output extraction but not for grid spacing less than about 10 km. However, a recent modeling study showed that, without the sub-grid cloud, the 4-km grid produced too much ozone over the Houston area due to enhanced photochemistry (Nopmongcol et al., 2014). Therefore, the DIAG option was used for the 4-km grid as well as the 36- and 12-km grids.

D.4.4 Configuration of Model Input Parameters

Configuration of the CAMx model is summarized in **Table D-10**. Additional key configuration selections include the following:

Chemical Mechanism: Gas phase chemistry using the Carbon Bond 6 revision 2h (CB6r2h) photochemical mechanism including active local excess methane emissions and halogen chemistry. For particles, CAMx was configured to use the Coarse-Fine (CF) aerosol scheme in which primary species are modeled using two static modes (coarse and fine), while all secondary species are modeled as fine particles only.

Photolysis Rates: The CAMx requires a lookup table of photolysis rates as well as gridded albedo/haze/ozone/snow as input. Day-specific ozone column data are based on the Total Ozone Mapping Spectrometer (TOMS) data measured using the satellite-based Ozone Monitoring Instrument (OMI). Albedo is based on land use data, which includes enhanced albedo values when snow cover is present. For CAMx, there is an ancillary snow cover input that is based on WRF output that overrides the land use-based albedo input to use an enhanced snow cover albedo value. The Tropospheric Ultraviolet and Visible (TUV) Radiation Model photolysis rate processor was used. The CAMx is configured to use the in-line TUV to adjust for cloud cover and account for the effects aerosol loadings have on photolysis rates; this latter effect on photolysis may be especially important in adjusting the photolysis rates due to the occurrence of PM concentrations associated with emissions from fires. Note that the same photolysis rates are used in the 2012 base case and future year scenario model runs.

Landuse: Landuse fields were generated based on U.S. Geological Survey (USGS) Geographic Information Retrieval and Analysis System (GIRAS) data[10]. The WRF estimated snow cover data is used to override the USGS land cover categories when snow cover is present.

Meteorological Inputs: The WRF-derived meteorological fields were processed to generate CAMx meteorological inputs for the using the WRFCAMx processor.

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[10] http://pubs.usgs.gov/ds/2006/240/

Plume in Grid: The subgrid-scale Plum-in-Grid module was not used to avoid unacceptably long model run times and given the fact that most sources in the OCS are far upwind of the receptor sites of interest.

Boundary Conditions: Boundary conditions (BCs) for the 36-km domain were derived from a GEOS-Chem global chemistry model run for 2012 as described bove. The BCs for the 12/4-km model runs were based on BCs extracted from the 36-km simulations.

Advection/Diffusion Methods: The piecewise parabolic method (PPM) advection solver was used for horizontal transport (Colella and Woodward, 1984), along with the spatially varying (Smagorinsky) horizontal diffusion approach. The CAMx used K-theory for vertical diffusion, using the CMAQ-like vertical diffusivities from WRFCAMx.

Initial Conditions: The 36-km simulation used default initial conditions (ICs) that represent clean remote conditions. A 10-day spin-up period was then used to eliminate any significant influence of the ICs. The ICs and BCs for the nested (12/4-km) grid simulations were extracted from the parent grid simulation outputs with a shorter (3 day) spin-up period.

Boundary Conditions: The lateral boundary conditions (BCs) for the 36-km grid were based on results from a GEOS-Chem GCM simulation for year 2012. The GEOS2CAMx processor was used to interpolate from the GEOS-Chem horizontal and vertical coordinate system to the CAMx coordinate system and to map the GEOS-Chem chemical species to the chemical mechanisms being used by CAMx. The use of an alternative global model (MOZART-4/GEOS5; available at http://www.acd.ucar.edu/wrf-chem/mozart.shtml) as a source for the BCs was explored via a test simulation on the 36-km domain with BCs derived from MOZART and subsequent comparison of model predictions with observations at rural monitoring sites. Results of this comparison indicated slightly worse model performance for ozone when using the MOZART BCs as compared to GEOS-Chem with mixed results for PM depending on species and monitoring network used for evaluation. Based on these results and the fact that, in contrast to GEOS-Chem, MOZART does not use day-specific values for dust emissions, resulted in the selection of BCs based on the GEOS-Chem model.

Table D-10. CAMx Model Configuration.

Science Options	Configuration	Notes
Model Codes	CAMx V6.20	
Horizontal Grid	36/12/4 km	Refer to **Section D.2**
36-km grid	148 x 112 cells	
12-km grid	254 x 176 cells	
4-km grid	299 x 200 cells	
Vertical Grid	19 vertical layers (layer-collapsed from 23 WRF layers)	
Grid Interaction	36/12 km one-way nesting 12/4 km two-way nesting	
Initial Conditions	Clean initial conditions	Use 10-day spin-up for the 36-km grid; 3-day spin-up for the nested (12/4 km) grids
Boundary Conditions	36 km from GCM simulation	GEOS-Chem GCM 2012 output data
Land-use Data	Land-use fields based on USGS GIRAS data	
Photolysis Rate Preprocessor	TUV V4.8	Clear-sky photolysis rates based on day-specific Total Ozone Mapping Spectrometer (TOMS) data
Chemistry		
Gas-phase	CB6r2h	Updated isoprene chemistry; heterogeneous hydrolysis of organic nitrates; active methane chemistry and ECH_4 tracer species (Hildebrandt Ruiz and Yarwood, 2013); halogen chemistry (Yarwood et al., 2014)
Aerosol-phase	CF	Coarse and fine mode aerosols
Meteorological Input Preprocessor	WRFCAMx V4.3	Compatible with CAMx V6.20
Diffusion Scheme		
Horizontal-grid	Explicit horizontal diffusion	Spatially varying horizontal diffusivities determined based on the methods of Smagorinsky (1963)
Vertical-grid	K-theory 1st-order closure	WRFCAMx-derived vertical diffusivities based on the Yonsei University (YSU) planetary boundary layer (PBL) scheme (Hong and Noh, 2006); land-use dependent minimum diffusivity (minimum Kv = 0.1 to 1.0 m^2/s) with a cloud Kv patch recently developed to address deep convective mixing (ENVIRON, 2012)
Deposition Scheme		
Dry deposition	ZHANG03	Dry deposition scheme by Zhang et al. (2001; 2003)
Wet deposition	CAMx-specific formulation	Scavenging model for gases and aerosols (Seinfeld and Pandis, 1998)
Numerical Solvers		
Gas-phase chemistry	Euler Backward Iterative (EBI) solver	Hertel et al., 1993
Horizontal advection	Piecewise Parabolic Method (PPM)	Colella and Woodward, 1984
Vertical advection	Implicit scheme w/ vertical velocity update	

D.5 Model Performance Evaluation

Results from the CAMx base case model runs were compared with available air quality observations within the 12/4-km domain to evaluate the ability of the model to accurately reproduce observed conditions. Evaluation of CAMx model performance focused on ozone and PM species as these predictions play the primary role in the air quality impact analysis. Evaluation of the CAMx 2012 base case simulation followed USEPA's current (USEPA, 2007) and new draft (USEPA, 2014) PGM modeling guidance. The model performance evaluation (MPE) used the Atmospheric Model Evaluation Tool (AMET[11]), which is the evaluation tool discussed in USEPA's latest PGM guidance (USEPA, 2014). Note that AMET requires that a monitoring site have at least 75% valid data capture in order to be used in the MPE, which eliminated observed data from some sites for use in the MPE.

D.5.1 Implications of WRF Model Performance on PGM Simulations

The WRF model performance evaluation results are presented in **Appendix B**. The effects of the meteorological model performance on PGM modeled concentrations, visibility and deposition is difficult to predict given the multiple effects the meteorological model can have. As described in **Appendix B**, overall WRF model performance was found to be good and significant impediments to PGM model performance due to errors in meteorology are not anticipated.

D.5.2 Ambient Data Used In the Model Performance Evaluation

Ozone model performance was evaluated using observed hourly and daily maximum 8-hour (DMAX8) ozone concentrations from the USEPA's Air Qu ality System (AQS[12]) and the Clean Air Status and Trends Network (CASTNet[13]). **Figure D-19** displays the locations of the AQS and CASTNet ozone monitoring sites used in the ozone model performance evaluation. Historically, CASTNet ozone monitoring sites operated by the U.S. Dept. of the Interior's National Park Service (NPS) were included as part of AQS (i.e., ozone compliance monitors), while those operated by the USEPA were not. This has recently been changed and now all CASTNet ozone data are also reported in AQS. Thus, CASTNet ozone monitoring sites operated by the NPS are included in both the AQS and CASTNet monitoring databases. Apart from this overlap, most AQS monitoring sites tend to be more urban-oriented, while CASTNet sites tend to be more rural. Ramboll Environ therefore provides separate performance results for the AQS and CASTNet monitoring sites in order to provide insight into ozone performance at urban vs. rural sites.

[11] https://www.cmascenter.org/help/documentation.cfm?MODEL=amet&VERSION=1.1
[12] http://www.epa.gov/ttn/airs/airsaqs/aqsweb/
[13] http://java.epa.gov/castnet/

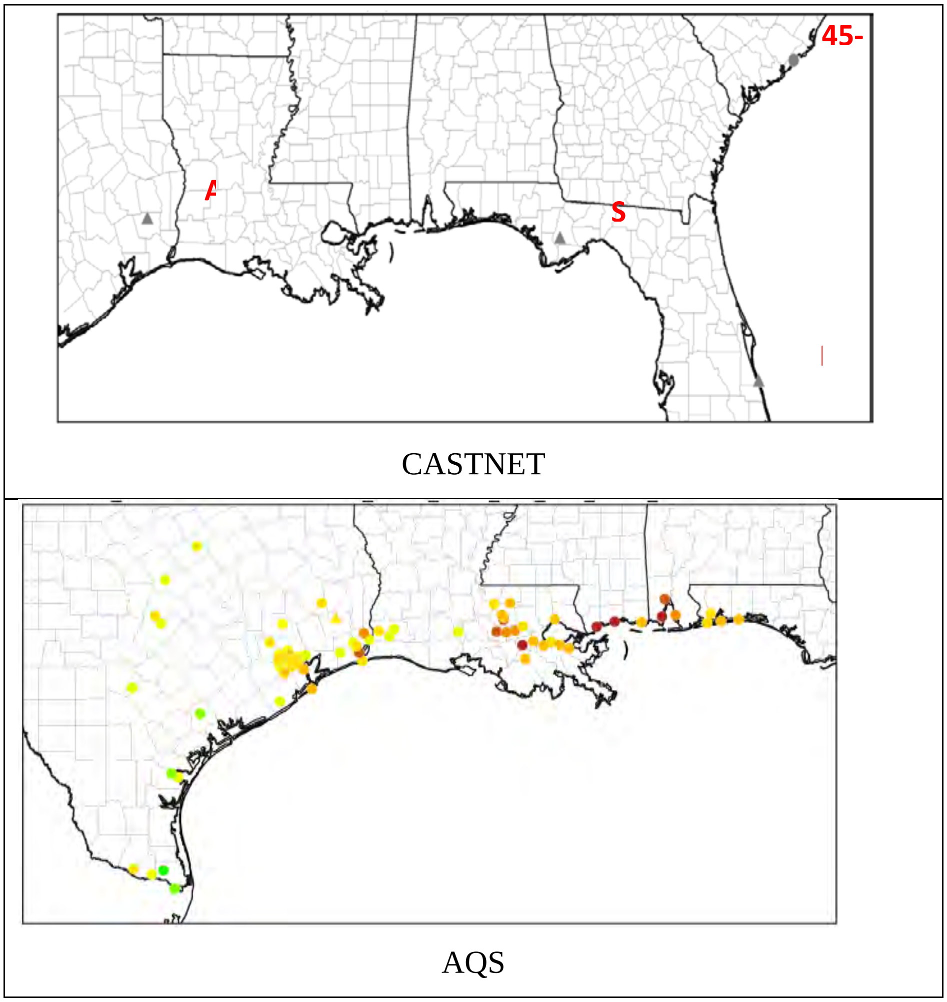
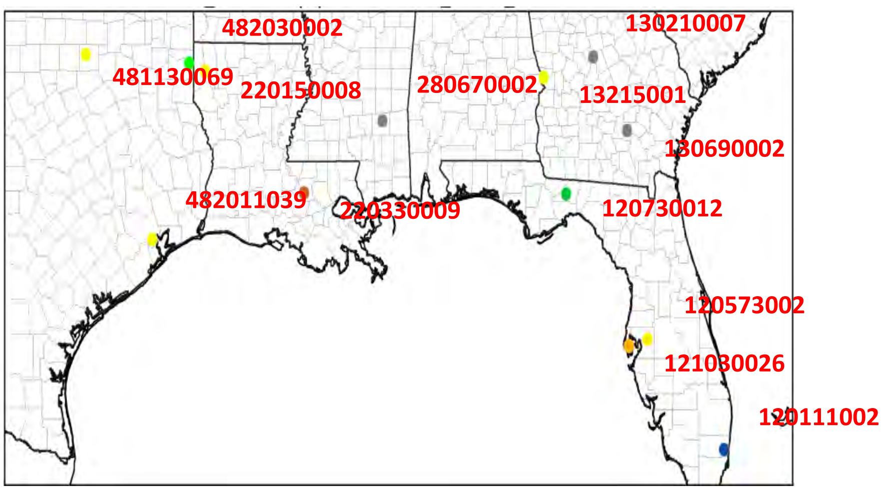


Figure D-19. Ozone Monitoring Sites Used in the Model Performance Evaluation: CASTNet Sites in the Southeastern U.S. (top) and AQS Sites within the 4-km Modeling Domain (bottom) (color coding of AQS monitor locations is arbitrary).

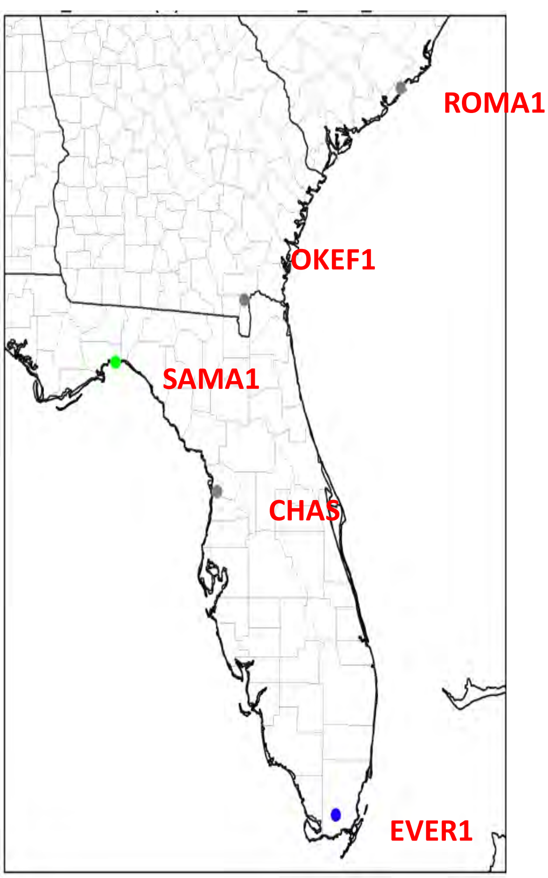
The $PM_{2.5}$ model performance was evaluated using observed speciated PM data from CSN, IMPROVE, and SEARCH monitoring sites in the southeastern U.S. as shown in **Figure D-20**. This was augmented by 24-hour integrated total $PM_{2.5}$ mass measurements using Federal Reference Method (FRM) or equivalent method monitoring sites reporting to the AQS. Most of these FRM sites collect samples on a 1-in-3 day schedule, although some collect data every day. The CSN data consist of 24-hour integrated particulate samples analyzed for SO_4, NO_3, NH_4, EC, OC, and elements using a 1:3 or 1:6 day sampling frequency. The Interagency Monitoring of Protected Visual Environments (IMPROVE[14]) network collects 24-hour average $PM_{2.5}$ and PM_{10} mass and speciated $PM_{2.5}$ concentrations (with the exception of ammonium) using a 1:3 day sampling frequency. The SEARCH network data consist of hourly and 24-hour $PM_{2.5}$ mass and speciated $PM_{2.5}$ data (including ammonia). The FRM and CSN monitoring sites tend to be more urban, whereas the IMPROVE sites are mostly located at national parks and wilderness areas and so are more rural.

There are additional monitoring sites within the modeling domain that collect hourly $PM_{2.5}$ and PM_{10} total mass. However, automated hourly PM measurements are in some cases subject to additional measurement artifacts and uncertainties relative to data collected on filters and do not include speciated PM measurements. Although MPE results were generated using hourly PM data, they are not shown here to maintain consistency with the 24-hour PM NAAQS and the speciated PM results, as well as for the sake of brevity. Some hourly PM data, including speciated PM data, are available at SEARCH network sites. Comparison of MPE results for model bias and error did not show large overall differences between the hourly and daily SEARCH network comparisons.

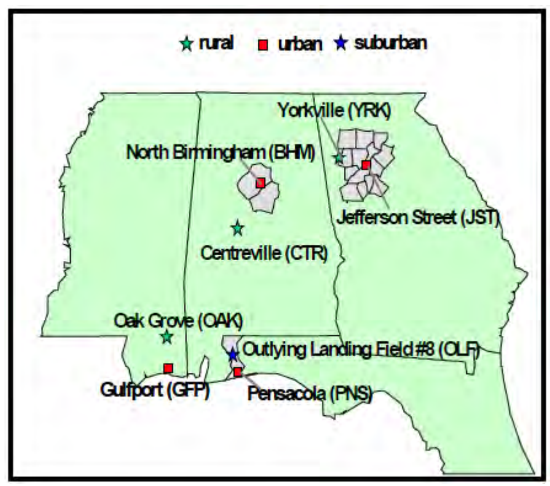
[14] http://vista.cira.colostate.edu/IMPROVE/



CSN



IMPROVE



SEARCH (source: EPRI, 2011)

Figure D-20. Speciated PM Monitoring Sites Used in the Model Performance Evaluation: CSN Network (top), IMPROVE Network (bottom left), and SEARCH Network (bottom right).

D.5.3 Model Performance Statistics

Statistical performance measures applicable to air quality model evaluation are defined in **Table D-11**.

Table D-11. Definitions of Model Performance Evaluation Statistical Metrics.

Statistical Measure	Mathematical Expression	Notes
Ap: Accuracy of paired peak	$\frac{P - O_{peak}}{O_{peak}}$	Comparison of the peak observed value (Opeak) with the predicted value at same time and location
NME: Normalized Mean Error	$\frac{\sum_{i=1}^{N} \lvert P_i - O_i \rvert}{\sum_{i=1}^{N} O_i}$	Reported as %
RMSE: Root Mean Square Error	$\left[\frac{1}{N} \sum_{i=1}^{N} (P_i - O_i)^2 \right]^{1/2}$	Reported as %
FE: Fractional Gross Error	$\frac{2}{N} \sum_{i=1}^{N} \left\lvert \frac{P_i - O_i}{P_i + O_i} \right\rvert$	Reported as % and bounded by 0% to 200%
MAGE: Mean Absolute Gross Error	$\frac{1}{N} \sum_{i=1}^{N} \lvert P_i - O_i \rvert$	Reported as concentration (e.g., $\mu g/m^3$)
MNGE: Mean Normalized Gross Error	$\frac{1}{N} \sum_{i=1}^{N} \frac{\lvert P_i - O_i \rvert}{O_i}$	Reported as %
MB: Mean Bias	$\frac{1}{N} \sum_{i=1}^{N} (P_i - O_i)$	Reported as concentration (e.g., $\mu g/m^3$)
MNB: Mean Normalized Bias	$\frac{1}{N} \sum_{i=1}^{N} \frac{(P_i - O_i)}{O_i}$	Reported as %
FB: Mean Fractionalized Bias	$\frac{2}{N} \sum_{i=1}^{N} \left(\frac{P_i - O_i}{P_i + O_i} \right)$	Reported as %, bounded by -200% to +200%
NMB: Normalized Mean Bias	$\frac{\sum_{i=1}^{N} (P_i - O_i)}{\sum_{i=1}^{N} O_i}$	Reported as %

For over two decades, ozone model performance for bias and error has been compared against the USEPA's 1991 ozone modeling guidance model performance goals as follows (USEPA, 1991):

- Mean Normalized Bias (MNB) ≤ ±15%
- Mean Normalized Gross Error (MNGE) ≤ 35%

In the USEPA's 1991 ozone modeling guidance, these performance metrics were for hourly ozone concentrations that were consistent with the form of the ozone NAAQS in those days. The MNB performance statistic uses hourly predicted and observed ozone concentrations paired by time and location and is defined as the difference between the predicted and the observed hourly ozone divided by the observed hourly ozone concentrations averaged over all predicted/observed pairs within a given region and for a given time period (e.g., by day, month or modeling period). The MNGE is defined similarly only it uses the absolute value of the difference between the predicted and observed hourly ozone concentrations, so it is an unsigned metric. Note that, because the MNB and MNGE performance metrics divide by the observed ozone concentrations, they weigh performance for low ozone concentrations highly and can become unstable as the observed ozone approaches zero. Consequently, they are no longer recommended. Instead, the Fractional Bias and Error (FB/FE) and Normalized Mean Bias and Error (NMB/NME) are the preferred bias and error statistical performance measures.

For PM species, a separate set of model performance statistics and performance goals and criteria have been developed as part of the regional haze modeling performed by several Regional Planning Organizations (RPOs). The USEPA's modeling guidance notes that PM models might not be able to achieve the same level of model performance as ozone models. Indeed, $PM_{2.5}$ species definitions are defined by the measurement technology used to measure them, and different measurement technologies can produce very different $PM_{2.5}$ concentrations. Given this, several researchers have developed PM model performance goals and criteria that are less stringent than the ozone goals that are shown in **Table D-12** (Boylan, 2004; Boylan and Russell, 2006; Morris et al., 2009a and 2009b). However, unlike the 1991 ozone model performance goals that use the MNB and MNGE performance metrics, the Fractional Bias (FB) and Fractional Error (FE) are typically used for PM species with no observed concentration threshold screening. The FB/FE differs from the MNB/MNGE in that the difference in the predicted and observed concentrations are divided by the average of the predicted and observed values, rather than just the observed value as in the MNB/MNGE. This results in the FB being bounded by -200% to +200%, and the FE being bounded by 0% to +200%. There are additional statistical performance metrics that evaluate correlation, scatter, and normalized mean bias and error (NMB/NME), as shown in **Table D-12**.

Table D-12. Ozone and PM Model Performance Goals and Criteria.

Bias (FB/NMB)	Error (FE/NME)	Comment
≤±15%	≤35%	Ozone model performance goal that would be considered very good model performance for PM species
≤±30%	≤50%	PM model performance Goal, considered good PM performance
≤±60%	≤75%	PM model performance Criteria, considered average PM performance

More recently, the USEPA compiled and interpreted the model performance from 69 PGM modeling studies in the peer-reviewed literature between 2006 and March 2012 and developed recommendations on what should be reported in a model performance evaluation (Simon et al., 2012). Although these recommendations are not official USEPA guidance, their recommendations were integrated in this CAMx MPE.

- The PGM MPE studies should, at a minimum, report the Mean Bias (MB) and Error (ME or RMSE), and Normalized Mean Bias (NMB) and Error (NME) and/or Fractional Bias (FB) and Error (FE). Both the MNB and FB are symmetric around zero with the FB bounded by -200% to +200%.
- Use of the Mean Normalized Bias (MNB) and Gross Error (MNGE) is not encouraged because they are skewed toward low observed concentrations and can be misinterpreted due to the lack of symmetry around zero.
- The model evaluation statistics should be calculated for the highest resolution temporal resolution available (e.g., hourly ozone) and for important regulatory averaging times (e.g., daily maximum 8-hour ozone).
- It is important to report processing steps in the model evaluation and how the predicted and observed data were paired and whether data are spatially/temporally averaged before the statistics are calculated.
- Predicted values should be taken from the grid cell that contains the monitoring site, although bilinear interpolation to the monitoring site point can be used for higher resolution modeling (<12 km).
- The $PM_{2.5}$ should also be evaluated separately for each major component species (e.g., SO_4, NO_3, NH_4, EC, OA, and remainder other $PM_{2.5}$ [$OPM_{2.5}$]).
- Evaluation should be performed for subsets of the data, including high observed concentrations (e.g., ozone >60 ppb) by subregion and by season or month.
- Spatial displays should be used in the model evaluation to evaluate model predictions away from the monitoring sites. Time series of predicted and observed concentrations at a monitoring site should also be used.
- It is necessary to understand measurement artifacts in order to make meaningful interpretation of the model performance evaluation.

D.5.4 Approach

The PGM evaluation focused on ozone, both hourly and daily maximum 8-hour (DMAX8) ozone concentrations; total $PM_{2.5}$ mass and speciated $PM_{2.5}$ concentrations; gaseous NO_2, SO_2, and CO concentrations; and visibility. The evaluation was performed across all monitoring sites within either the southeastern U.S. as shown in the top panel of **Figure D-20** (in order to capture the regional CSN and IMPROVE network sites) or the 4-km modeling domain (**Figure D-5**), as well as at each individual site on an annual, seasonal (quarterly), and monthly basis. In addition to generating numerous statistical performance metrics (refer to **Table D-11**), graphical representation of model performance used three main types of displays.

- Soccer Plots of monthly bias and error that are compared against the ozone performance goals and the PM performance goals and criteria (refer to **Table D-11**). Monthly soccer plots allow the easy identification of when performance goals/criteria are achieved and an evaluation of performance across seasons.
- Spatial statistical performance maps that display bias/error on a map at the locations of the monitoring sites in order to better understand spatial attributes of model performance, along with tabular summaries of statistical performance metrics.
- Time series plots that compare predicted and observed concentrations at a monitoring site as a function of days.
- Scatter plots of predicted and observed concentrations.

All performance statistics and displays are performed matching the predicted and observed concentrations by time and location using the modeled prediction in the 12/4-km grid cell containing the monitoring site.

The CAMx model performance for PM was evaluated using total $PM_{2.5}$ mass and speciated $PM_{2.5}$ measurements compared against the PM performance goals and criteria given in **Table D-12**. Note that the PM goals and criteria are not as stringent as those for ozone because the measurements themselves, as well as the PM emissions, are much more uncertain and there are more processes involved in PM (e.g., dispersion, transformation and deposition of primary PM and formation of secondary PM from gaseous precursors). Each PM measurement technique has its own artifacts; different measurement technology could produce different observed $PM_{2.5}$ values that differ by as much as 30 percent. The USEPA's latest PGM modeling guidance includes a section on PM measurement artifacts for the monitoring technologies used in routine networks in the U.S. (USEPA, 2014). Thus, the PM model performance needs to recognize these measurement uncertainties and artifacts and take them into account in the interpretation of model performance, as even a "perfect" model may not achieve the PM performance goals and criteria.

The PM_{10} consists of particles with a mean aerodynamic diameter of 10 microns or less and consists of fine ($PM_{2.5}$, i.e., particles with a diameter of 2.5 microns or less) and coarse (PMC, i.e., particles with a diameter between 2.5 and 10 microns) modes. The $PM_{2.5}$ is composed of the following component species:

- sulfate (SO_4) that is typically in the form of ammonium sulfate;
- nitrate (NO_3) that is typically in the form of ammonium nitrate;
- ammonium (NH_4) that is associated with SO_4 and NO_3;
- elemental carbon (EC) that is also called black carbon (BC) and light-absorbing carbon (LAC);

- organic aerosol (OA) that includes primary (POA) and secondary organic aerosol (SOA) and is composed or organic carbon (OC) and other atoms (e.g., oxygen) that are adhered to the OC; and
- other $PM_{2.5}$ ($OPM_{2.5}$) that is primarily crustal in nature (SOIL) but can also include other compounds as well as measurement artifacts.

Model performance statistics were calculated for total PM mass using observations from the FRM, CSN, SEARCH, and IMPROVE networks and then evaluated for PM_{10} and $PM_{2.5}$ component species using data from the CSN, SEARCH, and IMPROVE sites.

D.5.5 Initial Model Performance Results

Results of initial CAMx runs for the 36- and 12-km domains configured as described in **Section D.4** were evaluated in terms of the MPE statistics described above to determine if any corrections or adjustments to model inputs were needed. In some cases, results from CAMx were compared with results from CMAQ to determine potential underlying causes of poor model performance. Results of these analyses indicated ozone and $PM_{2.5}$ over prediction biases, which were especially pronounced along the Gulf Coast. Evaluation of results for individual PM components showed that much of the $PM_{2.5}$ over prediction in coastal areas was associated with over prediction of sea salt emissions as evidenced by over prediction of sodium (Na) and consequently over prediction of nitrate PM as a result of nitrate substitution of chloride ions. This was confirmed by sensitivity tests in which sea salt emissions were reduced by a factor of five as suggested by regressions of predicted vs. observe Na at IMPROVE and CSN monitoring sites.

Consistent with results of other modeling studies in the southeastern U.S., the ozone over prediction bias was judged to likely be associated at least in part with known over prediction biases of ozone over the Gulf of Mexico in many different global models, including GEOS-Chem resulting in over estimates of boundary condition ozone and over prediction of isoprene by the MEGAN biogenic model (Johnson et al., 2015). A series of sensitivity tests based on CAMx performance over the 36-km domain with reduced ozone and ozone precursor BCs and reduced sea salt emissions confirmed that these modifications resulted in generally improved model performance. To this were added two additional modifications: the application of a commonly used adjustment to vertical diffusivity coefficients (Kv patch), which has been shown to improve model performance overnight and in urban areas (ibid); and a reduction in residential wood combustion (RWC) emissions following results of Adelman et al. (2014). A set of final 36-km and 12/4-km model runs were then completed with these modifications in place.

D.5.6 Final Model Performance Results

After making the model input and configuration revisions described in the previous section, CAMx was rerun on the 36-km grid and boundary conditions extracted for the 12/4-km, two-way nested grid run. Results of the MPE for the 12/4-km grid run are presented in this section.

D.5.6.1 Ozone

Model performance results for ozone are summarized in terms of monthly NMB and NME in soccer plots for AQS and CASTNet network monitors within the 4-km and 12-km domains in **Figure D-21**. Model performance for nearly all months is within the ±15% NMB and <35% NME ozone performance goals listed in **Table D-12** (which corresponds to the innermost "goal" box shown in the figure), with the principal exceptions being performance during July and August for sites in the 4-km domain (note only one CASTNet site – site ALC188, Alabama-Coushatta – is located within the 4-km domain).

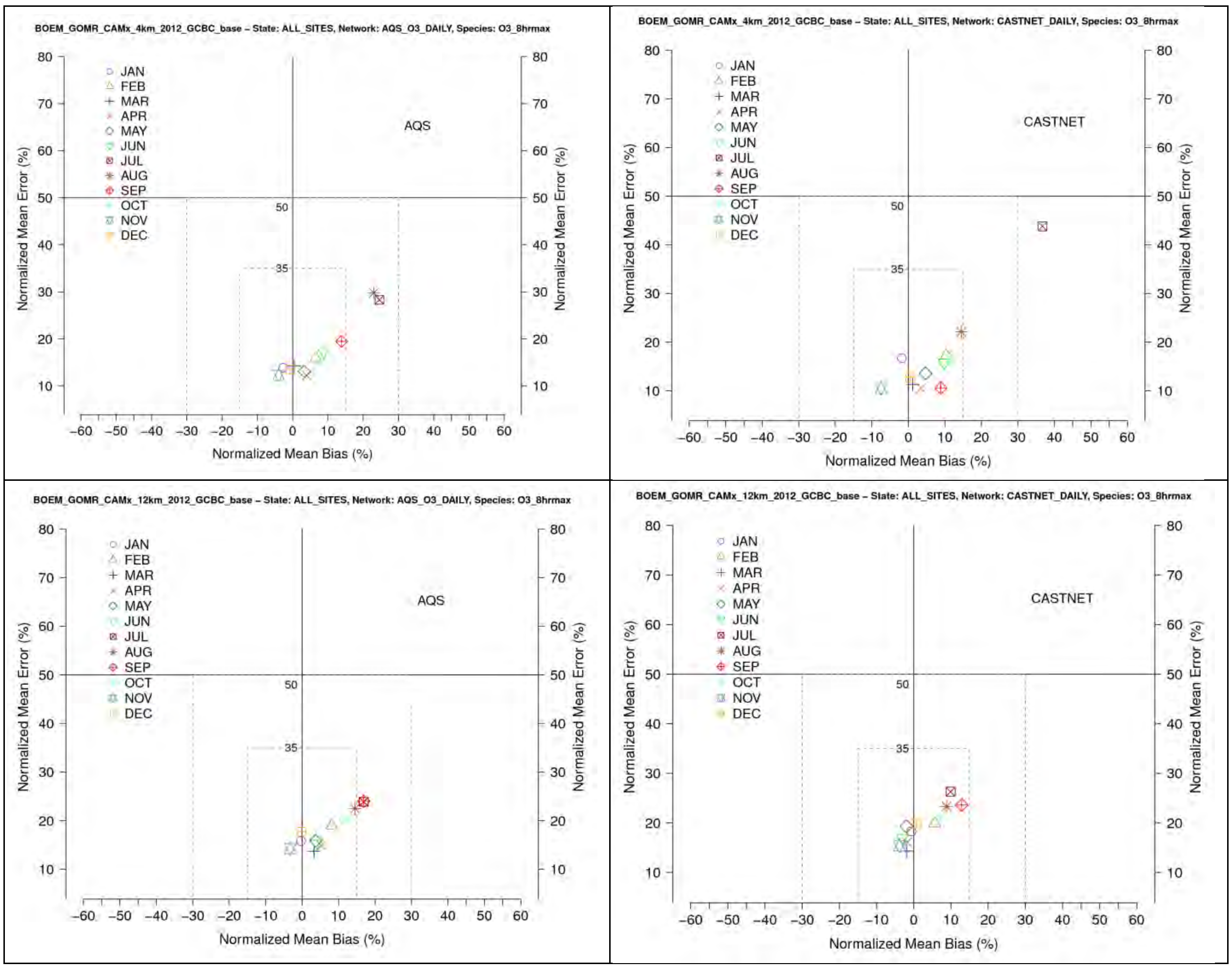


Figure D-21. Monthly Normalized Mean Bias and Normalized Mean Error for Daily Maximum 8-hour Average Ozone at AQS (left) and CASTNet (right) Monitoring Sites Located within the 4-km Modeling Domain (top) and the 12-km Domain (bottom).

As illustrated by the threshold exceedance counts in **Figure D-22**, the ozone season in the far South generally follows a bimodal distribution with a pronounced ozone peak in spring and a secondary peak in late summer to early fall. There is a noticeable lack of high ozone events during July. This seasonal pattern is reproduced in the model results as shown in **Figure D-23**. Model performance statistics generated using the AMET tool are summarized by calendar quarter. We therefore focus further attention on ozone model performance results for Q2 (April-June) and Q3 (July-September), as these roughly coincide with the seasonal ozone peaks.

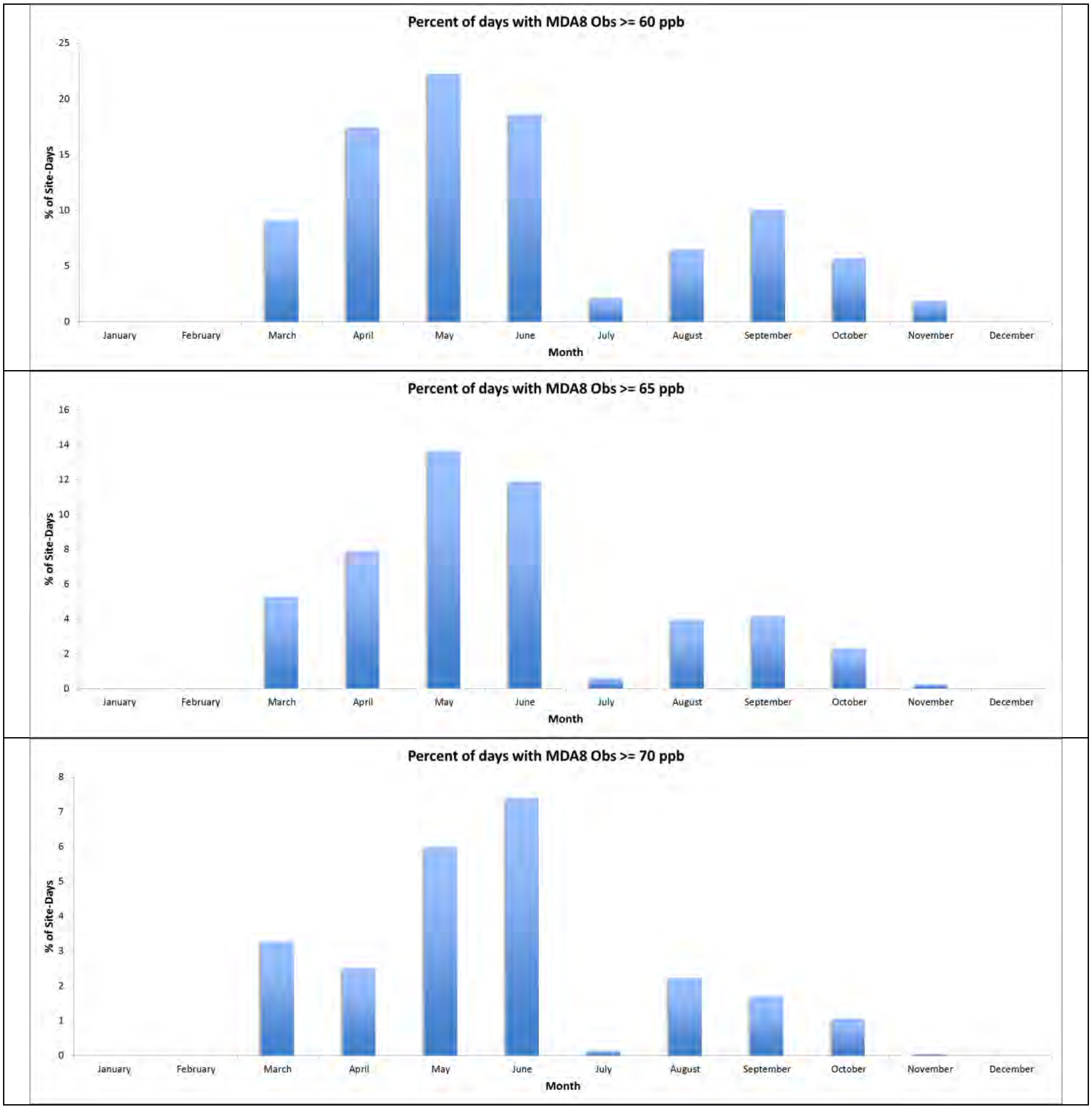


Figure D-22. Fraction of Site-days during Each Month of 2012 with Observed Daily Maximum 8-hour Ozone Exceeding 60 (top), 65 (middle), or 70 (bottom) ppb Over All Monitoring Sites in the 4-km Domain.

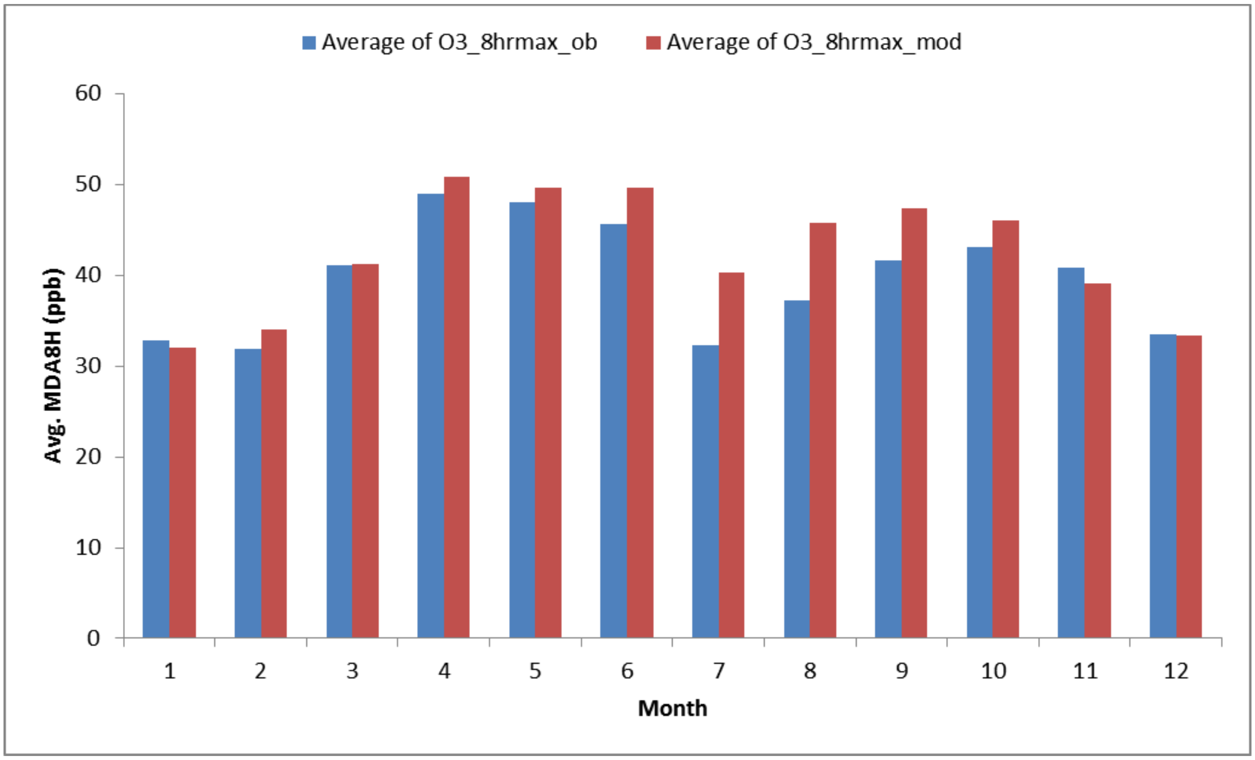


Figure D-23. Observed (blue) and Predicted (red) Monthly Mean Daily Maximum 8-hour Average Ozone Over All Sites in the 4-km Modeling Domain.

Ozone model performance for Q2 (April-May) and Q3 (July-September) over sites in the 4-km domain is illustrated by the scatter plots in **Figure D-24**. Standard scatter plots are shown in the left-hand column and corresponding scatter density plots are shown in the right-hand column. Colors in the scatter density plot indicate the fraction of data in each 2 ppb bin, thus revealing the data density variations that are otherwise obscured in regions with numerous overlapping points in the standard scatter plots. Model performance in Q2 is better than in Q3 primarily due to a lower bias (NMB of 5.2% in Q2 as compared to 20.1% in Q3). The scatter density plots show that the Q3 bias is primarily associated with over prediction of mid- and low-range values with less bias for values exceeding 60 ppb. Summaries of ozone performance statistics with a 60 ppb observed ozone cutoff applied are further discussed below.

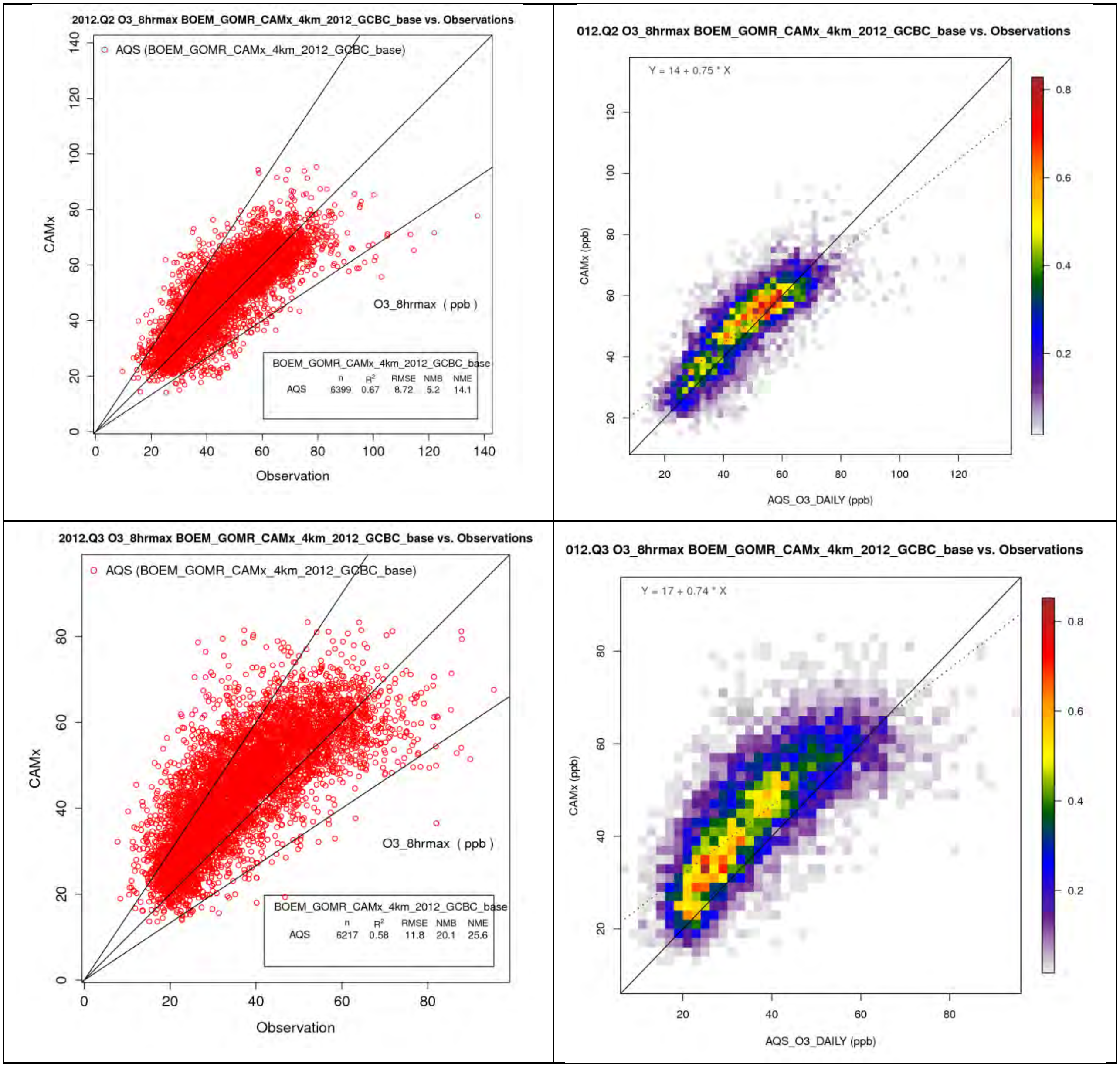


Figure D-24. Scatter (left) and Scatter Density (right) Plots for Observed vs. Predicted Daily Maximum 8-hour Ozone in Q2 (top) and Q3 (bottom) for All AQS Monitoring Sites in the 4-km Modeling Domain.

The spatial distribution of NMB over the full 12-km domain is shown in **Figure D-25**. Note that these results are based on the 12-km gridded model resolution for all sites shown. The NMB is within ±15% at most sites during Q2 but exceeds +15% at most sites along the Gulf Coast and throughout the southern tier and southeast Atlantic States in Q3.

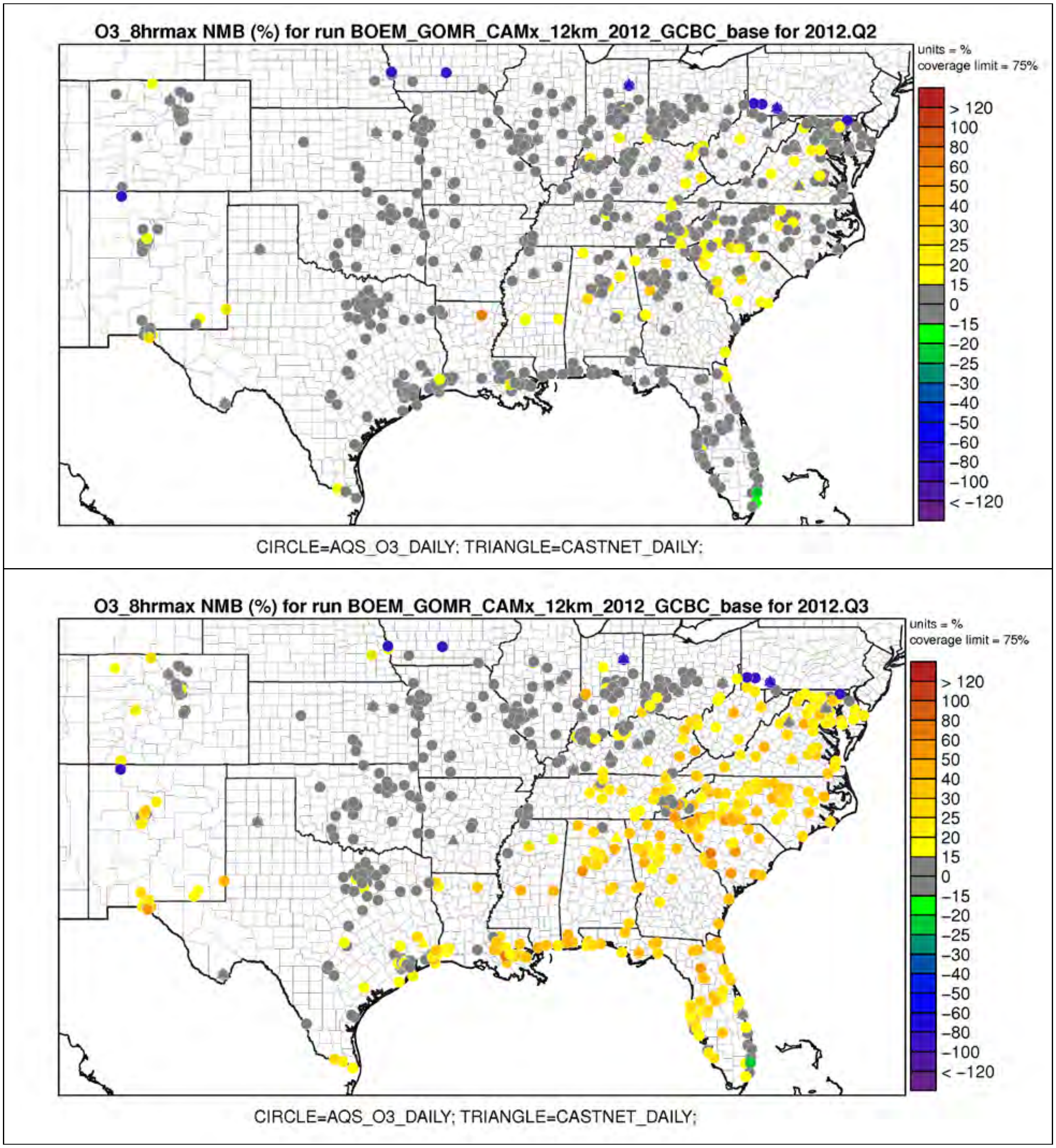


Figure D-25. Normalized Mean Bias (NMB) for Daily Maximum 8-hour Ozone for Q2 (top) and Q3 (bottom).

The USEPA recommends that ozone model performance statistics be calculated using a 60-ppb observed ozone concentration cut-off value (Simon et al., 2012; USEPA 2014). That is, the model performance statistics are calculated for all predicted and observed ozone pairs matched by time and location for which the observed value is 60 ppb or higher. **Table D-13** lists model performance summary statistics derived from the 4-km resolution model output for hourly and 8-hour daily maximum ozone with no concentration cut-off applied and with cut-offs of 40 or 60 ppb applied for Q2 and Q3. Values of NMB and NME exceeding USEPA's performance goals as listed in **Table D-12** are highlighted. Biases trend from positive to slightly negative as the threshold concentration increases but are always within the Performance Goal for Q2 and also under application of the 40- and 60-ppb thresholds in Q3. The NME is always within the USEPA Performance Goal except for hourly values in Q3 when no cut-off is applied.

Table D-13. Model Performance Statistics at Different Observed Ozone Concentration Screening Thresholds Based on All Monitoring Sites in the 4-km Domain (shaded cells indicate values exceeding USEPA performance goals).

Monitor Site	Q2 (April – June)			Q3 (July – September)		
	N	NMB (%)	NME (%)		NMB (%)	NME (%)
USEPA Performance Goal		≤±15%	≤35%		≤±15%	≤35%
Ozone Cut-Off Concentrations	DMAX8 Ozone					
0	6399	5.2	14.1	6217	20.1	25.6
40	4326	2.1	11.6	3218	7.9	15.9
60	1246	-5.7	9.9	375	-9.2	12.6
Ozone Cut-Off Concentrations	Hourly Ozone					
0	152327	10.9	30.5	149676	30.6	46.7
40	53213	-3.5	16.7	22751	1.5	19.6
60	11229	-10.6	14.7	3498	-13.9	17.8

Time series of observed and predicted daily maximum 8-hour ozone are plotted in **Figure D-26** for the monitoring site in each county in the Houston-Galveston-Brazoria ozone nonattainment area with the highest ozone design values during the 2010-2014 design value periods (2010-2012, 2011-2013, 2012-2014): Northwest Harris County site (AQS ID 48-201-0029)[15], Manvel Croix Park – Brazoria County (AQS ID 48-039-1004), and Galveston 99th St. – Galveston County (AQS ID 48-167-1034).

Time series of observed and predicted daily maximum 8-hour ozone are plotted in **Figure D-27** for two monitoring sites in the Baton Rouge ozone nonattainment area: LSU (AQS ID 22-033-0003) and Carville (AQS ID 22-047-0012). These sites typically had the highest ozone design values in the Baton Rouge area during the 2010-2014 design value periods.

The time series for the ALC188 (Alabama-Coushatta, Texas) CASTNet site (the only CASTNet site in the 4-km domain) are shown in **Figure D-28**.

Overall model performance as seen in these time series is good, especially in Q2 and especially in the Houston-Galveston area. There is a tendency towards over prediction in Q3 at

[15] This site recorded either the maximum or was within 1 ppb of the maximum ozone design value of all sites in Harris County during this period.

Galveston and more noticeably at the Baton Rouge sites, consistent with the results for all sites presented above.

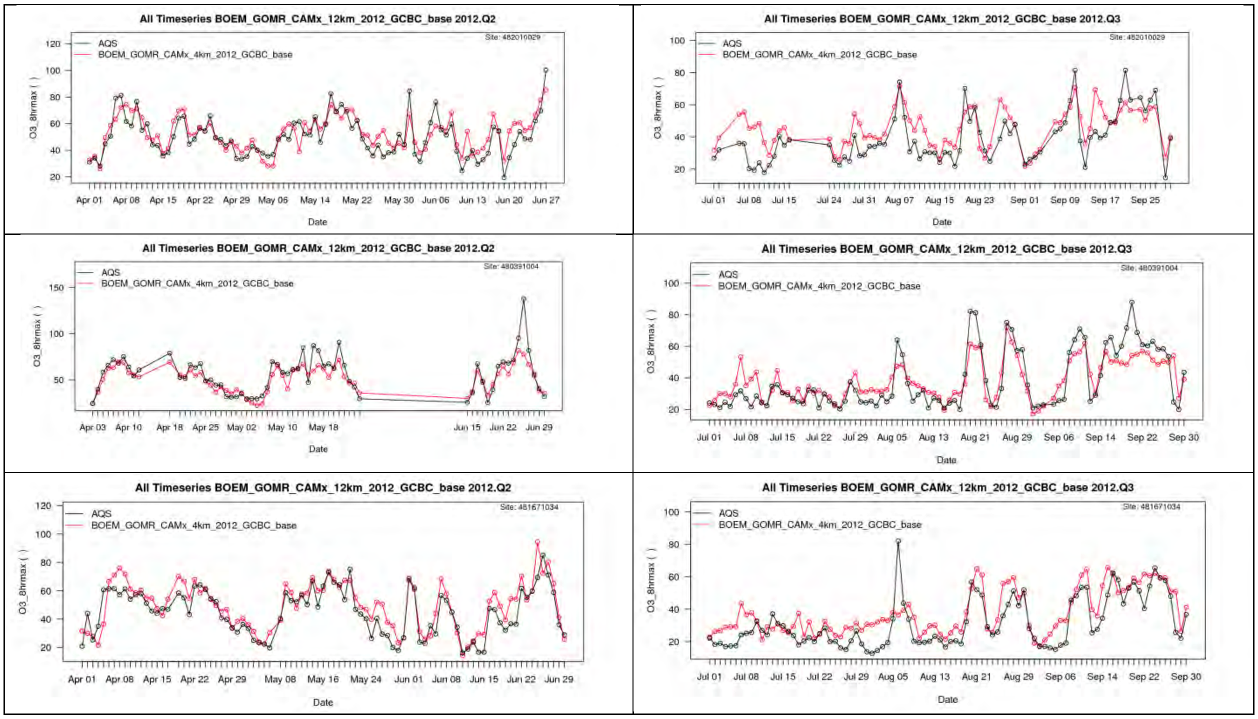


Figure D-26. Time Series of Daily Maximum 8-hour Ozone at Monitoring Sites with Highest Design Values in Harris (top), Brazoria (middle), and Galveston (bottom) Counties, Texas, for Q2 (left) and Q3 (right).

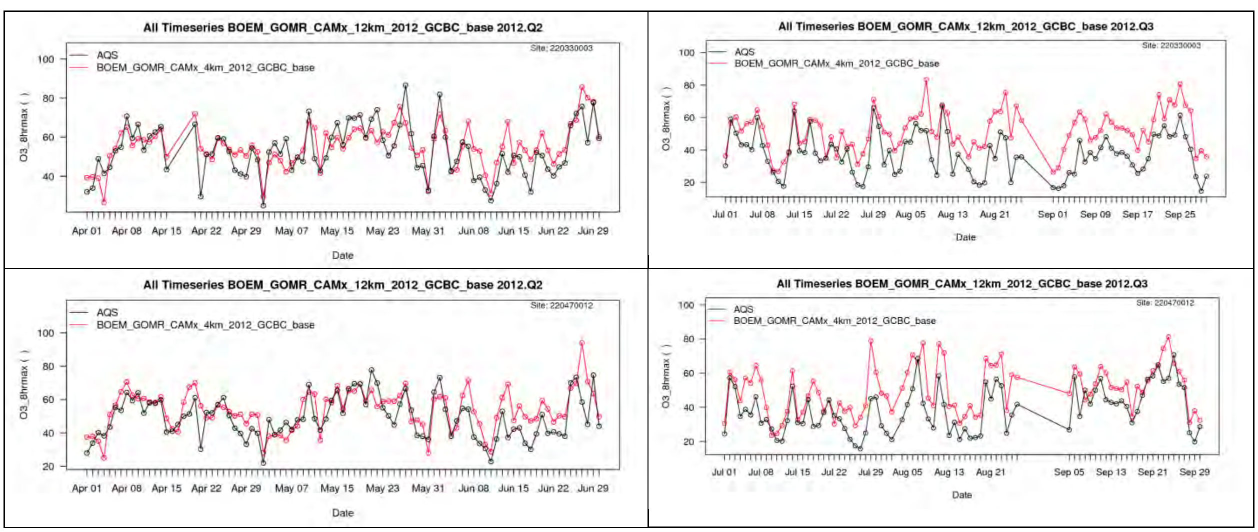


Figure D-27. Time Series of Daily Maximum 8-hour Ozone at Monitoring Sites in the Baton Rouge Nonattainment Area: LSU (top) and Carville (bottom) for Q2 (left) and Q3 (right).

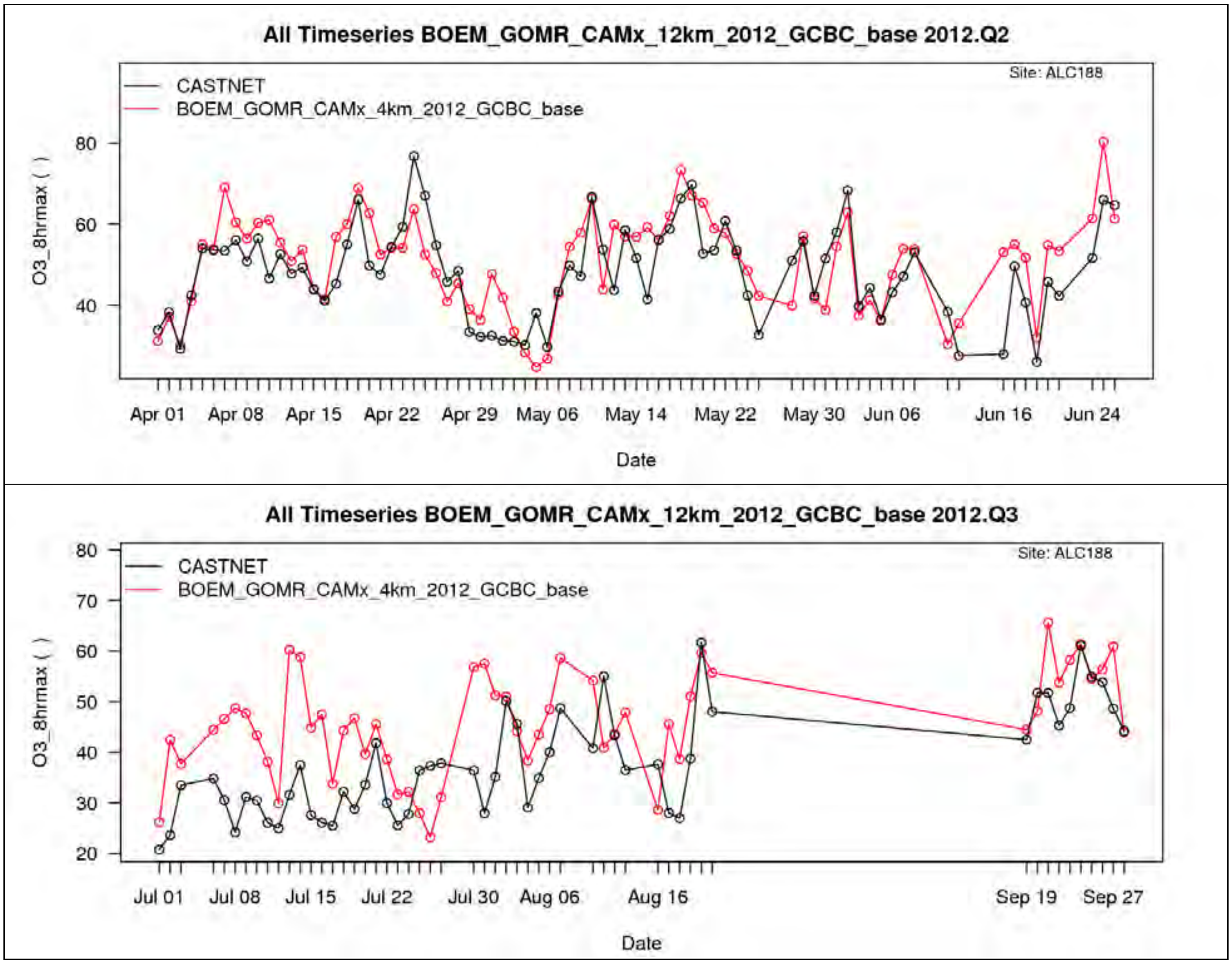


Figure D-28. Time Series of Daily Maximum 8-hour Ozone at the ALC188 (Alabama-Coushatta, Texas) CASTNet Monitoring Site for Q2 (top) and Q3 (bottom).

D.5.6.2 Particulate Matter

The CAMx model performance for particulate matter (PM) was evaluated for total $PM_{2.5}$ mass and speciated $PM_{2.5}$ measurements. The PM performance was compared against the performance goals and criteria given in **Table D-12**. Note that the PM goals and criteria are not as stringent as those for ozone because both PM measurements and PM emissions are subject to greater uncertainties and PM formation and transformation processes are more complex and difficult to model. Each PM measurement technique has its own artifacts; different measurement technologies can produce different observed $PM_{2.5}$ values that differ by as much as 30 percent. The USEPA's latest PGM modeling guidance includes a section on PM measurement artifacts for the monitoring technologies used in routine networks in the U.S. (USEPA, 2014). The PM model performance results must be evaluated in light of these measurement uncertainties and artifacts as even a "perfect" model may not achieve the PM performance goals and criteria relative to the imperfect measurements.

The PM_{10} consists of particles with a mean aerodynamic diameter of 10 microns or less and consists of fine ($PM_{2.5}$, i.e., particles with a diameter of 2.5 microns or less) and coarse (PMC, i.e., particles with diameter between 2.5 and 10 microns) modes. The $PM_{2.5}$ is composed of the following component species:

- sulfate (SO_4) that is typically in the form of ammonium sulfate;
- nitrate (NO_3) that is typically in the form of ammonium nitrate;
- ammonium (NH_4) that is associated with SO_4 and NO_3;
- elemental carbon (EC) that is also called black carbon (BC) and light-absorbing carbon (LAC);
- organic aerosol (OA) that includes primary (POA) and secondary organic aerosol (SOA) and is composed or organic carbon (OC) and other atoms (e.g., oxygen) that are adhered to the OC; and
- other $PM_{2.5}$ ($OPM_{2.5}$) that is primarily crustal in nature (SOIL) but can also include other compounds such as sea salt and may include measurement artifacts as it is determined by subtraction of the sum of individual measured species from the measured total $PM_{2.5}$.

In the following subsections, we first evaluate the CAMx 2012 base case simulation for total $PM_{2.5}$ mass using observations from the FRM, CSN, and IMPROVE monitoring networks and then evaluate results for PM_{10} and $PM_{2.5}$ component species. There are also numerous hourly $PM_{2.5}$ and PM_{10} monitoring sites in the region that are also used in the MPE, but results for these are not presented here as they may suffer from additional measurement artifacts and uncertainties and are not directly comparable to the speciated PM data.

D.5.6.2.1 Total $PM_{2.5}$ Mass

Daily total $PM_{2.5}$ mass is measured at FRM, IMPROVE, and CSN network monitors, and hourly $PM_{2.5}$ is measured at FRM equivalent and non-FRM monitoring sites. Because only three CSN sites and no IMPROVE network sites are located within the 4-km CAMx modeling domain, some performance statistics are presented here for all monitors within the southeastern U.S. domain shown in **Figure D-29**.[16]

[16] This area corresponds to the high-resolution domain used for the meteorological (WRF) modeling described in **Section D.2**.

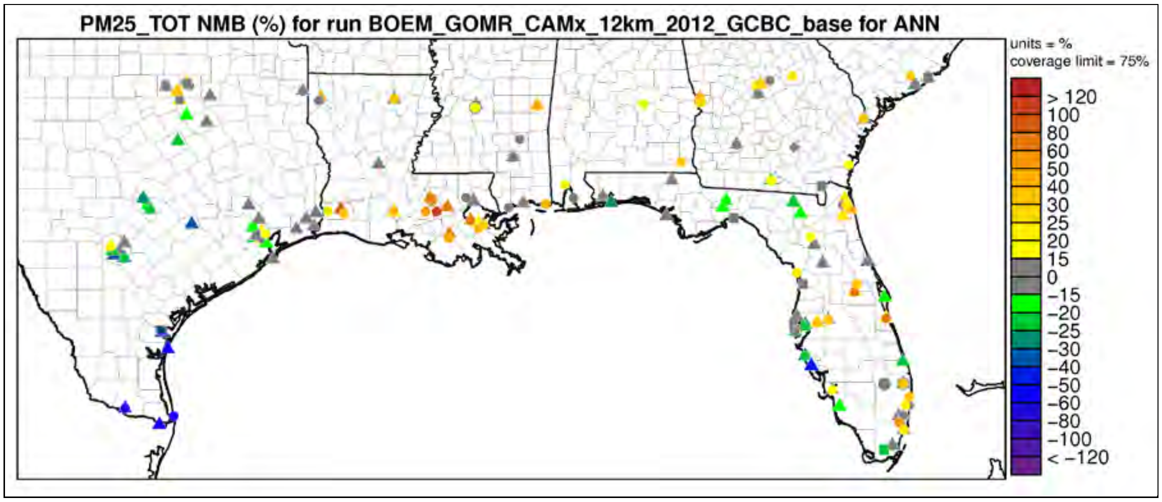


Figure D-29. PM Monitoring Sites in the Southeastern U.S. Domain (triangles – AQS hourly, square – IMPROVE, diamond – CSN, circles – AQS FRM daily).

Figure D-30 displays soccer plots of total $PM_{2.5}$ mass model performance across the FRM, CSN, and IMPROVE monitoring networks in the southeastern U.S. domain. Note that these results are based on 12-km resolution CAMx output. Also shown in the soccer plots are boxes that represent the performance goals for ozone (most inner) and PM (middle), and the PM performance criteria (most outer). Performance for the late fall and winter months (October-February) is characterized by larger positive NMB and higher NME in each network. This bias is somewhat more extreme in the FRM data. Performance results are within or nearly within the PM performance goals except for January and October-December for all networks and within the PM performance criteria for all months at all networks.

As illustrated in **Figure D-31**, over prediction in Q4 appears to be primarily associated with “other $PM_{2.5}$” ($OPM_{2.5}$). Measured OPM likely consists mostly of crustal material (dust) in addition to sea salt. Modeled $OPM_{2.5}$ is defined as the sum of unspeciated PM, crustal material, and sea salt.

Comparisons of particulate OC and EC performance statistics are presented in **Figure D-32**. The NMB and NME are within the PM performance goals with the exception of July and August EC predictions at CSN sites; the over prediction bias is smaller at SEARCH sites. Note that both the SEARCH and CSN networks use the Thermal Optical Reflectance (TOR) method to determine OC and EC.

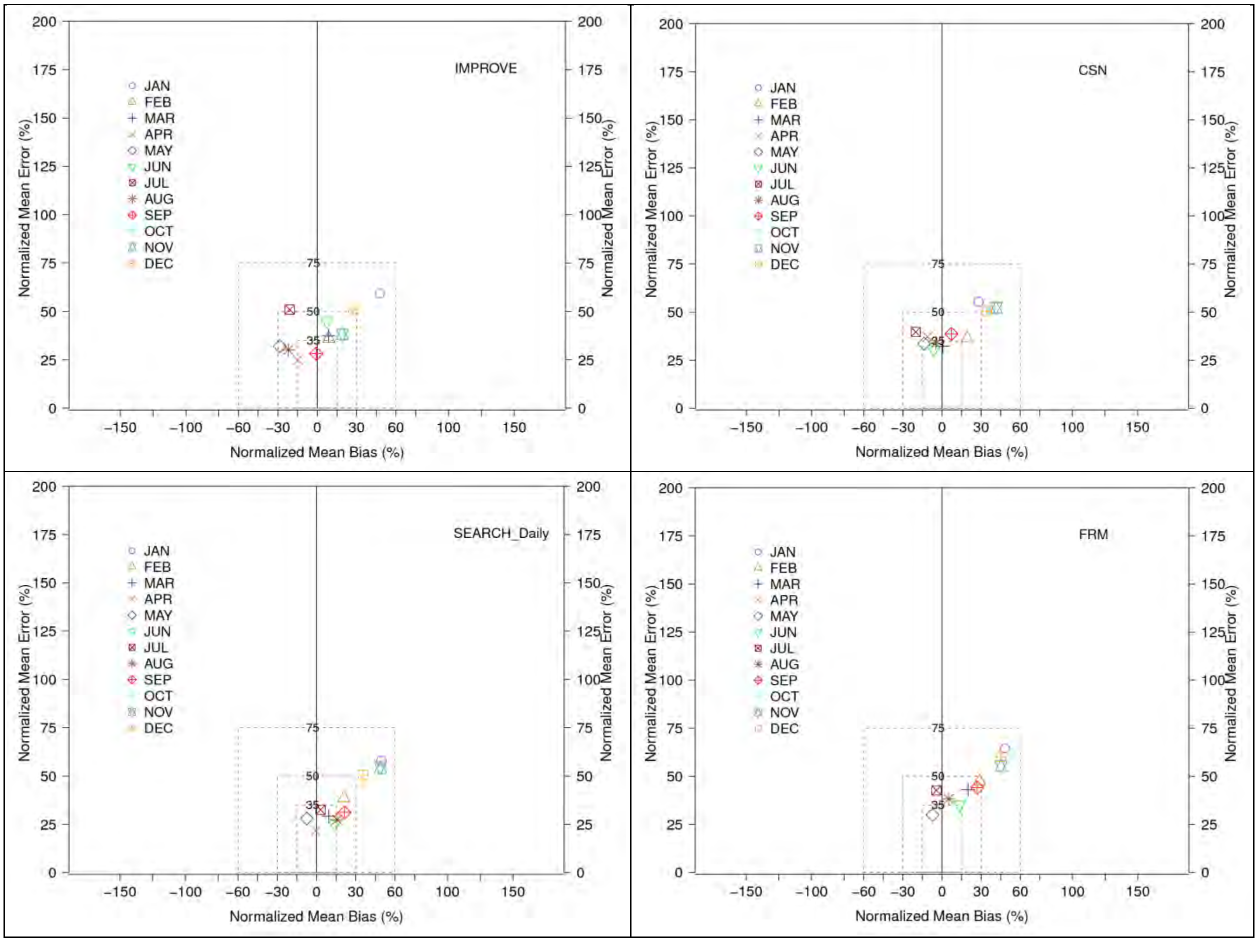


Figure D-30. Soccer Plots of Total $PM_{2.5}$ Mass Model Performance Across the IMPROVE (top left), CSN (top right), SEARCH (bottom left), and FRM Daily (bottom right) Monitoring Networks for Sites in the Southeastern U.S. Domain.

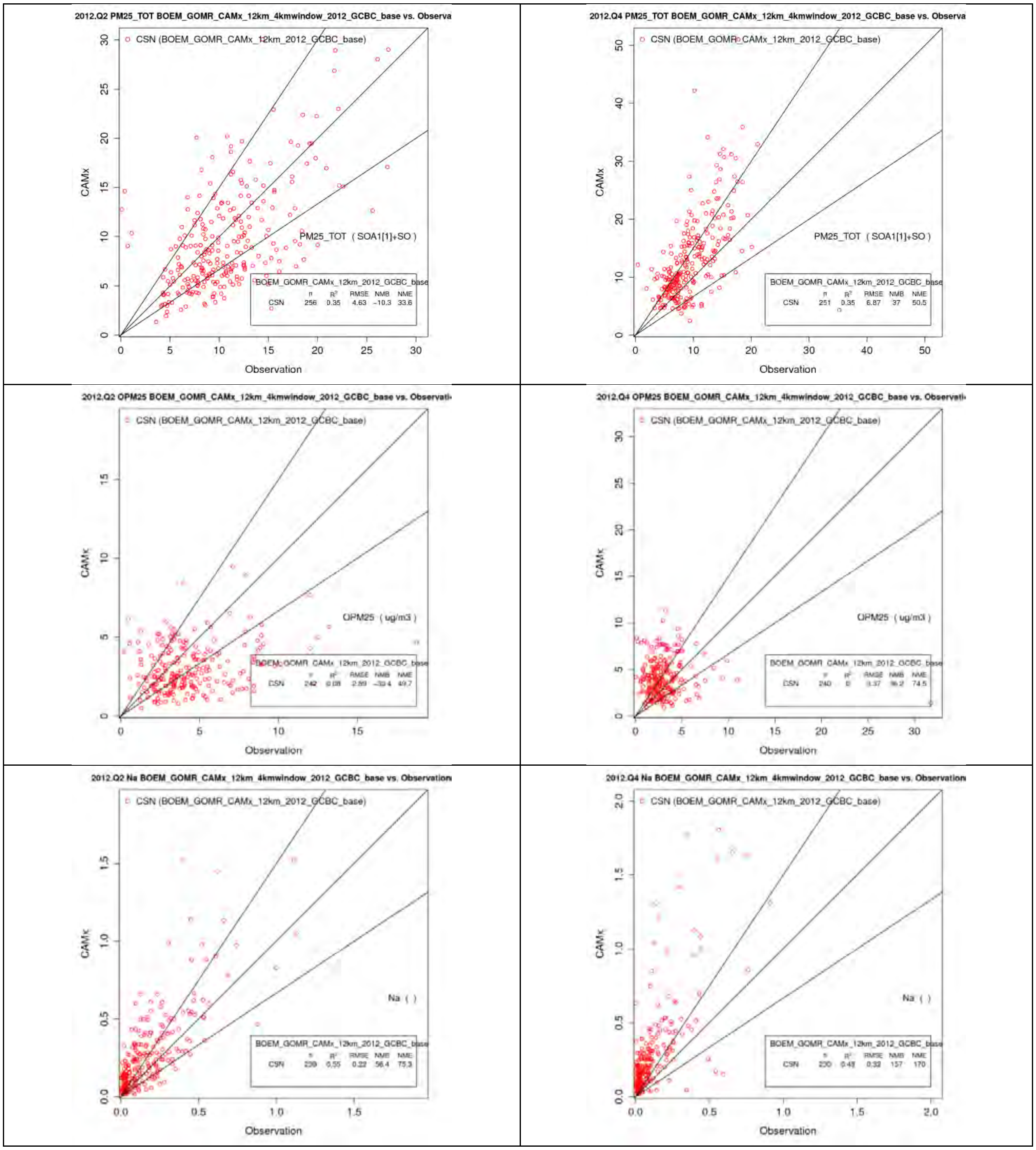


Figure D-31. Comparisons of Predicted with Observed Daily Average PM at CSN Network Sites in the Southeastern U.S. for Q2 (left) and Q4 (right) for Total $PM_{2.5}$ (top), Other $PM_{2.5}$ (middle), and Sodium (bottom).

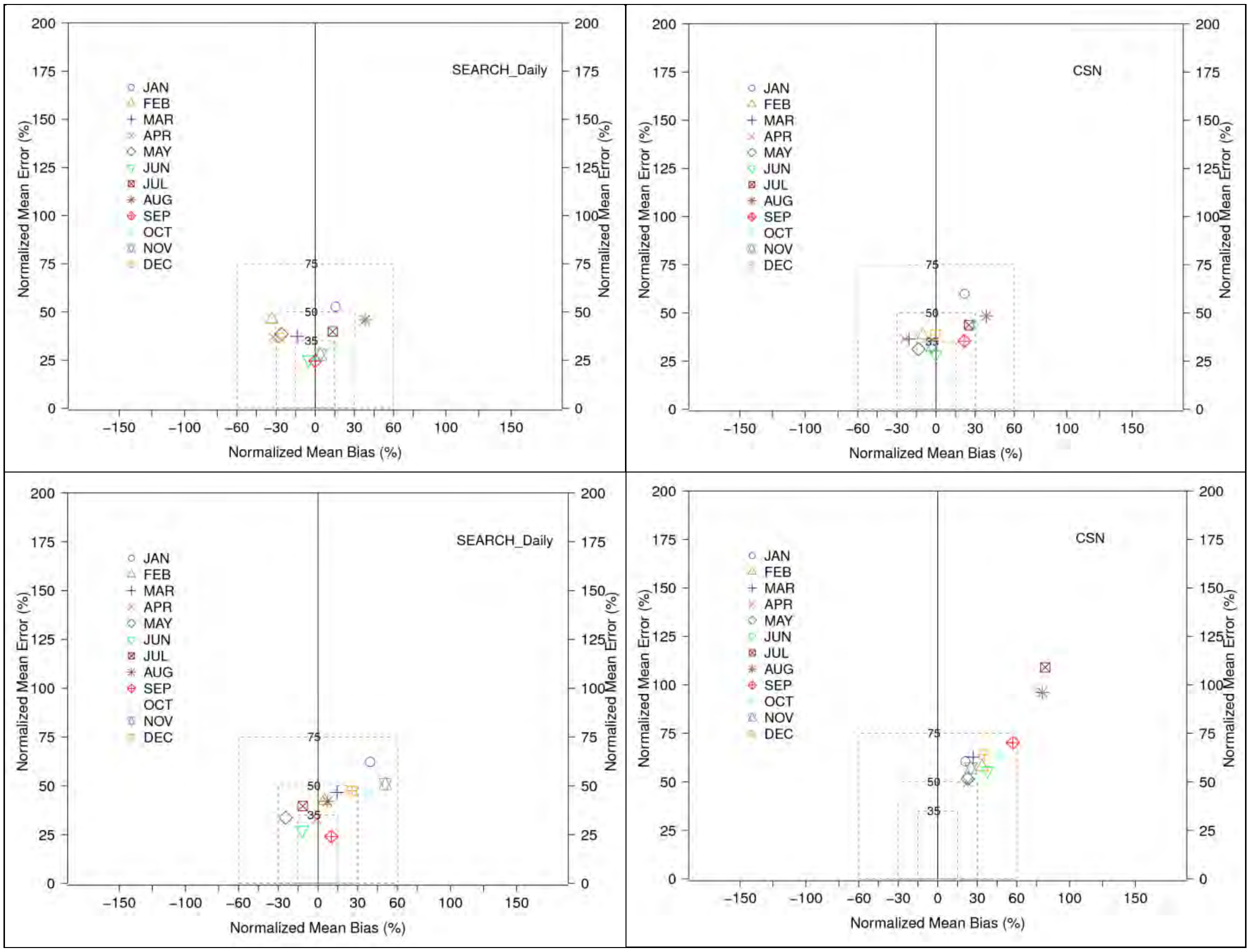


Figure D-32. Comparisons of Observed vs. redicted OC (top) and EC (bottom) at SEARCH (left) and CSN (right) Network Sites in the Southeastern U.S.

D.5.6.2.2 Nitrogen Species (NO_2, NOy, and NO_3)

Soccer plot summaries of NMB and NME for nitrogen species are shown in **Figures D-33 and D-34** for monitoring sites in the 4-km domain. The NO_2, NOy, and particulate NO_3 are over predicted, especially in the summer months. The NO_3 over prediction at coastal sites could be at least partially due to over prediction of sea salt emissions as a result of Cl- ion substitution. This is consistent with under prediction of particulate Cl at some sites despite over prediction of Na. Nitrate deposition biases fall within the performance criteria in all but one month, but errors are large indicating a lack of model precision. Measurement uncertainties may also be contributing to the large errors.

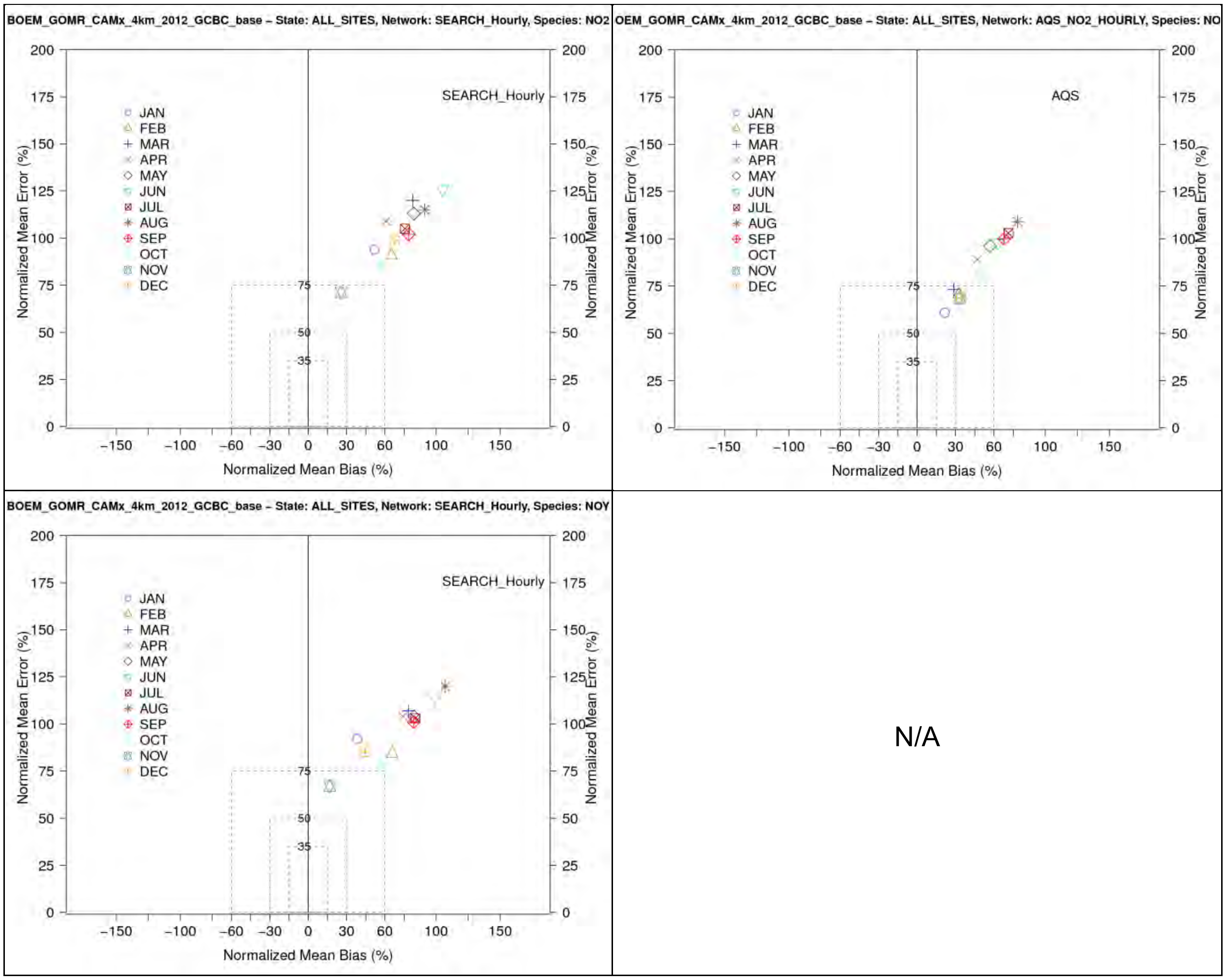


Figure D-33. Monthly Normalized Mean Bias and Normalized Mean Error for Hourly NO_2 (top) and Daily NOy (bottom) at SEARCH Network Sites (left) and AQS Sites (right) in the 4-km Domain.

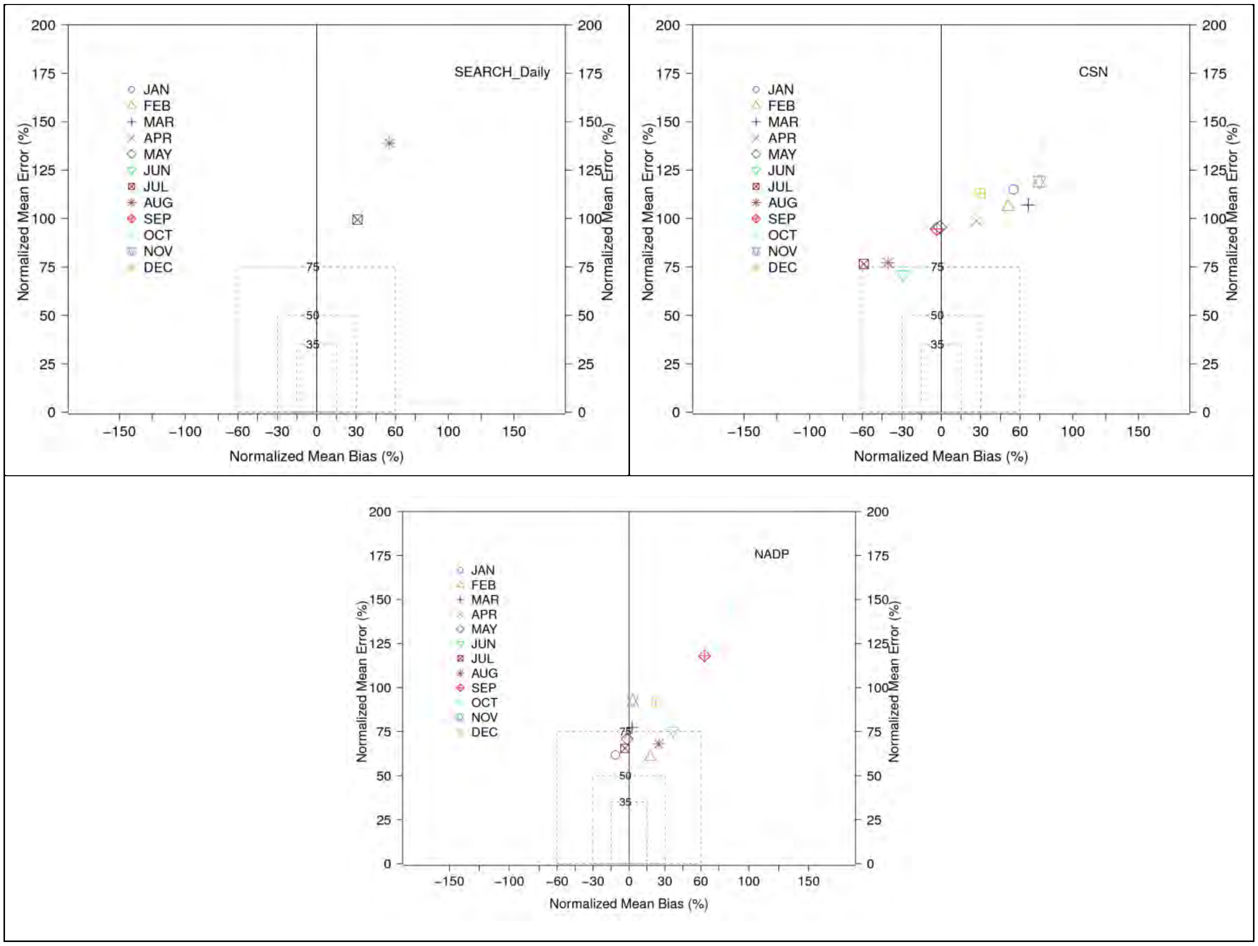


Figure D-34. Monthly Normalized Mean Bias and Normalized Mean Error for NO_3 at SEARCH Network Monitoring Sites (top left) and AQS Sites (top right) and NO_3 Deposition at NADP Sites (bottom) in the Southeastern U.S. (Note: Additional months for SEARCH NO_3 not shown as the NMB and NME exceed the upper axis limits.)

D.5.6.2.3 Sulfur Species (SO_2 and SO_4)

Model performance for hourly SO_2 within the 4-km domain is summarized in terms of monthly NME and NMB in **Figure D-35**. The AQS network SO_2 monitors are typically cited to represent the influence of major utility or industrial SO_2 sources and thus may measure short-term peaks associated with plume impacts from a discrete source. As a result, the timing, location, and magnitudes of peak SO_2 concentrations are not well represented within the 4-km grid modeling results. In addition, monitors near large ports may be influenced by discrete plumes from passing marine vessels, which could be sufficient to cause 1-hour peaks in the monitoring data. Since marine vessel emission inputs to the model are temporally averaged, these discrete events cannot be properly simulated by the model. Given these characteristics of the SO_2 monitoring data, we would expect large 1-hour SO_2 modeling errors as shown in **Figure D-35**, although we would not necessarily expect the positive normalized mean biases that occur in every month.

Over prediction bias of hourly SO_2 at SEARCH network sites seen in the top row of **Figure D-35** is in contrast to lower SO_4 bias shown in the next row. Good performance for SO_4 is also evident at CSN network sites. The SO_4 deposition is under predicted in most months. Reasons for the overall SO_2 over prediction bias at sites in the 4-km domain (top row of **Figure D-33**) are not immediately apparent. Examination of results over all sites in the 12-km domain (**Figure D-36**) shows wide variations in bias from site-to-site, including between sites in the 4-km domain, suggesting that the lower bias in the network average performance statistics in **Figure D-33** are partly the result of over- and under-predictions cancelling each other out.

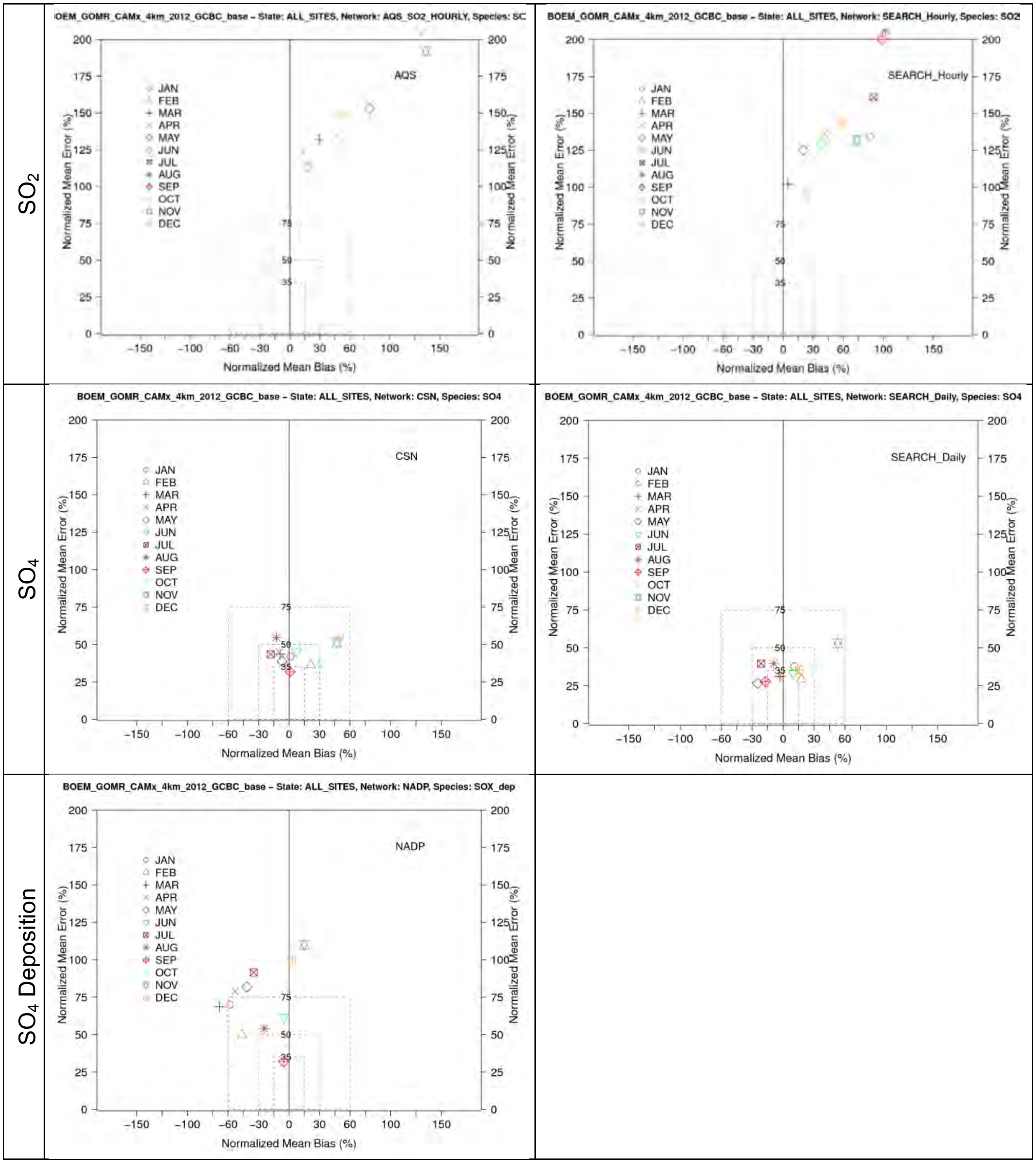


Figure D-35. Monthly Normalized Mean Bias and Normalized Mean Error at Monitoring Sites in the 4-km Domain for SO_2 (top row, AQS sites left panel, SEARCH sites right panel), SO_4 (middle row, CSN sites left panel, SEARCH sites right panel), and SO_4 Deposition Measured at NADP Sites (bottom row).

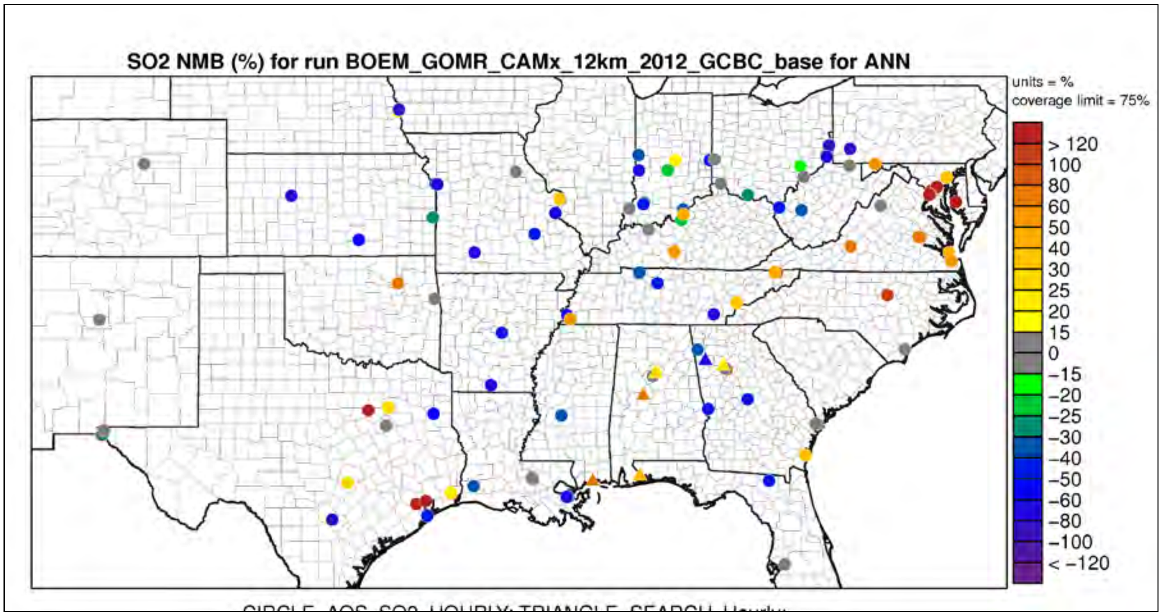
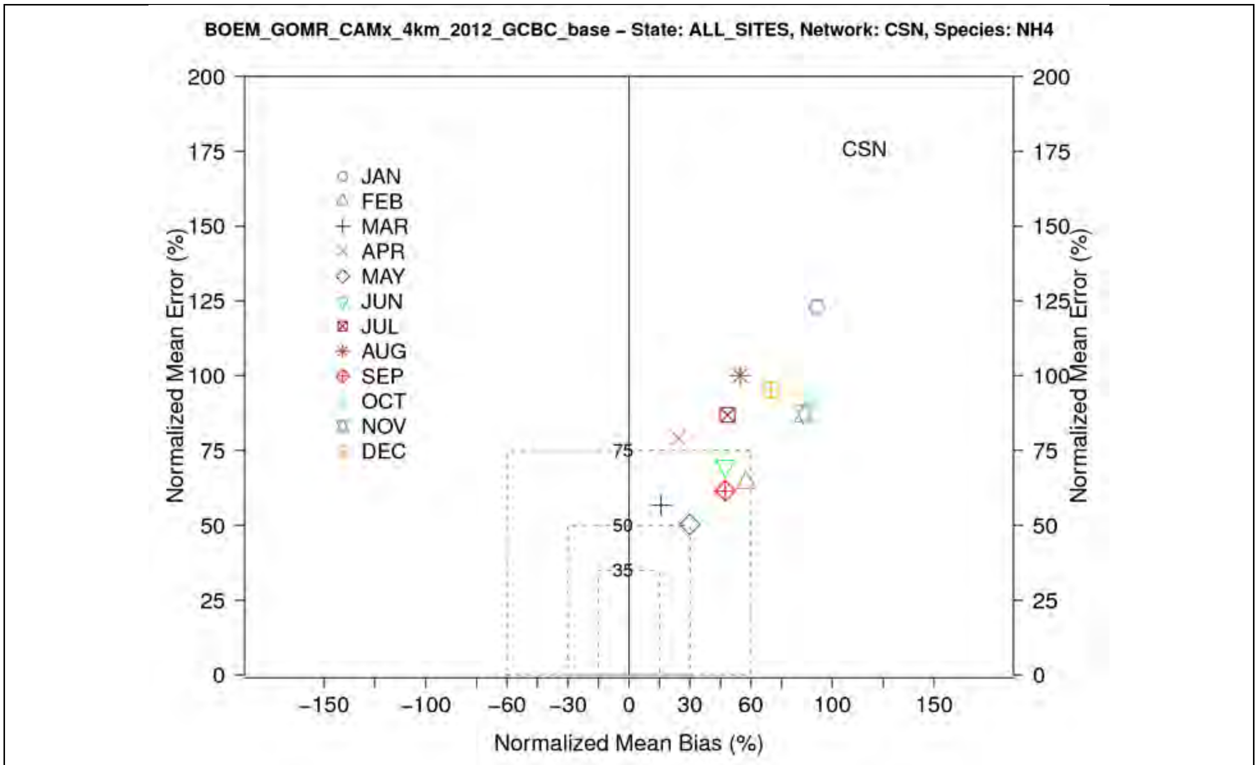


Figure D-36. Annual Normalized Mean Bias for Hourly SO_2 (based on 12-km resolution CAMx results).

D.5.6.2.4 Ammonium (NH_4)

Model performance for particulate ammonium at monitors within the 4-km domain is summarized in terms of monthly NME and NMB in **Figure D-37**. Performance at the two SEARCH network sites falls within the PM criteria bounds, but positive biases and large errors are seen at the three CSN sites. Note that results based on all sites in the southeastern U.S. domain (at 12-km resolution) are very similar. The NH_4 overestimation bias at the CSN sites is likely due to NO_3 over-prediction (**Figure D-34**), as SO_4 is showing biases closer to zero (**Figure D-35**). Examination of individual CSN site results shows acceptable performance at the Houston site (NMB=20%, NME=59%), but large positive biases and errors at the Baton Rouge, Louisiana, and Laurel, Mississippi, monitors.



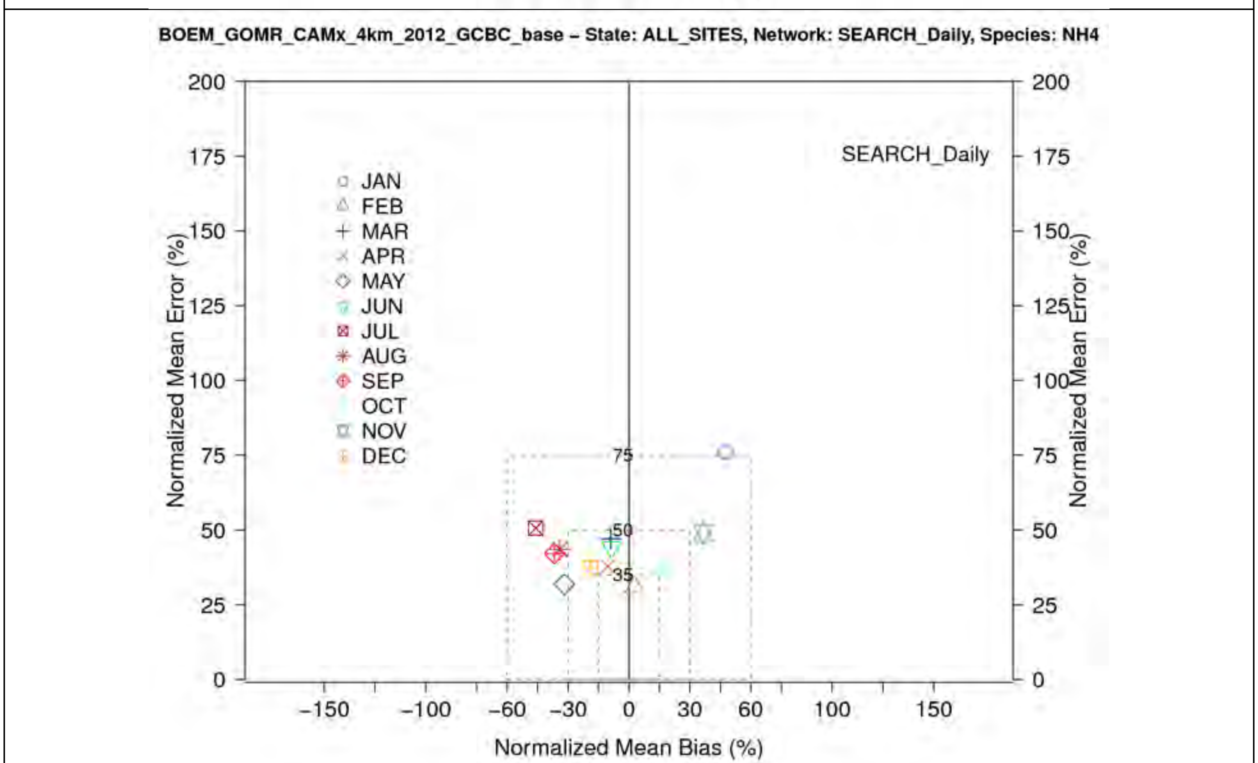


Figure D-37. Monthly Normalized Mean Bias and Normalized Mean Error for Daily Average NH_4 at CSN (top) and SEARCH (bottom) Network Sites in the 4-km Modeling Domain.

D.5.6.2.5 Carbon Monoxide (CO)

Model performance for hourly CO within the 4-km domain is summarized in terms of monthly NME and NMB in **Figure D-38**. Hourly CO is under predicted on average at AQS sites where the influenced of local mobile sources at sub-grid scales is not adequately resolved by the model's 4-km grid resolution; model performance is better at the SEARCH sites, several of which are in rural locations.

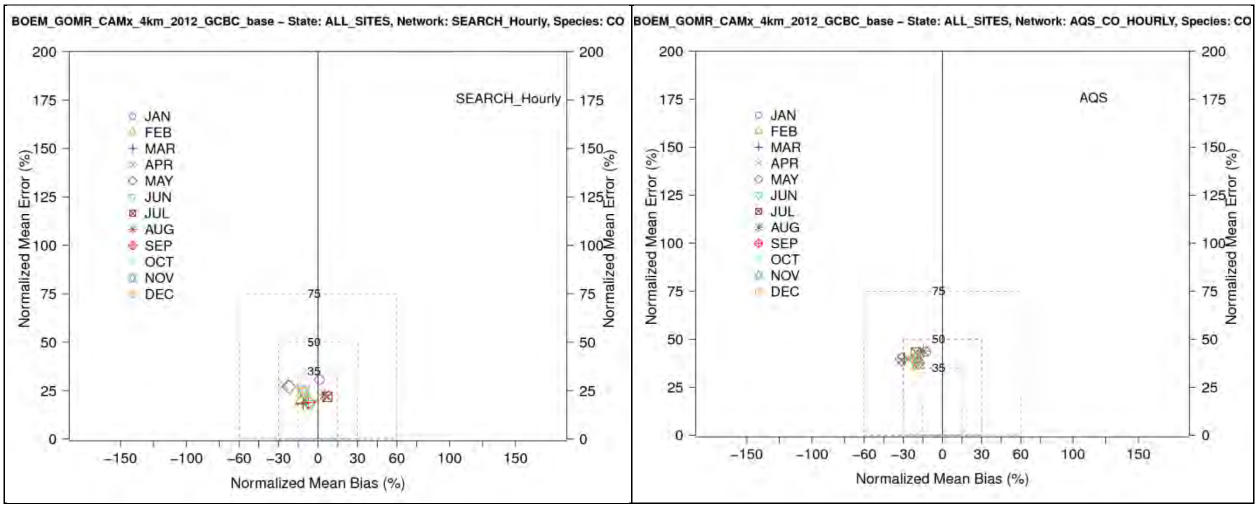


Figure D-38. Monthly Normalized Mean Bias and Normalized Mean Error for Hourly CO at SEARCH Network Sites (left) and AQS Sites (right).

D.6 AIR RESOURCE ASSESSMENT APPROACH

D.6.1 Future Year Modeling

The CAMx was run with the Future Year scenario emissions inventory, including emissions from the 2017-2022 GOM Multisale EIS sources described in **Appendix C**; this Supplemental EIS tiers from the 2017-2022 GOM Multisale EIS. Model results were post-processed for analysis of air quality impacts with respect to the NAAQS and AQRVs; PSD increments were also calculated for information purposes. Source apportionment technology was used to provide estimates of source group impacts, including impacts of potential new sources associated with the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers. Details of the source apportionment and post-processing procedures are presented in this section.

D.6.1.1 Source Apportionment Design

The CAMx Ozone Source Apportionment Technology (OSAT) and Particulate Source Apportionment Technology (PSAT) tools were used to obtain the separate air quality, deposition, and visibility impacts associated with existing and new (2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers) OCS oil and gas development in the GOM, as well as from other emission sources in the GOM and several other source categories as described in **Appendix C**. The CAMx OSAT and PSAT source apportionment tools use reactive tracers that operate in parallel to the host PGM to provide air quality and deposition contributions due to user-selected source groups. The CAMx determines the contributions of emissions from each source category to the total CAMx model concentrations and depositions during the course of the simulation. A detailed description of the CAMx source apportionment tools is available in the CAMx user's guide (ENVIRON, 2014).

The Anthropogenic Precursor Culpability Assessment (APCA) version of the CAMx Ozone Source Apportionment Technology (OSAT) was used in the future year scenario modeling. The APCA differs from OSAT in that it distinguishes between natural and anthropogenic emissions; when ozone is formed due to the interaction of biogenic VOC and anthropogenic NO_x under VOC-limited conditions, a case OSAT would assign the ozone formed to the biogenic VOC, APCA recognizes that biogenic VOC is uncontrollable and re-directs the ozone formed to the anthropogenic NO_x. Thus, APCA only assigns ozone formed to natural emissions when it is due to natural VOC interacting with natural NO_x emissions. The APCA requires that the first source category is always natural emissions. Like OSAT, APCA uses four reactive tracers to track the ozone contributions of each source group: NO_x emissions (Ni); VOC emissions (Vi);and ozone formed under VOC-limited (O_3Vi) and NO_x-limited (O_3Ni) conditions.

For PM, three families of Particulate Source Apportionment Technology (PSAT) source apportionment tracers were used to track contributions of SO_4, NO_3/NH_4, and primary PM that require, respectively, 2, 7, and 6 reactive tracers for each family. Thus, combined APCA/PSAT source apportionment uses 19 reactive tracers to track the contribution of each source category. The Secondary Organic Aerosol (SOA) family of PSAT tracers was not used in the future year scenario source apportionment modeling because (1) only a few specific kinds of VOC species form SOA (i.e., isoprene, terpenes, sesquiterpenes, and aromatics), and these VOCs are mainly emitted by biogenic sources with some aromatic species (e.g., toluene and xylene) emitted by anthropogenic sources (e.g., gasoline combustion) (emissions from oil and gas exploration and production has negligible aromatic VOC emissions); and (2) the chemistry of SOA is quite complex, involving numerous gaseous, semi-volatile, and particulate species so that PSAT requires 21 tracers to track the SOA contributions of each source group (Morris et al., 2015). As a result, including SOA would more than double the number of reactive tracers, resulting in doubling of the computer time needed for the CAMx source apportionment run.

D.6.1.2 Future Year Source Apportionment Simulation

The CAMx 2017 source apportionment simulation was conducted for 1 January to 31 December calendar year over the 12-km southeastern U.S. modeling domain shown in **Figure D-5**. The boundary conditions (BCs) defining inflow concentrations around the lateral boundaries of the 12-km domain were obtained from a future year CAMx simulation of the 36-km continental U.S. (CONUS) domain shown in **Figure D-5**. Both the 36-km and 12-km simulations made use of the same 2012 WRF meteorology and model configuration used in the base case simulation.

D.6.2 Post-Processing of Future Year Source Apportionment Modeling Results

D.6.2.1 Overview

The CAMx future year scenario model and ozone and particulate matter source apportionment modeling outputs were post-processed for comparison against the NAAQS and PSD concentration increments listed in **Table D-14** and other thresholds of concern (TOC), as discussed below. For analyzing NAAQS and AQRV impacts at Class I and sensitive Class II areas, the Thresholds of Concern (TOCs) used were as defined by the Federal Land Manager (FLM) that manages each Class I/II area as prescribed in the June 23, 2011, Memorandum of Understanding (MOU) for evaluating onshore oil and gas AQ/AQRV impacts.[17]

The CAMx source apportionment results for individual source categories were used to evaluate the incremental impacts of each of a set of hierarchical source groups as defined in **Table D-15**. Note that Source Group B represents all new direct emissions associated with the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers, and Source Group C represents these sources in addition to all existing OCS platforms and associated support vessel and aircraft activity. Also note that Source Group E includes Source Groups A-D, along with all other anthropogenic sources, but excludes fires and other natural sources (biogenics, lightning NO_x, sea salt) and the contribution of boundary conditions.

Table D-14. NAAQS and PSD Increments.

Pollutant	Pollutant/Averaging Time	NAAQS	PSD Class I Increment[1]	PSD Class II Increment[1]
CO	1-hour[2]	35 ppm 40,000 μg/m^3	--	--
CO	8-hour[2]	9 ppm 10,000 μg/m^3	--	--
NO_2	1-hour[3]	100 ppb 188 μg/m^3	--	--
NO_2	Annual[4]	53 ppb 100 μg/m^3	2.5 μg/m^3	25 μg/m^3
O_3	8-hour[5]	0.070 ppm 137 μg/m^3	--	--
PM_{10}	24-hour[6]	150 μg/m^3	8 μg/m^3	^{3}0 μg/m^3
PM_{10}	Annual[7]	--	4 μg/m^3	17 μg/m^3
$PM_{2.5}$	24-hour[8]	35 μg/m^3	2 μg/m^3	9 μg/m^3
$PM_{2.5}$	Annual[9]	12 μg/m^3	1 μg/m^3	4 μg/m^3
SO_2	1-hour10	75 ppb 196 μg/m^3		
SO_2	3-hour[11]	0.5 ppm 1,300 μg/m^3	25 μg/m^3	512 μg/m^3
SO_2	24-hour	--	5 μg/m^3	91 μg/m^3
SO_2	Annual[4]	--	2 μg/m^3	20 μg/m^3

[17] http://www.epa.gov/compliance/resources/policies/nepa/air-quality-analyses-mou-2011.pdf

Pollutant	Pollutant/Averaging Time	NAAQS	PSD Class I Increment[1]	PSD Class II Increment[1]

[1] The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
[2] No more than one exceedance per calendar year.
[3] 98th percentile, averaged over 3 years.
[4] Annual mean not to be exceeded.
[5] Fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years, NAAQS promulgated December 28, 2015.
[6] Not to be exceeded more than once per calendar year on average over 3 years.
[7] 3-year average of the arithmetic means over a calendar year.
[8] 98th percentile, averaged over 3 years.
[9] Annual mean, averaged over 3 years, NAAQS promulgated December 14, 2012.
[10] 99th percentile of daily maximum 1-hour concentrations in a year, averaged over 3 years.
[11] No more than one exceedance per calendar year (secondary NAAQS).

Table D-15. Source Group for Incremental Impacts Analysis.

Source Group	Included Source Categories[a]	Comment
A	SC3	New oil and gas platform sources under the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers (w/Action)
B	SC3, SC4	Add support vessels and aircraft associated with new platform sources (w/Action)
C	SC3, SC4, SC5	Add oil and gas platforms and associated support vessels and aircraft under the No Action alternative (existing base case sources)
D	SC3, SC4, SC5, SC6	Add all other marine vessel activity in the GOM, not associated with OCS oil and gas activities
E	SC3, SC4, SC5, SC6, SC7, SC8	Add all other U.S. and non-U.S. anthropogenic sources
F	SC1, SC2, SC8, SC10	Natural and non-U.S. sources (including U.S. sources outside of the 12-km modeling domain)

[a] Refer to **Table D-6**.

D.6.2.2 Comparison against NAAQS

The CAMx future year scenario predicted total concentrations from all emission sources were post-processed for comparison to the applicable NAAQS, as listed in **Table D-14**, in two different ways. First, the CAMx predictions were compared directly against each NAAQS. This is referred to as the "absolute" prediction comparison. These absolute prediction comparisons may be misleading in cases in which the model exhibits significant prediction bias. In recognition of this, USEPA modeling guidance (USEPA, 2007 and 2014) recommends using the model in a relative sense when projecting future year ozone, $PM_{2.5}$, and regional haze levels; and the USEPA has developed the Modeled Attainment Test Software (MATS; Abt., 2014) for making such future year projections. This approach uses the ratio of future year to current year modeling results to develop Relative Response Factors (RRFs) that are applied to observed current year Design Values (abbreviated as either DVC or DVB) to make future year Design Value (DVF) projections (i.e., DVF = DVC x RRF). The MATS was applied to the prediction of both ozone and $PM_{2.5}$ DVFs. The MATS was also used for assessing the cumulative visibility impacts at IMPROVE monitoring sites in the 12-km domain, as discussed in more detail below.

D.6.2.3 Impacts at Class I and Sensitive Class II Areas

The incremental AQ/AQRV contributions associated with emissions from each source group listed in **Table D-15** were calculated at the Class I and sensitive Class II areas shown in **Figure D-39**. The selected areas include all Class I and sensitive Class II areas within the 4-km modeling domain plus additional Class I areas within the 12-km modeling domain.

Table D-16 lists those areas that are located in Gulf Coast or nearby states and thus are of greatest interest to this analysis. Refer to **Section D.7.3.1** for a complete list of all areas shown in **Figure D-39**, along with the results of the visibility analyses.

Receptors for each Class I and sensitive Class II area were defined based on the spatial extent of the Class I/II area defined using shapefiles obtained from the applicable Federal Land Management Agency. A GIS was used to determine the set of grid cells overlapping each area by at least 5%. Model results for the identified grid cells were then used to represent predicted ambient concentrations and deposition in each area.

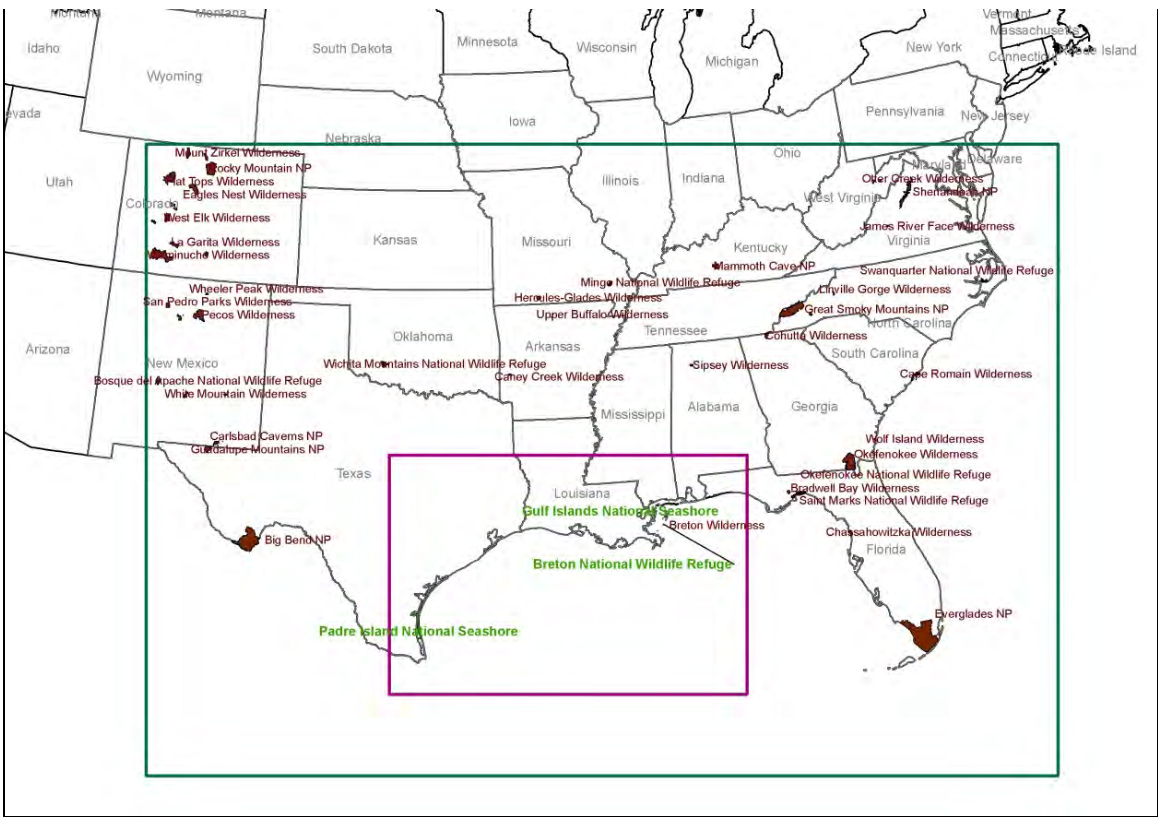


Figure D-39. Class I and Sensitive Class II Areas for Which Incremental AQ/AQRV Impacts Were Calculated.

Table D-16. Class I and Sensitive Class II Areas in Gulf Coast and Nearby States.

Type	Name	Agency[1]	State	Modeling Domain
Class I	Breton Wilderness	FWS	LA	4 km
Class II	Breton NWR	FWS	LA	4 km
Class II	Gulf Islands NS	NPS	MS, FL	4 km
Class II	Padre Island NS	NPS	TX	4 km
Class I	Bradwell Bay	FS	FL	12 km
Class I	St. Marks	FWS	FL	12 km
Class I	Chassahowitzka	FWS	FL	12 km
Class I	Everglades NP	NPS	FL	12 km
Class I	Okefenokee	FWS	GA	12 km
Class I	Wolf Island	FWS	GA	12 km
Class I	Cohutta	FS	GA	12 km
Class I	Sipsey	FS	AL	12 km
Class I	Guadalupe Mountains	NPS	TX	12 km
Class I	Big Bend	NPS	TX	12 km
Class I	Wichita Mountains	FWS	OK	12 km
Class I	Caney Creek	FS	AR	12 km
Class I	Upper Buffalo	FS	AR	12 km

[1] FWS = U.S. Dept. of the Interior, Fish and Wildlife Service; FS = U.S. Dept. of Agriculture, Forest Service; NPS = U.S. Dept. of the Interior, National Park Service; NS = National Seashore; NWR = National Wildlife Refuge.

D.6.2.3.1 Incremental Visibility Impacts

Visibility impacts were calculated for each source group using incremental concentrations as quantified by the CAMx PSAT tool. Changes in light extinction from CAMx model concentration increments due to emissions from each source group were calculated for each day at grid cells representing each Class I and sensitive Class II area. The FLAG (2010) procedures were used in the incremental visibility assessment analysis.

The visibility evaluation metric used in this analysis is based on the haze index (HI), which is measured in deciview (dv) units and is defined as follows:

$$HI = 10 \times \ln[b_{ext}/10]$$

Where b_{ext} is the atmospheric light extinction measured in inverse megameters (Mm^{-1}) and is calculated primarily from atmospheric concentrations of particulates.

A more intuitive measure of haze is visual range (VR), which is defined as the distance at which a large black object just disappears from view, and is measured in km. Visual range is related to b_{ext} by the formula $VR = 3912/b_{ext}$. The advantage of using the HI rather than VR is that a given change in HI is approximately associated with the same degree of <u>perceived</u> change in visibility regardless of the baseline conditions whereas small changes in VR are much more noticeable under clean conditions as compared to hazy conditions.

The incremental concentrations due to each source group were added to natural background extinction in the extinction equation (b_{ext}) and the difference between the haze index with the source group concentrations included and the haze index based solely on natural background concentrations is calculated. This quantity is the change in haze index, which is referred to as “delta deciview” (Δdv):

$$\Delta dv = 10 \times \ln[b_{ext(SC+background)}/10] - 10 \times \ln[b_{ext(background)}/10]$$
$$\Delta dv = 10 \times \ln[b_{ext(SC+background)}/b_{ext(background)}]$$

Here $b_{ext(SCi+background)}$ refers to atmospheric light extinction due to impacts from the source category plus background concentrations, and $b_{ext(background)}$ refers to atmospheric light extinction due to natural background concentrations only.

For each source group, the estimated visibility degradation at the Class I areas and sensitive Class II areas due to the source group are presented in terms of the number of days that exceed a threshold change in deciview (Δdv) relative to background conditions. The number of days with a deciview greater than 0.5 and 1.0 are reported.

IMPROVE Reconstructed Mass Extinction Equations

The FLAG (2010) procedures for evaluating visibility impacts at Class I areas use the revised IMPROVE reconstructed mass extinction equation to convert PM species in μg/m^3 to light extinction (b_{ext}) in inverse megameters (Mm^{-1}) as follows:

$$b_{ext} = b_{SO4} + b_{NO3} + b_{EC} + b_{OCM} + b_{Soil} + b_{PMC} + b_{SeaSalt} + b_{Rayleigh} + b_{NO2}$$

where

$b_{SO4} = 2.2 \times f_S(RH) \times$ [Small Sulfate] $+ 4.8 \times f_L(RH) \times$ [Large Sulfate]

$b_{NO3} = 2.4 \times f_S(RH) \times$ [Small Nitrate] $+ 5.1 \times f_L(RH) \times$ [Large Nitrate]

$b_{OCM} = 2.8 \times$ [Small Organic Mass] $+ 6.1 \times$ [Large Organic Mass]

$b_{EC} = 10 \times$ [Elemental Carbon]

$b_{Soil} = 1 \times$ [Fine Soil]

$b_{CM} = 0.6 \times$ [Coarse Mass]

$b_{SeaSalt} = 1.7 \times f_{SS}(RH) \times$ [Sea Salt]

$b_{Rayleigh}$ = Rayleigh Scattering (Site-specific)

$b_{NO2} = 0.33 \times [NO_2$ (ppb)] {or as: $0.1755 \times [NO_2$ (μg/m^3)]}.

f(RH) are relative humidity adjustment factors that account for the fact that sulfate, nitrate, and sea salt aerosols are hygroscopic and are more effective at scattering solar radiation at higher relative humidity. FLAG (2010) recommends using monthly average f(RH) values rather than the hourly averages recommended in the previous FLAG (2000) guidance document in order to moderate the effects of extreme weather events on the visibility results.

The revised IMPROVE equation treats "large sulfate" and "small sulfate" separately because large and small aerosols affect an incoming beam of light differently. However, the IMPROVE measurements do not separately measure large and small sulfate; they measure only the total $PM_{2.5}$ sulfate. Similarly, CAMx writes out a single concentration of particulate sulfate for each grid cell. Part of the definition of the new IMPROVE equation is a procedure for calculating the large and small sulfate contributions based on the magnitude of the model output sulfate concentrations; the procedure is documented in FLAG (2010).[18] The sulfate concentration magnitude is used as a surrogate for distinguishing between large and small sulfate concentrations. For a given grid cell, the large and small sulfate contributions are calculated from the model output sulfate (which is the "Total Sulfate" referred to in the FLAG [2010] guidance) as

For Total Sulfate <20 μg/m^3:

$$[\text{Large Sulfate}] = ([\text{Total Sulfate}] / 20\ \mu g/m^3) \times [\text{Total Sulfate}]$$

For Total Sulfate ≥20 μg/m^3:

$$[\text{Large Sulfate}] = [\text{Total Sulfate}]$$

For all values of Total Sulfate:

$$[\text{Small Sulfate}] = [\text{Total Sulfate}] - [\text{Large Sulfate}]$$

The procedure is identical for nitrate and organic mass.

The PSAT source apportionment algorithm does not separately track NO_2 concentrations but instead tracks total reactive nitrogen (RGN) that consists of NO, NO_2, and other reactive nitrogen compounds (e.g., N_2O_5, HONO, etc.). Thus, for each hour and each grid cell representing a Class I/II area, a source group's incremental PSAT RGN contribution is converted to NO_2 by multiplying by the total (all emissions) CAMx model NO_2/RGN concentration ratio. Note that this same procedure is also used for contributions to NO_2 concentrations.

Although sodium and particulate chloride are treated in the CAMx core model, these species are not carried in the CAMx PSAT tool. This does not affect the calculations of visibility impacts from individual source groups other than impacts from the natural source category (SC2).

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[18] http://www.nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf

Predicted daily average modeled concentrations due to each source group for receptor grid cells containing Class I and sensitive Class II areas were processed using the revised IMPROVE reconstructed mass extinction equation FLAG (2010) to obtain changes in bext at each sensitive receptor area that are converted to deciview and reported.

Annual average natural conditions for each Class I area were obtained from Table 6 in FLAG (2010) and monthly relative humidity factors for each Class I area from Tables 7-9 in FLAG (2010). The Δdv was calculated for each grid cell that overlaps a Class I or sensitive Class II area by 5% or more for each day of the annual CAMx run. The highest Δdv across all grid cells overlapping a Class I or sensitive Class II area by at least 5% was selected to represent the daily value at that Class I/II area. Visibility impacts due to emissions from each source group that exceed the 0.5 and 1.0 Δdv thresholds are noted.

Cumulative Visibility Impacts

The cumulative visibility impacts of the 2017-2022 GOM Multisale EIS, from which this Supplemental EIS tiers, were assessed following the recommendations from the U.S. Dept. of the Interior's Fish and Wildlife Service (FWS) and NPS (USDOI, FWS and USDOI, NPS, official communication, 2012). This approach is based on an abbreviated regional haze rule method that estimates the future year visibility at Class I and sensitive Class II areas for the average of the Worst 20% (W20%) and Best 20% (B20%) visibility days with and without the effects of the source group emissions on visibility impairment. The cumulative visibility impacts used CAMx model output from the 2012 Base Year and 2017 Future Year emissions scenarios in conjunction with monitoring data to produce cumulative visibility impacts at each Class I and sensitive Class II area. The USEPA's Modeled Attainment Test Software (MATS[19]) was used to make the 2017 visibility projections for the W20% and B20% days. The basic steps in the recommended cumulative visibility method are as follows (USDOI, FWS and USDOI, NPS, official communication, 2012):

(1) Calculate the observed average 2012 current year cumulative visibility impact using the haze index (HI, in deciviews) at each Class I area using representative IMPROVE measurement data to determine the 20% of days with the worst and 20% of days with the best visibility. The MATS is designed to use 5 years of monitoring data centered on the base case year, which for 2012 would include 2010-2014. However, MATS only includes IMPROVE monitoring data through 2012, so the 2008-2012 5-year period was used to define the visibility baseline conditions in the MATS visibility projections.

(2) Estimate the relative response factors (RRFs) for each component of $PM_{2.5}$ and for coarse mass (CM) corresponding to the new IMPROVE visibility algorithm using the CAMx 2012 and 2017 model output. The RRFs are based on the

[19] http://www.epa.gov/ttn/scram/modelingapps_mats.htm

average concentrations across a 3 x 3 array of 4-km grid cells centered on the IMPROVE monitoring site location.

(3) Using the RRFs and ambient data, calculate 2017 future year daily concentration data for the B20% and W20% days using the CAMx 2012 base case and 2017 standard model concentration estimates and PSAT source apportionment modeling results two ways:

(a) 2017 Total Emissions: Use total 2017 CAMx concentration results due to all emissions;

(b) 2017 No Cumulative Emissions: Use PSAT source apportionment results to eliminate contributions of PM concentrations associated with each source group.

(4) Use the information in Step 3 to calculate the average 2017 visibility for the 20% Best and 20% Worst visibility days and the 2017 emissions.

5. Assess the average differences in cumulative visibility impacts for each source group and also compare with the future and current observed Baseline visibility conditions.

Because of the need for IMPROVE observations, monitoring data from nearby Class I areas were used to represent areas without any IMPROVE monitors.

D.6.2.3.2 Sulfur and Nitrogen Deposition

The CAMx-predicted wet and dry fluxes of sulfur- and nitrogen-containing species were processed to estimate total annual sulfur and nitrogen deposition values at each Class I and sensitive Class II area. The maximum annual sulfur and nitrogen deposition values from any grid cell that intersects a Class I receptor area was used to represent deposition for that area, in addition to the average annual deposition values of all grid cells that represent a Class I receptor area. Although the convention in the past has been to report just the maximum deposition in any receptor in a Class I/II area, since deposition relates to the total amount deposited across an entire watershed, the average metric may be considered a more relevant parameter for evaluating potential environmental effects. Maximum and average predicted sulfur and nitrogen deposition impacts are reported separately for each source group.

Nitrogen deposition impacts were calculated by taking the sum of the nitrogen contained in the fluxes of all nitrogen species modeled by the CAMx PSAT source apportionment tool. The CAMx species used in the nitrogen deposition flux calculation are reactive gaseous nitrate species, RGN (NO, NO_2, NO_3 radical, HONO, N_2O_5), TPN (PAN, PANX, PNA), organic nitrates (NTR), particulate nitrate formed from primary emissions plus secondarily formed particulate nitrate (NO_3), gaseous nitric acid (HNO_3), gaseous ammonia (NH_3), and particulate ammonium (NH_4). The CAMx species used in the sulfur deposition calculation are primarily sulfur dioxide emissions (SO_2) and particulate sulfate ion from primary emissions plus secondarily formed sulfate (SO_4).

FLAG (2010) recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas. This guidance recognizes the importance of establishing critical deposition loading values ("critical loads") for each specific Class I area as these critical loads are completely dependent on local atmospheric, aquatic, and terrestrial conditions and chemistry. Critical load thresholds are essentially a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. FLAG (2010) does not include any critical load levels for specific Class I areas and refers to site-specific critical load information on FLM websites for each area of concern. This guidance does, however recommend the use of deposition analysis thresholds (DATs [20]) developed by the NPS and FWS. The DATs represent screening level values for nitrogen and sulfur deposition for individual projects with deposition impacts below the DATS considered negligible. A DAT of 0.005 kilograms per hectare per year (kg/ha/yr) for both nitrogen and sulfur deposition has been established for both nitrogen and sulfur deposition in western Class I areas. A DAT of 0.01 kg/ha/yr has been established for both nitrogen and sulfur deposition for areas in the eastern U.S. As a screening analysis, results for Source Group B (new platforms and associated support vessels and aircraft associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers) were compared to the DATs. Comparison of deposition impacts from cumulative sources to the DAT is not appropriate.

For the 2012 base case and the combined source groups and total 2012 and future year emissions, the annual nitrogen and sulfur deposition were compared against critical load values established by the Federal Land Management agencies. Published nitrogen critical load values for areas managed by the NPS[21] include minimum critical loads of 3 kg/ha/yr at the Gulf Islands National Seashore, as well as at Guadalupe Mountains and Big Bend, and 5 kg/ha/yr at Padre Island National Seashore and Everglades National Park. These values represent the minimum of the critical loads for each biological community type (i.e., forests, herbaceous plants, lichen, mycorrhizal fungi, and nitrate leaching). Nitrogen and sulfur critical load values for areas managed by the U.S. Dept. of Agriculture's Forest Service (USFS) include 5 kg/ha/yr at Bradwell Bay, Cohutta, Sipsey, Caney Creek and Upper Buffalo. The 5 kg/ha/yr critical load value for these areas applies separately to nitrogen and to sulfur deposition. As no separate critical load values for sulfur are available from the NPS areas, the sulfur critical loads were set equal to the values for nitrogen. No published critical load values were found for areas managed by the FWS; critical loads for these areas were set by reference to the NPS and USFS critical loads based on proximity and similarity of ecoregion types. Using this approach, both nitrogen and sulfur critical loads for the Breton Wilderness, Breton National Wildlife Refuge, St. Marks, Chassahowitzka, Okefenoke, and Wolf Island were set at 3 kg/ha/yr based on the Gulf Islands National Seashore value for Eastern Temperate Forests. The values for Wichita Mountains was set at 5 kg/ha/yr based on the NPS' Chickasaw National Recreation Area Great Plains ecoregion value.

[20] http://www.nature.nps.gov/air/Pubs/pdf/flag/nsDATGuidance.pdf
[21] http://www.nature.nps.gov/air/Studies/criticalloads/Ecoregions/index.cfm

D.6.2.4 PSD Increments

The maximum contribution of new oil and gas emissions in the Gulf of Mexico under the 2017-2022 GOM Multisale EIS scenario were reported for each Class I and sensitive Class II area and were compared against the PSD increments given in **Table D-14**. Under the Clean Air Act, a PSD increment consumption analysis requires major stationary sources subject to PSD review to demonstrate that emission increases from the proposed source, in conjunction with all other emissions increases or reductions in the impacted area (typically within 50 kilometers), will not cause or contribute to concentrations of air pollutants that exceed PSD increments. The PSD increments have been established for NO_x, SO_2, and PM in Class I and Class II areas. Actions to be authorized by BOEM under the 2017-2022 GOM Multisale EIS scenario do not typically constitute major stationary sources and do not typically trigger PSD permits or review. However, a comparison of ambient concentrations from an accumulation of new oil and gas sources within the entire study area to PSD increments at specific Class I and Class II areas is included in this analysis for information purposes. This information is presented to aid State agencies in tracking the potential minor source increment consumption and to aid Federal Land Managers or Tribal governments responsible for protecting air resources in Class I areas. This Supplemental EIS tiers from the 2017-2022 GOM Multisale EIS and uses the scenario and alternatives analyzed in the 2017-2022 GOM Multisale EIS.

D.7 AIR RESOURCE ASSESSMENT RESULTS

D.7.1 NAAQS Impacts

Future year CAMx modeling results were used to examine future air quality relative to the NAAQS and the individual contributions of each source group relative to the NAAQS. For the ozone and $PM_{2.5}$ NAAQS, comparisons are presented both in terms of the "absolute" CAMx results and in terms of using the base case and future year CAMx results in a relative sense to scale the observed base ("current" or "base") year design value (DVC or DVB) to obtain the projected future year design value (DVF) as recommended by the USEPA's modeling guideline (USEPA, 2007 and 2014) and as described in **Section D.6.2.2.**

D.7.1.1 Ozone NAAQS Analysis using Relative Model Results

The USEPA's Model Attainment Test Software (MATS) was used to make future year ozone DVF projections using the CAMx 2012 base case and future year scenario modeling results as described in **Section D.6.2.2.** The MATS was used to make DVF projections at the locations of ambient air monitoring sites as well as throughout the 4-km modeling domain using the MATS Unmonitored Area Analysis (UAA) procedures.

D.7.1.1.1 Monitored Ozone Design Value Projections using MATS

The MATS results for the future year ozone design values (DVFs) at individual ambient air monitoring sites in the 4-km domain are listed in **Tables D-17 and D-18**. Updated MATS data files containing ozone design values up through 2014 were obtained from the USEPA.[22] To make future year projections, MATS starts with a current year design value (DVC) that is based on an average of three ozone design values from the 5-year period centered on the base case modeling year, which was 2012 for this analysis. Thus, MATS DVCs are based on ozone design values from the 2010-2012, 2011-2013, and 2012-2014 periods. The MATS makes ozone DVF projections using the changes in daily maximum 8-hour ozone concentrations near (3 x 3 array of 4-km grid cells) a monitor using the ratio of future year to current year modeling results to scale the observed DVCs. These modeled derived scaling factors are called Relative Response Factors (RRFs; DVF = DVC x RRF). The RRFs are based on the 10 highest modeled ozone days above a threshold ozone concentration. A lower bound observed ozone threshold value of 50 ppb was used in MATS.

Of the 74 monitors with valid DVCs as calculated by MATS, 39 have DVCs exceeding the NAAQS (70 ppb). The DVFs are less than DVCs at all 74 sites. A total of 22 sites have predicted DVFs exceeding the MATS, all of which are among the sites with DVCs above the NAAQS.

Contributions of each source group to the DVFs were calculated as the difference between the DVF calculated from the CAMx results with all sources included and a revised DVF calculated after first subtracting out the individual hourly contributions of each source group in the future year model run. These source group contributions are tabulated in **Table D-18**. The maximum contribution from Source Group A (new platforms associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers) is 0.5 ppb. The maximum contribution from Source Group B (new platforms and support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers) is 5.1 ppb.

Five sites in Texas and one in Louisiana were identified where the contribution of the new platforms and associated support vessels and aircraft under the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group B) to the DVF was enough to push the DVF from just below the 70-ppb NAAQS (with Source Group B contributions removed) to just above the NAAQS when all sources were included (**Table D-19**). In each case, the “contribution” from Source Group B is less than 5 ppb. At each of these sites, the DVCs are all also greater than 70 ppb as noted above. At the Galveston, Texas, monitor, the 0.3-ppb contribution of Source Group A (new platforms) alone was sufficient to bump the future year design value from just below the NAAQS to just above the NAAQS (recall comparisons to the 70 ppb NAAQS are made after truncating design values to the nearest ppb).

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[22] https://www3.epa.gov/scram001/modelingapps_mats.htm

For the ozone impacts assessment, please note that the states will not designate under the 2015 ozone standard of 70 ppb until 2017, with the earliest attainment date of March 2021 for marginal areas. For this impacts assessment, the non-OCS source emissions were based on the USEPA's 2017 emission projections, with a future modeled year of 2017 and compared to the 70-ppb standard. This assessment is assuming the standard will be attained way before the actual attainment date, but it wanted to give maximum OCS oil and gas impacts under the new 70 ppb ozone standard.

Table D-17. Current Year (DVC) and Future Year (DVF) Ozone Design Values at Ambient Air Monitoring Sites within the 4-km Modeling Domain from MATS.

Site ID	Site Name	State	County	DVC	DVF
10030010	FAIRHOPE HIGH SCHOOL, FAIRHOPE, ALABAMA	AL	Baldwin County	68	66.2
10970003	CHICKASAW, MOBILE CO., ALABAMA	AL	Mobile County	67.3	64.4
10972005	BAY RD. ,MOBILE AL.	AL	Mobile County	72	66.5
120330004	ELLYSON INDUSTRIAL PARK-COPTER ROAD	FL	Escambia County	67.7	65.1
120330018	NAS PENSACOLA	FL	Escambia County	70.7	68.1
120910002	720 Lovejoy Rd	FL	Okaloosa County	65	62.9
121130015	1500 WOODLAWN WAY	FL	Santa Rosa County	69.3	67.4
220050004	11153 Kling Road	LA	Ascension Parish	71.3	67.8
220190002	HIGHWAY 27 AND HIGHWAY 108	LA	Calcasieu Parish	70.7	68.9
220190008	2646 John Stine Road	LA	Calcasieu Parish	66.7	64.7
220190009	2284 Paul Bellow Road	LA	Calcasieu Parish	70	67.3
220330003	EAST END OF ASTER LANE	LA	East Baton Rouge Parish	75.3	71.3
220330009	1061-A Leesville Ave	LA	East Baton Rouge Parish	72.3	68.3
220330013	11245 Port Hudson-Pride Rd. Zachary, La	LA	East Baton Rouge Parish	69	65.1
220470009	65180 Belleview Road	LA	Iberville Parish	70.3	64.6
220470012	HIGHWAY 171, CARVILLE	LA	Iberville Parish	73.3	68.6
220511001	West Temple Pl	LA	Jefferson Parish	71.3	68.4
220550007	646 Cajundome	LA	Lafayette Parish	69.7	67.2
220570004	Nicholls University Farm Highway 1	LA	Lafourche Parish	71	65.7
220630002	Highway 16, French Settlement	LA	Livingston Parish	72.3	68.6
220710012	Corner of Florida Ave & Orleans Ave	LA	Orleans Parish	68.3	66.5
220770001	TED DAVIS RESIDENCE. HIGHWAY 415	LA	Pointe Coupee Parish	74	68.2
220870004	4101 Mistrot Dr. Meraux, LA 70075	LA	St. Bernard Parish	68	64.4
220890003	1 RIVER PARK DRIVE	LA	St. Charles Parish	67.7	65.2
220930002	ST. JAMES COURTHOUSE, HWY 44 @ CANAPELLA	LA	St. James Parish	66.3	62.7
220950002	Anthony F. Monica Street	LA	St. John the Baptist Parish	72	69.3
221030002	1421 Hwy 22 W, Madison Ville, LA 70447	LA	St. Tammany Parish	72.3	68.7

Site ID	Site Name	State	County	DVC	DVF
221210001	1005 Northwest Drive, Port Allen	LA	West Baton Rouge Parish	68	63.8
280450003	400 Baltic St	MS	Hancock County	66.3	63.4
280470008	47 Maple Street	MS	Harrison County	70.3	67
280590006	Hospital Road at Co. Health Dept.	MS	Jackson County	71.3	69.2
480271047	1605 Stone Tree Drive	TX	Bell County	73.7	71
				80.3	78
				68.7	66.3
480391004	4503 CROIX PKWY	TX	Brazoria County	85	81.9
480391016	109 B BRAZORIA HWY 332 WEST	TX	Brazoria County	69.3	66.8
480610006	344 PORTER DRIVE	TX	Cameron County	60.7	59.2
				69.3	66.6
481671034	9511 AVENUE V ½	TX	Galveston County	75.3	71.2
482010024	4510 1/2 ALDINE MAIL RD.	TX	Harris County	76.7	75.1
482010026	1405 SHELDON ROAD	TX	Harris County	73	71.2
482010029	16822 KITZMAN	TX	Harris County	80	76.3
482010046	7330 1/2 NORTH WAYSIDE	TX	Harris County	73.7	71.6
482010047	4401 1/2 LANG RD.	TX	Harris County	77	74.8
482010051	13826 1/2 CROQUET	TX	Harris County	78.7	76.3
482010055	6400 BISSONNET STREET	TX	Harris County	78.7	77.3
482010062	9726 1/2 MONROE	TX	Harris County	76.7	74.4
482010066	3333 1/2 HWY 6 SOUTH	TX	Harris County	77.7	75.2
482010070	5425 POLK AVE., SUITE H	TX	Harris County	75	73.5
482010416	7421 PARK PLACE BLVD	TX	Harris County	77.3	74.8
482011015	1001 B LYNCHBURG ROAD	TX	Harris County	71	68.5
482011034	1262 1/2 MAE DRIVE	TX	Harris County	78	76.1
482011035	9525 CLINTON DR	TX	Harris County	74.7	72.5
482011039	4514 1/2 DURANT ST.	TX	Harris County	78.3	75.5
482011050	4522 PARK RD.	TX	Harris County	76.3	74
482151048	325 Golf Course Road	TX	Hidalgo County	60	58.1
482450009	1086 Vermont Avenue	TX	Jefferson County	71.7	68.3
482450011	800 EL VISTA ROAD & 53RD STREET	TX	Jefferson County	74	70.5
482450022	12552 SECOND ST.	TX	Jefferson County	70.3	66.7
482450101	6019 MECHANIC	TX	Jefferson County	75	72.3
482450102	SETRPC 43 Jefferson Co Airport	TX	Jefferson County	67	64.4
482450628	UNAVAILABLE	TX	Jefferson County	69.3	66.4
482451035	Seattle Street	TX	Jefferson County	69.3	66.9
483091037	4472 MAZANEC RD	TX	McLennan County	71.7	69.1
483390078	9472 A HWY 1484	TX	Montgomery County	78	74.7
483491051	Corsicana Airport	TX	Navarro County	70	68.2
483550025	CORPUS CHRISTI STATE SCHOOL, AIRPORT RD	TX	Nueces County	69.3	68.2
483550026	9860 LA BRANCH	TX	Nueces County	68.3	66.2
483611001	2700 AUSTIN AVE	TX	Orange County	69.3	66.5

Site ID	Site Name	State	County	DVC	DVF
483611100	INTERSECTION OF TX HWYS 62 AND 12	TX	Orange County	68	65.4
484530014	3724 NORTH HILLS DR, AUSTIN, TX 78758	TX	Travis County	71.3	67.7
484530020	12200 LIME CREEK RD.	TX	Travis County	71.7	68.3
484690003	106 MOCKINGBIRD LANE	TX	Victoria County	66.3	64.2

Table D-18. Ozone Current (DVC) and Future Year (DVF) Design Values and Reduction in DVF with Contributions from Individual Source Groups Removed.

Site ID	State	County	DVC	DVF	Change in DVF with Source Group Removed				
					A	B	C	D	E
10030010	AL	Baldwin County	68	66.2	0.3	4.7	7.6	10.2	42.6
10970003	AL	Mobile County	67.3	64.4	0.1	2.3	4.2	5.4	40.4
10972005	AL	Mobile County	72	66.5	0.1	5.1	6.5	7.9	44.7
120330004	FL	Escambia County	67.7	65.1	0.3	1.7	5.5	7.4	35.3
120330018	FL	Escambia County	70.7	68.1	0.4	2.6	7.8	10.9	37.8
120910002	FL	Okaloosa County	65	62.9	0.3	1.9	6.8	9.5	33.6
121130015	FL	Santa Rosa County	69.3	67.4	0.5	2.6	9.3	12.7	37.5
220050004	LA	Ascension Parish	71.3	67.8	0.1	0.7	2.3	3.1	43.6
220190002	LA	Calcasieu Parish	70.7	68.9	0.3	2	5.6	8.3	40.2
220190008	LA	Calcasieu Parish	66.7	64.7	0.3	1.7	4.9	7.4	37.6
220190009	LA	Calcasieu Parish	70	67.3	0.2	1.5	4.2	6.1	39.7
220330003	LA	East Baton Rouge Parish	75.3	71.3	0.1	0.7	2.9	4	45.3
220330009	LA	East Baton Rouge Parish	72.3	68.3	0.1	0.7	2.6	3.7	43.3
220330013	LA	East Baton Rouge Parish	69	65.1	0.2	1	3.2	4.3	37.7
220470009	LA	Iberville Parish	70.3	64.6	0	0.2	0.7	1.1	41.2
220470012	LA	Iberville Parish	73.3	68.6	0	0.4	1.5	2.3	45.7
220511001	LA	Jefferson Parish	71.3	68.4	0.2	1.1	5.2	6.6	45
220550007	LA	Lafayette Parish	69.7	67.2	0.1	1.4	3.9	5.6	41.5
220570004	LA	Lafourche Parish	71	65.7	0.1	0.5	1.7	2.4	40.9
220630002	LA	Livingston Parish	72.3	68.6	0.2	1.1	4.4	5.9	44.3
220710012	LA	Orleans Parish	68.3	66.5	0.3	1.2	5.6	7.2	42
220770001	LA	Pointe Coupee Parish	74	68.2	0	0.5	2	3	43.7
220870004	LA	St. Bernard Parish	68	64.4	0.3	1.4	5.5	7.2	41.1
220890003	LA	St. Charles Parish	67.7	65.2	0.1	0.6	2.5	3.3	44.7
220930002	LA	St. James Parish	66.3	62.7	0.1	0.5	2.1	2.8	39.3
220950002	LA	St. John the Baptist Parish	72	69.3	0.2	0.9	3.5	4.6	45
221030002	LA	St. Tammany Parish	72.3	68.7	0.2	1.1	5	6.3	42.9
221210001	LA	West Baton Rouge Parish	68	63.8	0	0.5	2.1	2.9	40
280450003	MS	Hancock County	66.3	63.4	0.3	1.6	5.3	7.1	39.9
280470008	MS	Harrison County	70.3	67	0.3	1.7	5.4	7.3	42.8
280590006	MS	Jackson County	71.3	69.2	0.4	2.7	6	8.9	44.9

Site ID	State	County	DVC	DVF	Change in DVF with Source Group Removed				
					A	B	C	D	E
480271047	TX	Bell County	73.7	71	0	0.3	0.9	1.2	30.9
			80.3	78	0	0.3	0.9	1.3	37.4
			68.7	66.3	0.1	0.2	0.4	0.5	33.3
480391004	TX	Brazoria County	85	81.9	0.1	0.7	2.2	3.1	49.5
480391016	TX	Brazoria County	69.3	66.8	0.2	1.3	3.4	4.8	37.4
480610006	TX	Cameron County	60.7	59.2	0.2	1.3	2.4	3.3	29.2
			69.3	66.6	0.1	0.2	0.3	0.5	29.9
481671034	TX	Galveston County	75.3	71.2	0.3	3.6	9.8	16.6	46.6
482010024	TX	Harris County	76.7	75.1	0.2	1.5	4	5.8	44.1
482010026	TX	Harris County	73	71.2	0.2	1.6	4.1	5.9	42.1
482010029	TX	Harris County	80	76.3	0.2	1.1	3.3	4.8	48
482010046	TX	Harris County	73.7	71.6	0.2	1.3	3.4	4.9	41.8
482010047	TX	Harris County	77	74.8	0.2	1	3	4.4	46
482010051	TX	Harris County	78.7	76.3	0.1	0.6	1.8	2.6	47.5
482010055	TX	Harris County	78.7	77.3	0.1	0.8	2.4	3.3	46.9
482010062	TX	Harris County	76.7	74.4	0.2	1.1	3.1	4.5	45.3
482010066	TX	Harris County	77.7	75.2	0.1	0.7	2.2	3.1	46.6
482010070	TX	Harris County	75	73.5	0.2	1.3	3.4	5	41.6
482010416	TX	Harris County	77.3	74.8	0.1	1.2	3.1	4.6	44.4
482011015	TX	Harris County	71	68.5	0.2	1.3	3.7	5.3	39.1
482011034	TX	Harris County	78	76.1	0.3	1.7	4.1	5.9	44.3
482011035	TX	Harris County	74.7	72.5	0.2	1.3	3.3	5	41.7
482011039	TX	Harris County	78.3	75.5	0.2	1.3	3.4	5.1	42.8
482011050	TX	Harris County	76.3	74	0.3	2.2	5.8	9.1	43.5
					0.1	0.6	1.5	2.2	27.5
482151048	TX	Hidalgo County	60	58.1	0.1	0.6	1.4	2	24.3
482450009	TX	Jefferson County	71.7	68.3	0.1	0.7	2	2.9	42.2
482450011	TX	Jefferson County	74	70.5	0.2	1.9	4.9	7.2	43.9
482450022	TX	Jefferson County	70.3	66.7	0.1	0.8	2.4	3.5	40.3
482450101	TX	Jefferson County	75	72.3	0.3	3	8.2	12.4	45.9
482450102	TX	Jefferson County	67	64.4	0.2	1.3	4.1	6	40
482450628	TX	Jefferson County	69.3	66.4	0.2	2	5.3	7.8	41.8
482451035	TX	Jefferson County	69.3	66.9	0.2	1.5	4.5	6.7	41.9
483091037	TX	McLennan County	71.7	69.1	0	0.2	0.5	0.7	31.3
483390078	TX	Montgomery County	78	74.7	0.2	1	3.1	4.5	45.8
483491051	TX	Navarro County	70	68.2	0.1	0.2	0.6	0.8	33.5
483550025	TX	Nueces County	69.3	68.2	0.3	1.9	5.4	7.4	35
483550026	TX	Nueces County	68.3	66.2	0.3	1.3	3.6	4.9	32.7
483611001	TX	Orange County	69.3	66.5	0.1	1.4	4.8	6.9	41.3
483611100	TX	Orange County	68	65.4	0.1	1.5	4.6	6.9	40
484530014	TX	Travis County	71.3	67.7	0	0.2	0.9	1.3	37.5
484530020	TX	Travis County	71.7	68.3	0.1	0.3	1	1.4	35.8
484690003	TX	Victoria County	66.3	64.2	0.2	1	3	4.2	32.6

Table D-19. MATS Ozone Design Value Results for All Monitoring Sites Where Exclusion of Contributions from Source Group A or B is Sufficient to Reduce the Predicted Future Design Value (DVF) from Above the NAAQS to Below the NAAQS (all values in ppb).

Site ID	Location	State	DVC[1]	DVF[2]	DVF_A[3]	DVF – DVF_A	DVF_B[3]	DVF – DVF_B
220330003	East Baton Rouge Parish	LA	75.3	71.3	71.2	0.1	70.6	0.7
480271047	Bell County	TX	73.7	71.0	71.0	0.0	70.7	0.3
481671034	Galveston	TX	75.3	71.2	70.9	0.3	69.1	4.9
482010026	Houston	TX	73	71.2	71.0	0.2	69.6	1.6
482010046	Houston	TX	73.7	71.6	71.4	0.2	70.3	1.3
482450101	Port Arthur	TX	75	72.3	72.0	0.3	69.3	3.0

[1] The MATS base period ozone design value (ppb) representing combined contributions of all sources.
[2] The MATS future year ozone design value (ppb) representing combined contributions of all sources.
[3] The MATS future year ozone design value (ppb) calculated after removing source apportionment contributions of Source Group A or B.

Figure D-40 displays the MATS Unmonitored Area Analysis (UAA) results, which were generated using the observed ozone data in MATS and the base year and future year scenario CAMx results. The MATS UAA spatially interpolates the DVCs obtained from observations across the modeling domain and then calculates the DVF for each model grid cell by multiplying the interpolated DVC by the RRF value (i.e., the ratio of the modeled future year to base year design values) in each grid cell. Future year design values calculated using the MATS UAA procedure are lower than base year design values throughout most of the 4-km modeling domain with the exception of a maximum 1.6-ppb increase of less than 3 ppb off the Louisiana coast.

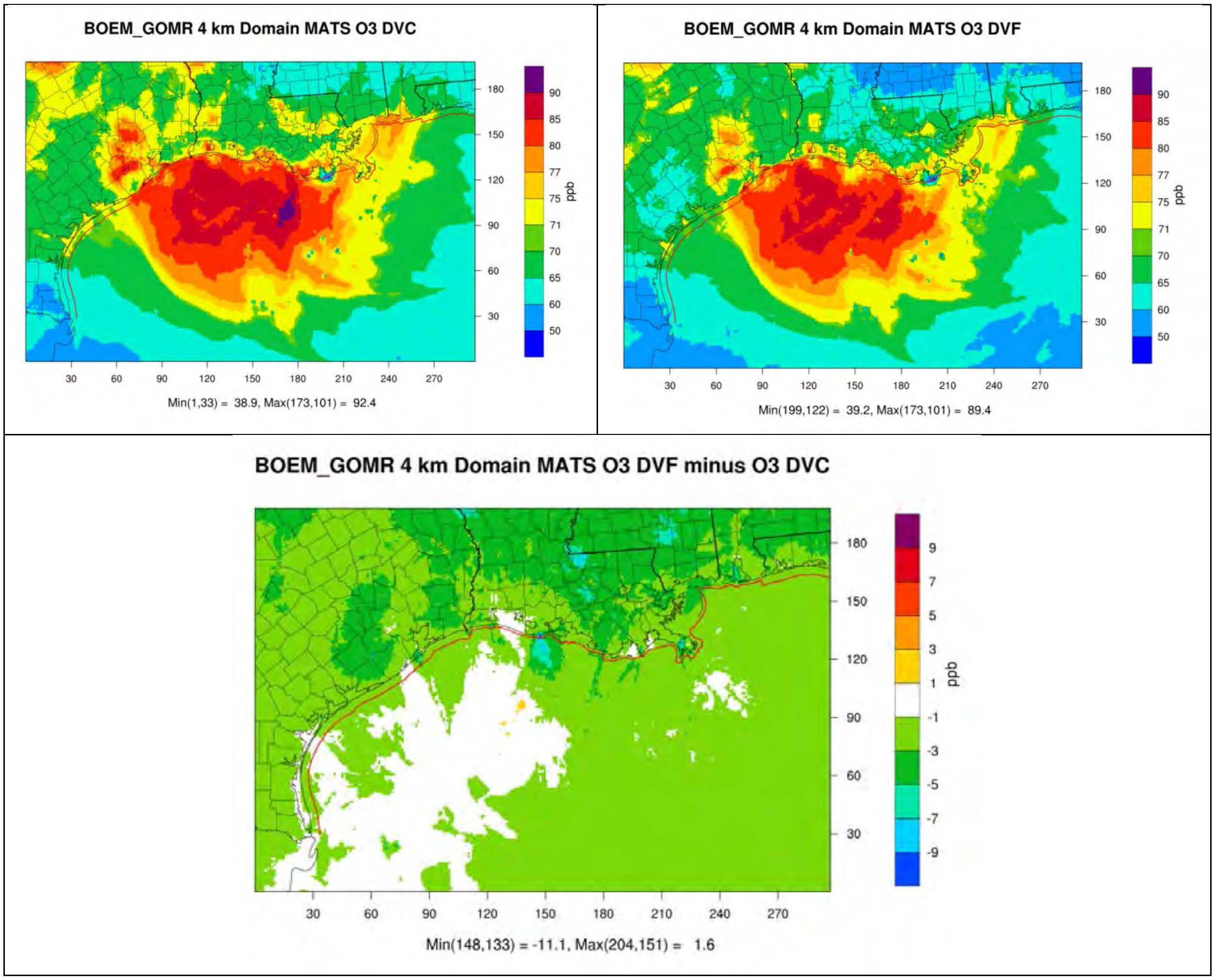


Figure D-40. Base Scenario Ozone Design Values (DVC, top left), Future Year Ozone Design Values (DVF, top right) and Their Differences (DVF – DVC; bottom) Calculated Using the MATS UAA Tool.

D.7.1.1.2 Ozone MATS Unmonitored Area Analysis

The MATS UAA DVF values calculated after first removing the hourly contributions from Source Groups A (new platforms), B (new platforms and associated support vessels and aircraft), and D (all Gulf of Mexico sources) are shown in the left column of **Figure D-41**. The contributions of Source Groups A, B, and D calculated as the difference between these DVF values and the DVF values from all sources (as shown in the upper right-hand corner of **Figure D-40**) are shown in the right column of **Figure D-41**. Source Group A contributions are centered in the Gulf of Mexico offshore of Louisiana, with a peak impact of 2.2 ppb; maximum impacts from the State seaward boundaries inland are in the 1- to 1.2-ppb range along the coast of Cameron Parish. For Source Group B, the maximum contribution (10.8 ppb) is in approximately the same location, but the support vessel and helicopter activities result in greater impacts landward of the State seaward boundary, with maximum contributions in the 6- to 7-ppb range.

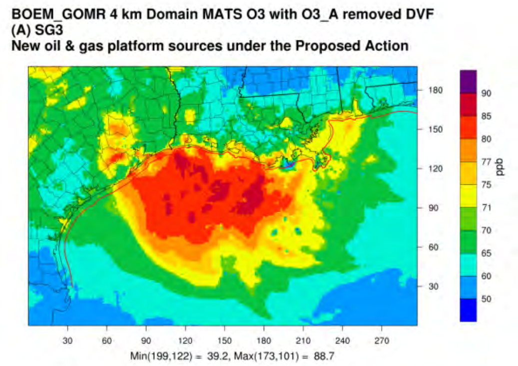
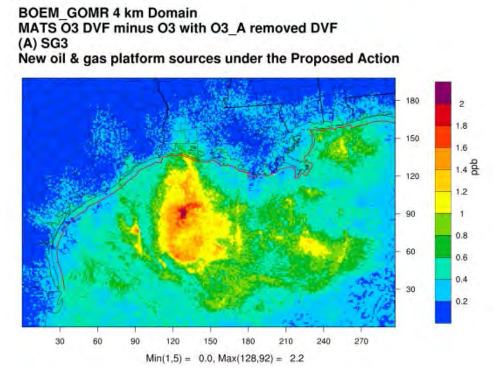
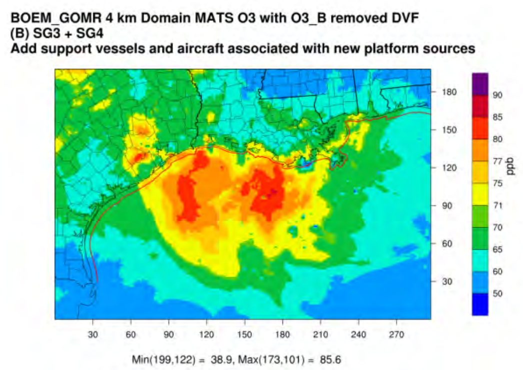
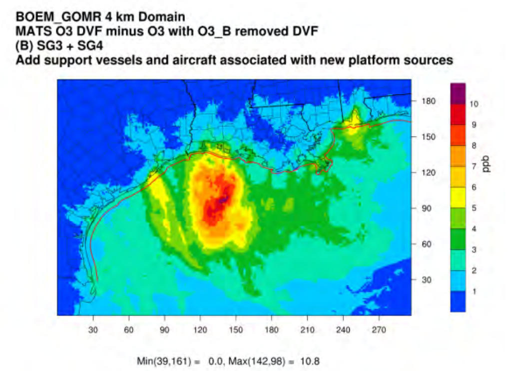
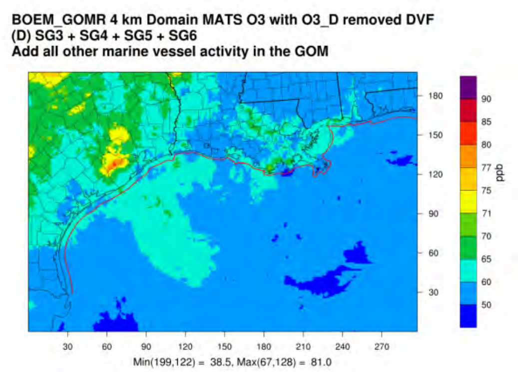
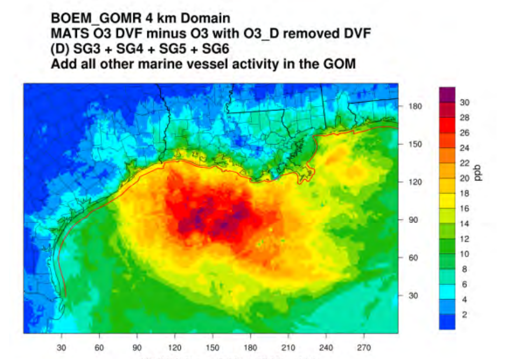
<table>
<tr><th>Source Group[1]</th><th>DVF with Source Group Contribution Removed</th><th>Source Group Contribution[2]</th></tr>
<tr><td>A</td><td>
</td><td>
</td></tr>
<tr><td>B</td><td>
</td><td>
</td></tr>
<tr><td>D</td><td>
</td><td>
</td></tr>
<tr><td colspan="3">[1] As defined in Table D-14.
[2] Source group contributions are calculated by subtracting the DVF values calculated after removing the hourly source group contributions from the DVF values calculated when all sources are included.</td></tr>
</table>

*Figure D-41. MATS UAA Future Year Ozone Design Values (DFV) Calculated After First Removing the Hourly Contributions from a Source Group (left column) and the Corresponding Contributions of the Source Group to DVF (right column) Calculated by Subtracting the DVFs Shown in the Left-hand Column from the "All Sources" DVF Shown in the Top Right-hand Corner of **Figure D-40**. Top row – source group B; middle row – source group D.*

D.7.1.2 Ozone NAAQS Analysis Using Absolute Modeling Results

The CAMx source apportionment absolute modeling results from the future year scenario are analyzed and compared with the ozone NAAQS in this section. The ozone NAAQS is defined as the 3-year average of the 4th highest maximum daily average 8-hour (MDA_8) ozone concentration. Since only one calendar year of modeling results are available for the base year and future year scenarios, the future year 4th highest MDA_8 ozone concentration is used as a pseudo-NAAQS comparison metric.

Modeled 4th highest MDA_8 values in each model grid cell for the base and future year scenarios and the corresponding differences are shown in **Figure D-42**. Similar to the MATS results presented in **Figure D-40**, the 4th highest MDA_8 is lower under the future year scenario throughout most of the 4-km domain, with isolated areas of increases of less than 4 ppb located off the coasts of Louisiana and Texas and onshore in Cameron Parish, Louisiana.

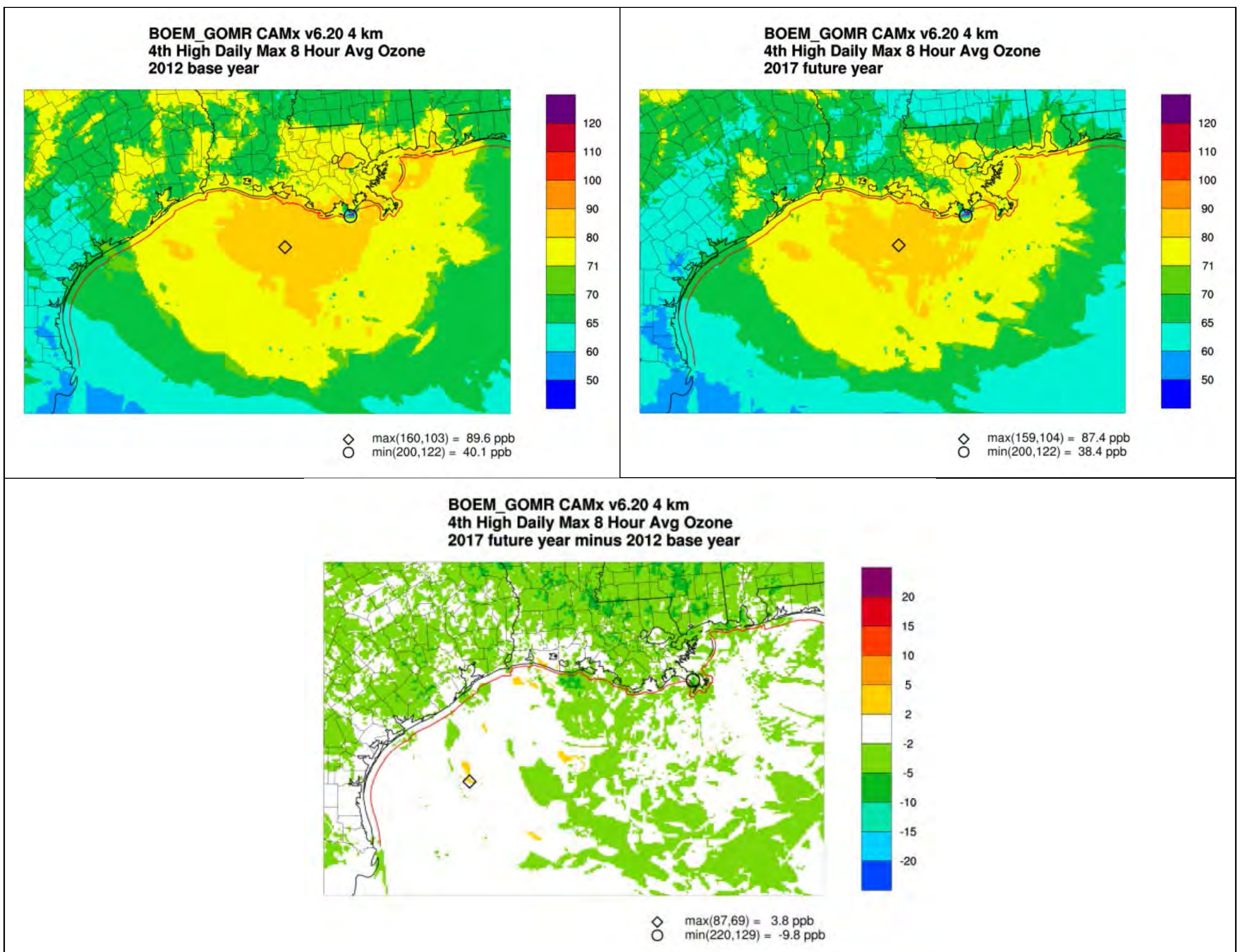


Figure D-42. Modeled 4th Highest MDA_8 Ozone for the Base Year (upper left) and Future Year (upper right) Scenarios and Their Differences (bottom center).

Contributions of each source group to the all sources future year 4th highest MDA_8 values shown in the upper right-hand panel of **Figure D-42** are shown in **Figures D-43 and D-44**. These contributions are matched in time to the all sources 4th highest MDA_8 values; contributions may be different during other periods with elevated MDA_8 values. As shown in **Figure D-43**, new platform sources under the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group A) are estimated to contribute as much as 7.4 ppb to design values out over the Gulf of Mexico. Within the states out to the State Seaward Boundary (SSB), the contributions range from near zero to approximately 3 ppb, with the maximum contributions occurring along the coast of Cameron Parish, Louisiana. Contributions increase by about 10 ppb when contributions from support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers, are added in (Source Group B). Also, adding in all existing platforms and support vessels and helicopters (Source Group C) raises the maximum contribution out over the Gulf of Mexico to nearly 38 ppb. Contributions landward of the SSB are generally below 15 ppb but with some areas along the Louisiana coast reaching maximum contributions up to 35 ppb. Adding in all other marine vessel activity in the Gulf of Mexico (Source Group D) only increases the contributions by a few ppb. The addition of land-based and Mexican and Canadian anthropogenic sources (Source Group E) results in source contributions that are typically about 30 ppb higher than the contributions from Gulf of Mexico sources alone (Source Group D). Contributions over the land areas are higher than for Source Group D although the highest contributions remain out over the Gulf of Mexico where biogenic emissions have minimal influence. In other words, to the extent that elevated ozone levels are predicted over the Gulf of Mexico, they are nearly entirely attributable to anthropogenic sources.

Contributions from natural sources (including biogenics and fires) and non-U.S. emissions, including 12-km domain boundary conditions (Source Group F), are shown in the left panel of **Figure D-44**; contributions from just the boundary conditions (BCs) are shown in the right panel. These results show an area south of Galveston where ozone design values were almost entirely driven by U.S. or Mexican anthropogenic BCs; however, over the rest of the Gulf of Mexico, including the near coastal areas, contributions are generally between 20 and 30 ppb and are overwhelmingly attributable to the BCs. Higher contributions are seen inland where biogenic sources play a larger role in ozone formation.

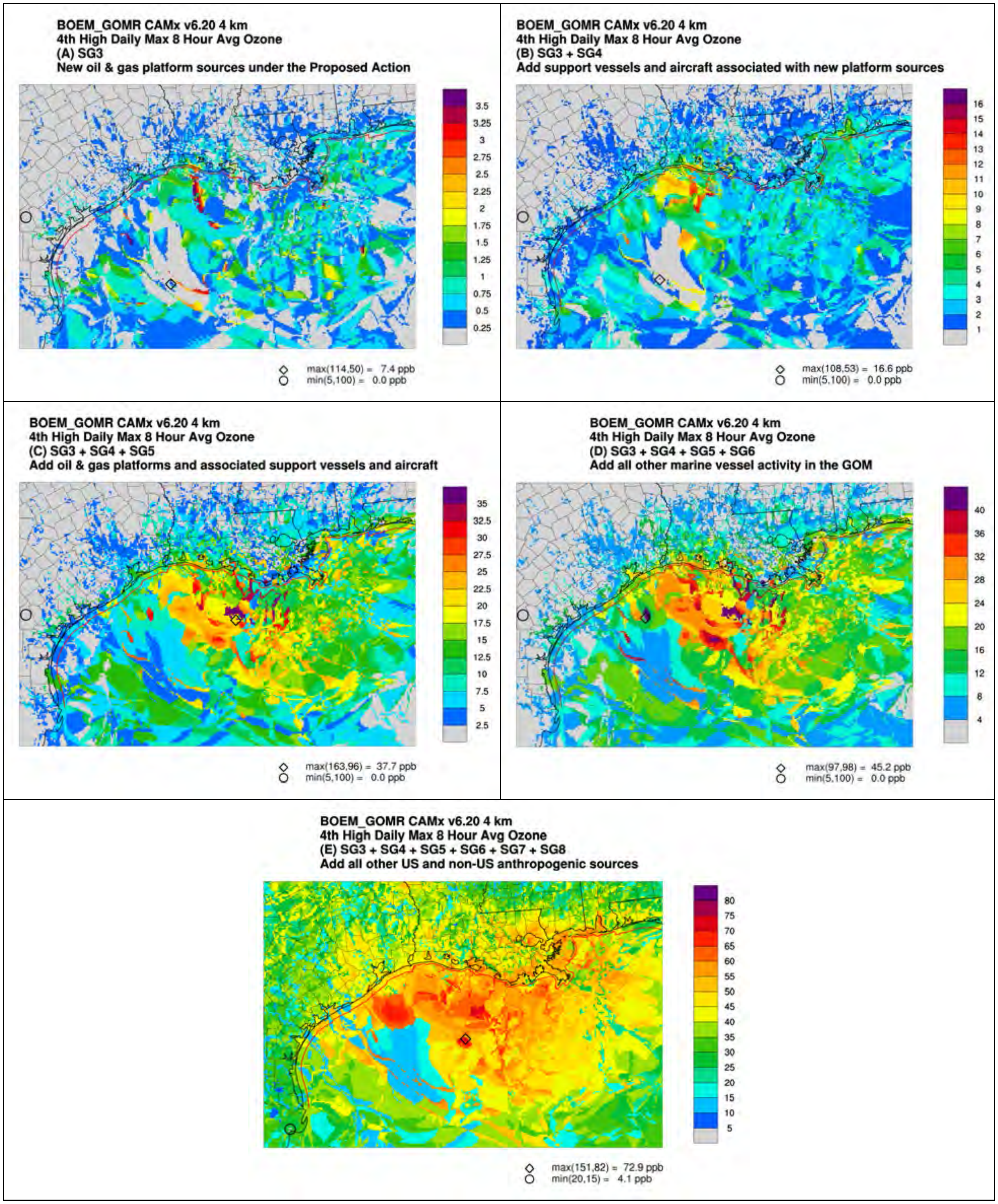


Figure D-43. Contributions of Source Groups A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to Future Year All-sources 4th Highest MDA_8 (note different color scales in each panel).

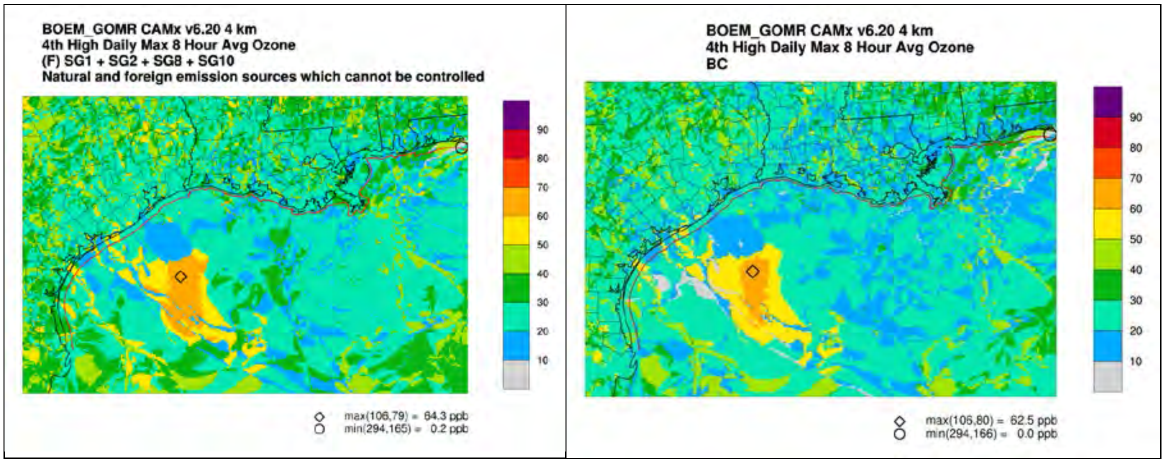


Figure D-44. Contributions from (left) Source Group F (natural and non-U.S. emission sources including boundary conditions) and (right) Boundary Conditions Only, to Future Year All-sources 4^{th} Highest MDA_8.

D.7.1.3 $PM_{2.5}$ NAAQS Analysis using Relative Model Results

There are two $PM_{2.5}$ NAAQS, one for 24-hour averaging time that is expressed as a 3-year average of the annual 98^{th} percentile in a year with a threshold of 35 µg/m^3 and an annual average over 3 years with a threshold of 12 µg/m^3. With 1 year of complete everyday modeling, the annual 98^{th} percentile will correspond to the 8^{th} highest 24-hour $PM_{2.5}$ concentration in a year.

Predictions of future year 24-hour and annual average $PM_{2.5}$ design values were made based on the use of model results in a relative sense as was done for ozone design values in **Section D.7.1.1**. The MATS software was used to generate predicted future year design values (DVFs) from current (base year) design values (DVB or DVC). The MATS was configured to use ambient measurements of total $PM_{2.5}$ for the period 2008-2012 to generate DVCs based on an average of three overlapping 3-year average DVs as recommended in the USEPA's guidance (USEPA, 2014) and speciated $PM_{2.5}$ monitoring data for the period 2010-2012 to generate the projected DVFs based on model predicted species RRFs.

D.7.1.3.1 24-Hour $PM_{2.5}$

As described for the ozone NAAQS analysis in **Section D.7.1.1**, the MATS was used to calculate DVFs for the 24-hour and annual $PM_{2.5}$ NAAQS. Observational data for use in the MATS were provided by the USEPA[23] for use in calculating the DVCs. For total $PM_{2.5}$, observational data covered the period 2008-2012; for the speciated $PM_{2.5}$ calculations, observational data covered the period 2010-2012.

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[23] https://www3.epa.gov/scram001/modelingapps_mats.htm

Results of the MATS analysis are shown in **Table D-20**. All current and future year design values are below the 35 μg/m^3 NAAQS, and the future year design values are projected to be lower than the current year design values at all sites. The reductions in the projected DVFs calculated after removing source contributions from each Source Group A, B, C, D, and E (i.e., DVF from **Table D-20** minus DVF calculated with hourly source group contributions removed) are listed in **Table D-21**. The largest of the Source Group A, B, C, or D contributions calculated in this manner occur at the Bay Rd. monitor in Mobile County, Alabama. New platforms and associated support vessels and helicopters (Source Group B) are calculated to contribute 1.2 μg/m^3 or 6.4% of the 18.9 μg/m^3 DVF at this location.

Table D-20. Current Year (DVC) and Future Year (DVF) 24-Hour $PM_{2.5}$ Design Values for Monitoring Sites in the 4-km Modeling Domain from MATS.

Site ID	Site Name	State	County	DVC	DVF
10030010	FAIRHOPE HIGH SCHOOL, FAIRHOPE, ALABAMA	AL	Baldwin County	19.5	17.7
10970003	CHICKASAW, MOBILE CO., ALABAMA	AL	Mobile County	19.1	17.2
10972005	BAY RD., MOBILE AL.	AL	Mobile County	20	18.9
120330004	ELLYSON INDUSTRIAL PARK-COPTER ROAD	FL	Escambia County	19.2	17.6
220190009	2284 Paul Bellow Road	LA	Calcasieu Parish	18.6	17
220190010	Common and East McNeese	LA	Calcasieu Parish	20.5	18.4
220330009	1061-A Leesville Ave	LA	East Baton Rouge Parish	21	19.2
220331001	Highway 964	LA	East Baton Rouge Parish	16.7	14.2
220470005	St Gabriel Agricultural Exp. Station	LA	Iberville Parish	21	19.9
220470009	65180 Belleview Road	LA	Iberville Parish	18.6	17.5
220511001	West Temple Pl	LA	Jefferson Parish	18.7	17.1
220512001	Patriot St. and Allo St.	LA	Jefferson Parish	18.5	16.6
220550006	121 East Point Des Mouton	LA	Lafayette Parish	18.8	17.5
220550007	646 Cajundome	LA	Lafayette Parish	20.2	18.1
220790002	8105 Tom Bowman Drive	LA	Rapides Parish	19.6	17.7
220870007	24 E. CHALMETTE CIRCLE	LA	St. Bernard Parish	20.2	17.4
221050001	21549 Old Hammond Hwy, Hammond, LA 70403	LA	Tangipahoa Parish	18.8	17.2
221090001	4047 Highway 24 North Gray	LA	Terrebonne Parish	17.6	16.2
221210001	1005 Northwest Drive, Port Allen	LA	West Baton Rouge Parish	21.7	20.2
280010004	Natchez Municipal Water Works, Brenham St.	MS	Adams County	20.3	17.7
280350004	205 Bay Street	MS	Forrest County	22.4	21
280450003	400 Baltic St.	MS	Hancock County	20	18.3
280470008	47 Maple Street	MS	Harrison County	18.3	16
280590006	Hospital Road at Co. Health Dept.	MS	Jackson County	20.8	19.6
280670002	26 Mason St.	MS	Jones County	23	21.7

Site ID	Site Name	State	County	DVC	DVF
480290059	14620 LAGUNA RD.	TX	Bexar County	21.4	20.9
480612004	LOT B 69 ½	TX	Cameron County	22.7	22.4
482010058	7210 1/2 BAYWAY DRIVE	TX	Harris County	20.8	20.2
482011035	9525 CLINTON DR	TX	Harris County	24	22.7
483550032	3810 HUISACHE STREET	TX	Nueces County	24.3	23.3
484530020	12200 LIME CREEK RD.	TX	Travis County	20.7	19.1
484530021	2600 B WEBBERVILLE RD.	TX	Travis County	21.8	20.5

Table D-21. 24-Hour $PM_{2.5}$ Current (DVC) and Future Year (DVF) Design Values and Reduction in DVF with Contributions from Individual Source Groups Removed.

Site ID	State	County	DVC	DVF	Change in DVF with Source Group Removed				
					A	B	C	D	E
10030010	AL	Baldwin County	19.5	17.7	0.0	0.2	0.3	0.4	8.8
10970003	AL	Mobile County	19.1	17.2	0.0	0.1	0.1	0.2	10.2
10972005	AL	Mobile County	20	18.9	0.0	1.2	1.2	1.3	12.0
120330004	FL	Escambia County	19.2	17.6	0.0	0.0	0.1	0.1	9.2
220190009	LA	Calcasieu Parish	18.6	17	0.0	0.1	0.2	0.5	9.9
220190010	LA	Calcasieu Parish	20.5	18.4	0.0	0.0	0.1	0.3	12.1
220330009	LA	East Baton Rouge Parish	21	19.2	0.0	0.1	0.2	0.3	12.3
220331001	LA	East Baton Rouge Parish	16.7	14.2	0.0	0.1	0.2	0.4	9.1
220470005	LA	Iberville Parish	21	19.9	0.0	0.0	0.2	0.4	14.2
220470009	LA	Iberville Parish	18.6	17.5	0.0	0.0	0.1	0.3	10.2
220511001	LA	Jefferson Parish	18.7	17.1	0.0	0.0	0.2	0.3	12.0
220512001	LA	Jefferson Parish	18.5	16.6	0.0	0.1	0.2	0.4	13.1
220550006	LA	Lafayette Parish	18.8	17.5	0.1	0.2	0.5	1.0	12.1
220550007	LA	Lafayette Parish	20.2	18.1	0.0	0.0	0.2	0.3	12.3
220790002	LA	Rapides Parish	19.6	17.7	0.0	0.0	0.2	0.4	8.1
220870007	LA	St. Bernard Parish	20.2	17.4	0.0	0.0	0.2	0.4	12.0
221050001	LA	Tangipahoa Parish	18.8	17.2	0.1	0.1	0.3	0.5	9.1
221090001	LA	Terrebonne Parish	17.6	16.2	0.0	0.1	0.3	0.4	10.8
221210001	LA	West Baton Rouge Parish	21.7	20.2	0.0	0.0	0.2	0.3	13.8
280010004	MS	Adams County	20.3	17.7	0.0	0.1	0.1	0.2	7.8
280350004	MS	Forrest County	22.4	21	0.0	0.1	0.1	0.2	11.4
280450003	MS	Hancock County	20	18.3	0.0	0.1	0.6	1.1	11.4
280470008	MS	Harrison County	18.3	16	0.0	0.0	0.3	0.4	8.8
280590006	MS	Jackson County	20.8	19.6	0.1	0.1	0.4	1.1	14.3
280670002	MS	Jones County	23	21.7	0.0	0.1	0.1	0.1	11.0
480290059	TX	Bexar County	21.4	20.9	0.0	0.0	0.0	0.0	11.8
480612004	TX	Cameron County	22.7	22.4	0.0	0.7	0.7	0.8	5.4
482010058	TX	Harris County	20.8	20.2	0.0	0.0	0.2	0.5	13.1

Site ID	State	County	DVC	DVF	Change in DVF with Source Group Removed				
					A	B	C	D	E
482011035	TX	Harris County	24	22.7	0.0	0.0	0.1	0.2	14.9
483550032	TX	Nueces County	24.3	23.3	0.0	0.1	0.1	0.2	12.3
484530020	TX	Travis County	20.7	19.1	0.0	0.0	0.0	0.1	9.4
484530021	TX	Travis County	21.8	20.5	0.0	0.0	0.0	0.1	12.1

D.7.1.3.2 Annual Average $PM_{2.5}$

The MATS projections of DVF for the annual average $PM_{2.5}$ design values are shown in **Table D-22**. The only design value exceeding the 12 µg/m^3 annual average NAAQS is the current year design value at the Clinton Dr. monitor in Houston, Texas. The projected future year design value at this location is below the NAAQS. Future year design values are projected to be less than the current year design values at all monitoring sites except for a 0.3 µg/m^3 increase at the Hidalgo County monitoring site just west of Brownsville, Texas.

Reductions in the projected annual average DVFs calculated after removing source contributions from each Source Group A, B, C, D, and E (i.e., DVF from **Table D-22** minus DVF calculated with hourly source group contributions removed) are shown in **Table D-23**. The largest of the Source Group A, B, C, or D contributions calculated in this manner occur at the Bay Rd. monitor in Mobile County, Alabama. New platforms and associated support vessels and helicopters (Source Group B) are calculated to contribute 0.7 µg/m^3 or 7.7% of the 9.1 µg/m^3 DVF at this location. Source Group B contributions at the Clinton Dr. monitor are calculated to be less than 0.05 µg/m^3. Source Group B contributions at the Hidalgo County monitoring site are calculated to be 0.1 µg/m^3.

Table D-22. Current (DVC) and Projected Future (DVF) Annual Average $PM_{2.5}$ Design Values for Monitoring Sites in the 4-km Modeling Domain (highlighted values exceed the 12 µg/m^3 NAAQS).

Site ID	Site Name	State	DVC	DVF
10030010	FAIRHOPE HIGH SCHOOL, FAIRHOPE, ALABAMA	AL	9.8	9.1
10970003	CHICKASAW, MOBILE CO., ALABAMA	AL	9.7	8.9
10972005	BAY RD., MOBILE AL.	AL	9.2	9.1
120330004	ELLYSON INDUSTRIAL PARK-COPTER ROAD	FL	8.9	8.3
220190009	2284 Paul Bellow Road	LA	8.6	7.9
220190010	Common and East McNeese	LA	9.1	8.5
220330009	1061-A Leesville Ave	LA	10.3	9.6
220331001	Highway 964	LA	9.3	8.3
220470005	St Gabriel Agricultural Exp. Station	LA	10.2	9.5
220470009	65180 Belleview Road	LA	8.9	8.1
220511001	West Temple Pl	LA	9	8.2
220512001	Patriot St. and Allo St.	LA	9.2	8.3
220550006	121 East Point Des Mouton	LA	8.9	8.2
220550007	646 Cajundome	LA	9.1	8.4
220790002	8105 Tom Bowman Drive	LA	8.8	8

Site ID	Site Name	State	DVC	DVF
220870007	24 E. CHALMETTE CIRCLE	LA	10.5	9.7
221050001	21549 Old Hammond Hwy, Hammond, LA 70403	LA	9	8.1
221090001	4047 Highway 24 North Gray	LA	8.5	7.8
221210001	1005 Northwest Drive, Port Allen	LA	10.8	10.1
280010004	Natchez Municipal Water Works Brenham St	MS	10.2	9.3
280350004	205 Bay Street	MS	11.7	10.9
280450003	400 Baltic St	MS	9.9	9.1
280470008	47 Maple Street	MS	9.6	8.7
280590006	Hospital Road at Co. Health Dept.	MS	9.5	9
280670002	26 Mason St.	MS	11.8	11.3
480290059	14620 LAGUNA RD.	TX	9	8.8
480612004	LOT B 69 ½	TX	11	10.9
482010058	7210 1/2 BAYWAY DRIVE	TX	11.1	10.9
482011035	9525 CLINTON DR	TX	12.4	11.6
482150043	2300 NORTH GLASSCOCK	TX	10.4	10.7
483550032	3810 HUISACHE STREET	TX	10.3	10
484530020	12200 LIME CREEK RD.	TX	8.4	7.9
484530021	2600 B WEBBERVILLE RD.	TX	10.2	9.8

Table D-23. Annual Average $PM_{2.5}$ Future Year Design Values (DVF) and Change in DVF with Contributions from Individual Source Groups Removed (highlighted values exceed the 12 $\mu g/m^3$ NAAQS).

Site ID	State	County	DVC	DVF	Change in DVF with Source Group Removed				
					A	B	C	D	E
10030010	AL	Baldwin County	9.8	9.1	0.0	0.1	0.2	0.3	5.5
10970003	AL	Mobile County	9.7	8.9	0.0	0.1	0.1	0.2	6.2
10972005	AL	Mobile County	9.2	9.1	0.0	0.7	0.8	0.9	6.1
120330004	FL	Escambia County	8.9	8.3	0.0	0.1	0.1	0.2	5.2
220190009	LA	Calcasieu Parish	8.6	7.9	0.0	0.1	0.2	0.4	5.0
220190010	LA	Calcasieu Parish	9.1	8.5	0.0	0.0	0.2	0.4	6.3
220330009	LA	East Baton Rouge Parish	10.3	9.6	0.0	0.1	0.2	0.3	7.2
220331001	LA	East Baton Rouge Parish	9.3	8.3	0.0	0.0	0.1	0.2	6.0
220470005	LA	Iberville Parish	10.2	9.5	0.0	0.0	0.1	0.2	7.4
220470009	LA	Iberville Parish	8.9	8.1	0.0	0.0	0.1	0.3	5.5
220511001	LA	Jefferson Parish	9	8.2	0.0	0.1	0.2	0.3	6.0
220512001	LA	Jefferson Parish	9.2	8.3	0.0	0.0	0.1	0.2	6.6
220550006	LA	Lafayette Parish	8.9	8.2	0.0	0.0	0.2	0.4	5.9
220550007	LA	Lafayette Parish	9.1	8.4	0.0	0.1	0.2	0.4	6.1
220790002	LA	Rapides Parish	8.8	8	0.0	0.0	0.1	0.2	4.7
220870007	LA	St. Bernard Parish	10.5	9.7	0.0	0.1	0.2	0.3	7.3
221050001	LA	Tangipahoa Parish	9	8.1	0.0	0.1	0.2	0.3	5.0
221090001	LA	Terrebonne Parish	8.5	7.8	0.0	0.0	0.2	0.4	5.5

Site ID	State	County	DVC	DVF	Change in DVF with Source Group Removed				
					A	B	C	D	E
221210001	LA	West Baton Rouge Parish	10.8	10.1	0.0	0.0	0.1	0.2	7.9
280010004	MS	Adams County	10.2	9.3	0.0	0.0	0.1	0.2	5.4
280350004	MS	Forrest County	11.7	10.9	0.0	0.0	0.1	0.2	7.2
280450003	MS	Hancock County	9.9	9.1	0.0	0.0	0.2	0.4	6.1
280470008	MS	Harrison County	9.6	8.7	0.0	0.0	0.2	0.3	5.6
280590006	MS	Jackson County	9.5	9	0.0	0.1	0.2	0.3	6.9
280670002	MS	Jones County	11.8	11.3	0.0	0.0	0.1	0.1	7.4
480290059	TX	Bexar County	9	8.8	0.0	0.0	0.1	0.1	5.0
480612004	TX	Cameron County	11	10.9	0.0	0.3	0.4	0.5	4.9
482010058	TX	Harris County	11.1	10.9	0.0	0.0	0.1	0.3	8.0
482011035	TX	Harris County	12.4	11.6	0.0	0.0	0.0	0.2	8.8
482150043	TX	Hidalgo County	10.4	10.7	0.0	0.1	0.1	0.1	6.4
483550032	TX	Nueces County	10.3	10	0.0	0.0	0.1	0.1	6.0
484530020	TX	Travis County	8.4	7.9	0.0	0.0	0.0	0.1	4.4
484530021	TX	Travis County	10.2	9.8	0.0	0.0	0.0	0.1	6.1

Figure D-45 displays the MATS UAA results for the annual average $PM_{2.5}$ DVC, DVF, and the difference, DVF - DVC.[24] Reductions in annual average $PM_{2.5}$ design values associated with emission reductions from all sources combined are projected throughout nearly the entire domain, with the exception of increases near the Freshwater Bayou Canal in Vermilion Parish, Louisiana, and Brownsville, Texas, in addition to a few additional areas in Texas and southern Louisiana. Some of the isolated areas of increases may represent artifacts of the MATS UAA spatial interpolation procedure and are not necessarily physically meaningful. Increases in the coastal ports are associated with new platforms and support vessel and helicopter traffic (Source Group B), as shown by the unmonitored area source group contributions in **Figure D-46**. Source Group B contributes as much as 1.8 μg/m^3 in these areas.

[24] The UAA analysis could only be performed for the annual average $PM_{2.5}$ NAAQS as the MATS software cannot calculate UAA results for the 24-hour average $PM_{2.5}$ NAAQS.

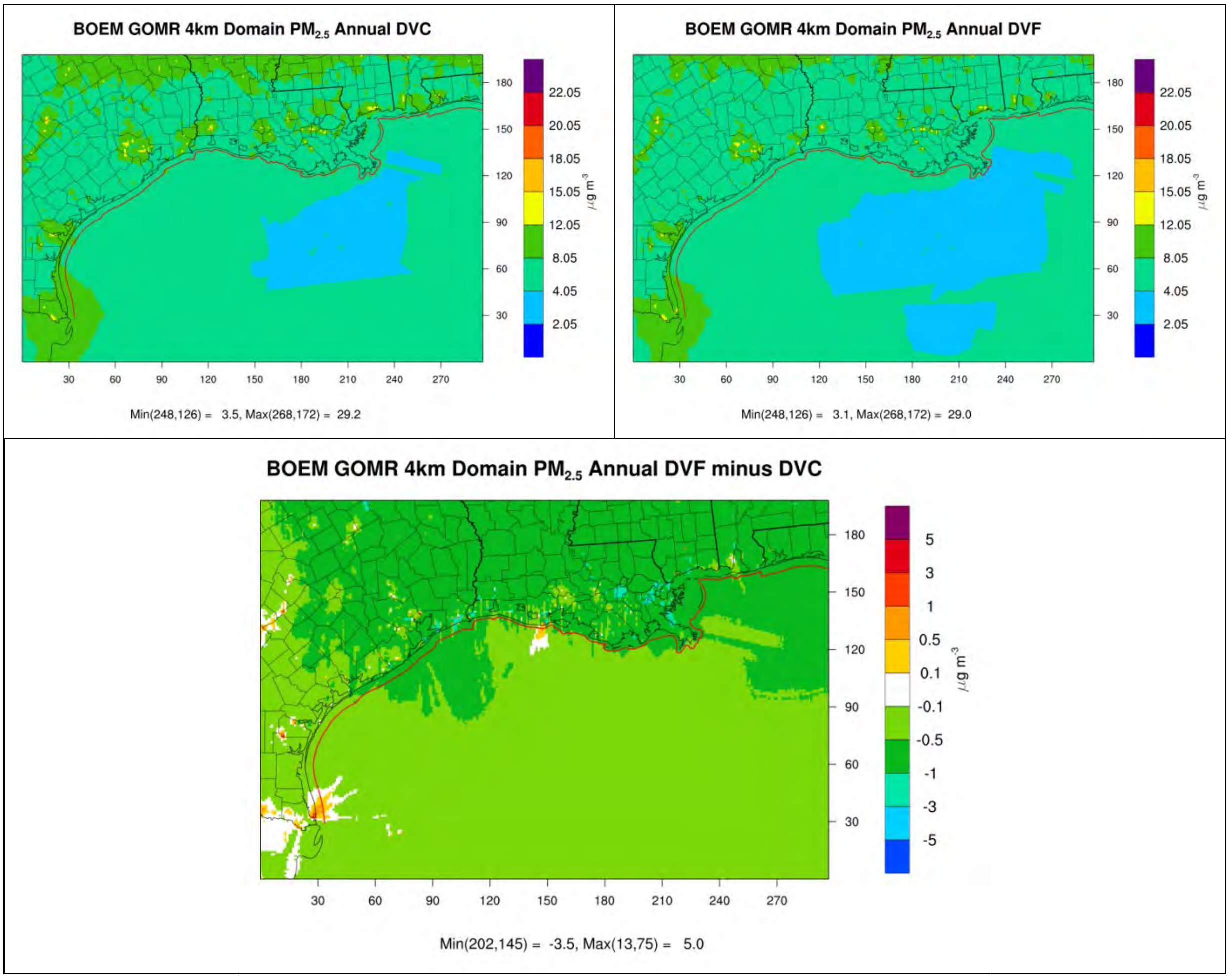

Figure D-45. Current Year (DVC) and Future Year (DVF) Annual Average $PM_{2.5}$ Design Values from the MATS Unmonitored Area Analysis (top left and top right, respectively) and the Difference, DVF – DVC (bottom).

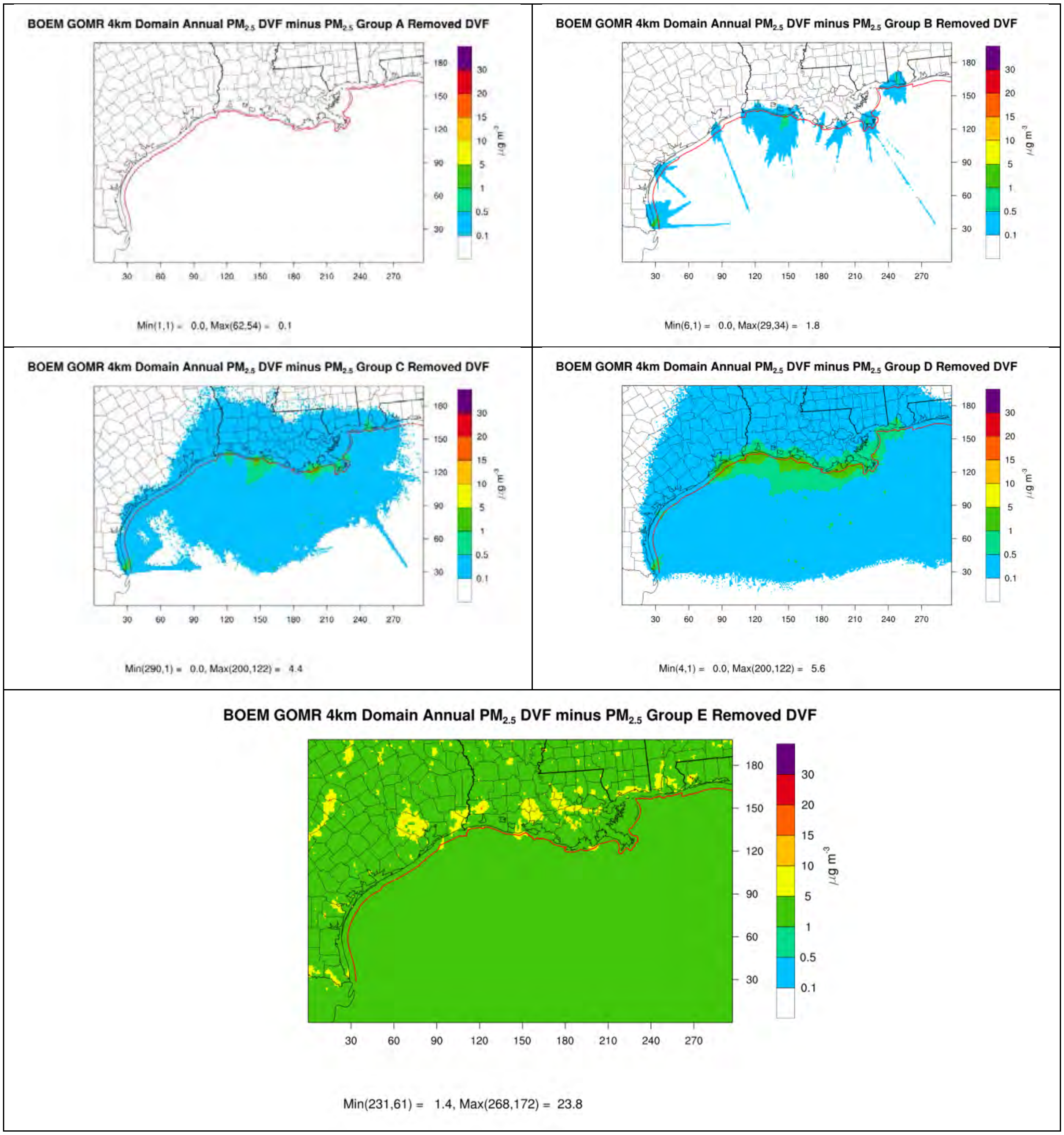

Figure D-46. Contributions of Source Groups A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources Annual Average $PM_{2.5}$ Concentration Based on the MATS Unmonitored Area Analysis (note different color scales used in each panel).

D.7.1.4 $PM_{2.5}$ NAAQS Analysis using Absolute Model Predictions

The CAMx source apportionment absolute modeling results from the future year scenario are analyzed and compared with the $PM_{2.5}$ 24-hour and annual NAAQS in this section.

D.7.1.4.1 24-Hour $PM_{2.5}$

The 24-hour $PM_{2.5}$ NAAQS is defined as the three-year average of the annual 98th percentile daily average which corresponds to the 8th highest daily average in each year assuming complete data. Since only one calendar year of modeling results are available for the base year and future year scenarios, the future year 8th highest daily average $PM_{2.5}$ concentration is selected for comparison with the NAAQS.

Modeled 8th highest daily $PM_{2.5}$ concentrations in each model grid cell for the base and future year scenarios and the corresponding differences are shown in **Figure D-47**. Areas of high predicted $PM_{2.5}$ occur along the Alabama, Louisiana and east Texas Gulf coasts in both the base and future year scenarios. Although predicted 8th highest daily $PM_{2.5}$ concentrations in these areas exceed the 35 μg/m^3 NAAQS, both base-year monitored design values (DVCs) and projected future year design values (DVFs) are below the NAAQS at monitoring sites in these areas as noted in **Section D.7.1.3.1** above. A tendency towards over prediction of daily $PM_{2.5}$ noted in the model performance evaluation results presented in **Section D.5**. The difference plot at the bottom of **Figure D-47** shows $PM_{2.5}$ reductions in the majority of the domain with some areas of increases in $PM_{2.5}$ along portions of the immediate shoreline and offshore in the western Gulf where additional activities are anticipated under the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers. Where $PM_{2.5}$ increases are predicted, they are limited to less than 15 μg/m^3 for nearly all grid cells.

Source group contributions to the annual 8th highest daily average $PM_{2.5}$ concentrations under the future year scenario are shown in **Figure D-48**. These contributions are matched in time to the all sources 8th highest daily average $PM_{2.5}$ concentrations; contributions may be different during other periods with elevated daily average $PM_{2.5}$ values. Impacts of the new sources associated with the 2017-2022 GOM Multisale EIS scenario (Source Groups A and B) are largely focused on the area offshore of western Louisiana. Impacts from new platforms associated with the 2017-2022 GOM Multisale EIS scenario (Source Group A) are less than 1 μg/m^3; adding in support vessels and helicopters (Source Group B) increases the near-shore impacts up to a maximum of 7 μg/m^3 as compared to a combined maximum impact of all Gulf of Mexico sources (Source Group D) of 44 μg/m^3. This Supplemental EIS tiers from the 2017-2022 GOM Multisale EIS and uses the scenario and alternatives analyzed in the 2017-2022 GOM Multisale EIS.

Contributions from Source Group E, which includes Source Group D plus all other U.S. and non-U.S. anthropogenic sources, shows the influence of inland urban areas on $PM_{2.5}$ levels, especially in Baton Rouge and Lake Charles, Louisiana.

Contributions from Source Group F (natural and non-U.S. emission sources including boundary conditions) shown in the left panel of **Figure D-49** are dominated by fire emissions near Beaumont, Texas, and in Vermilion and Lafourche Parishes, Louisiana. Boundary condition contributions are less than 4 μg/m^3 in the coastal areas as shown in the right panel of **Figure D-49**.

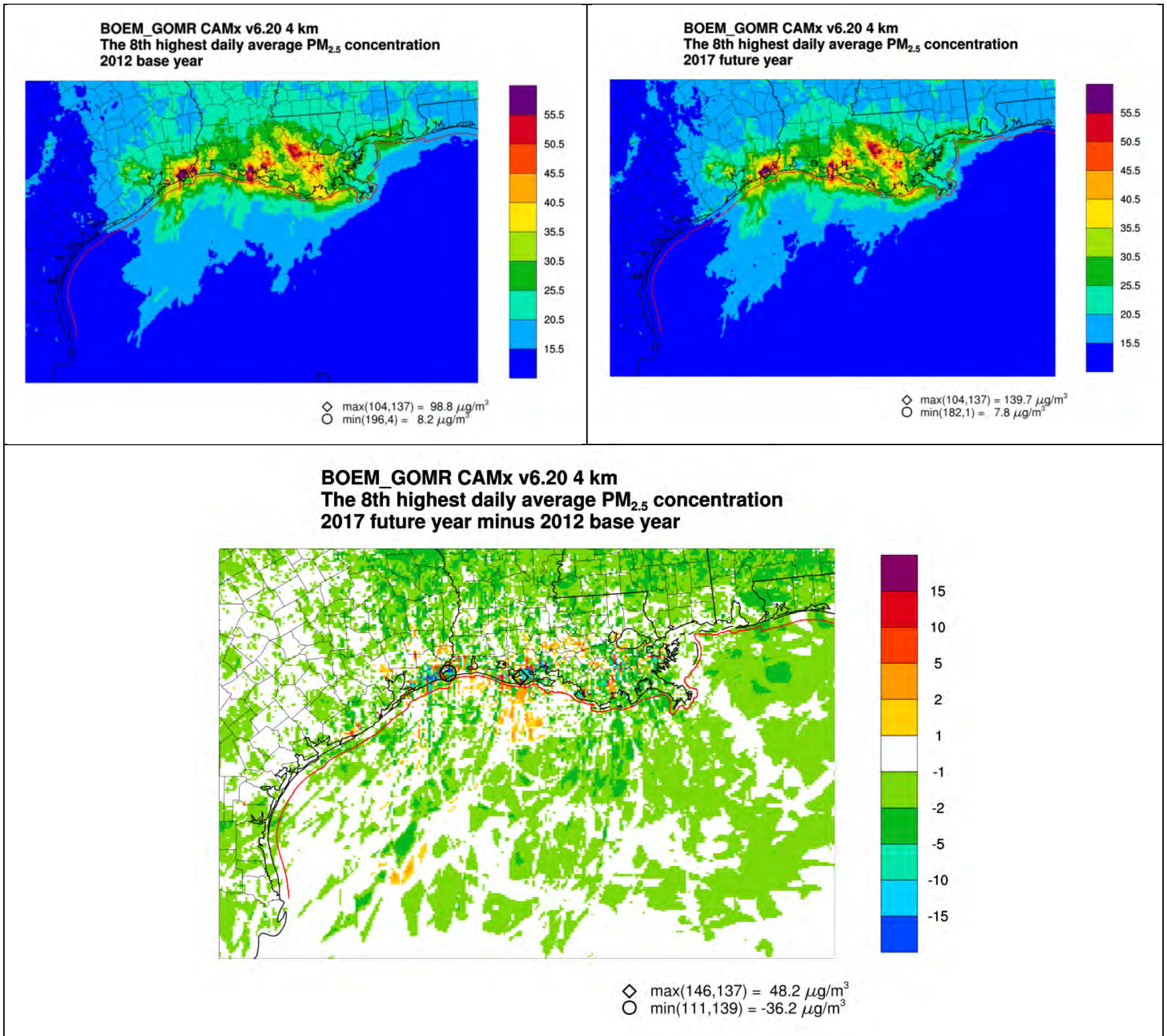

Figure D-47. Modeled 8th Highest Daily Average $PM_{2.5}$ Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

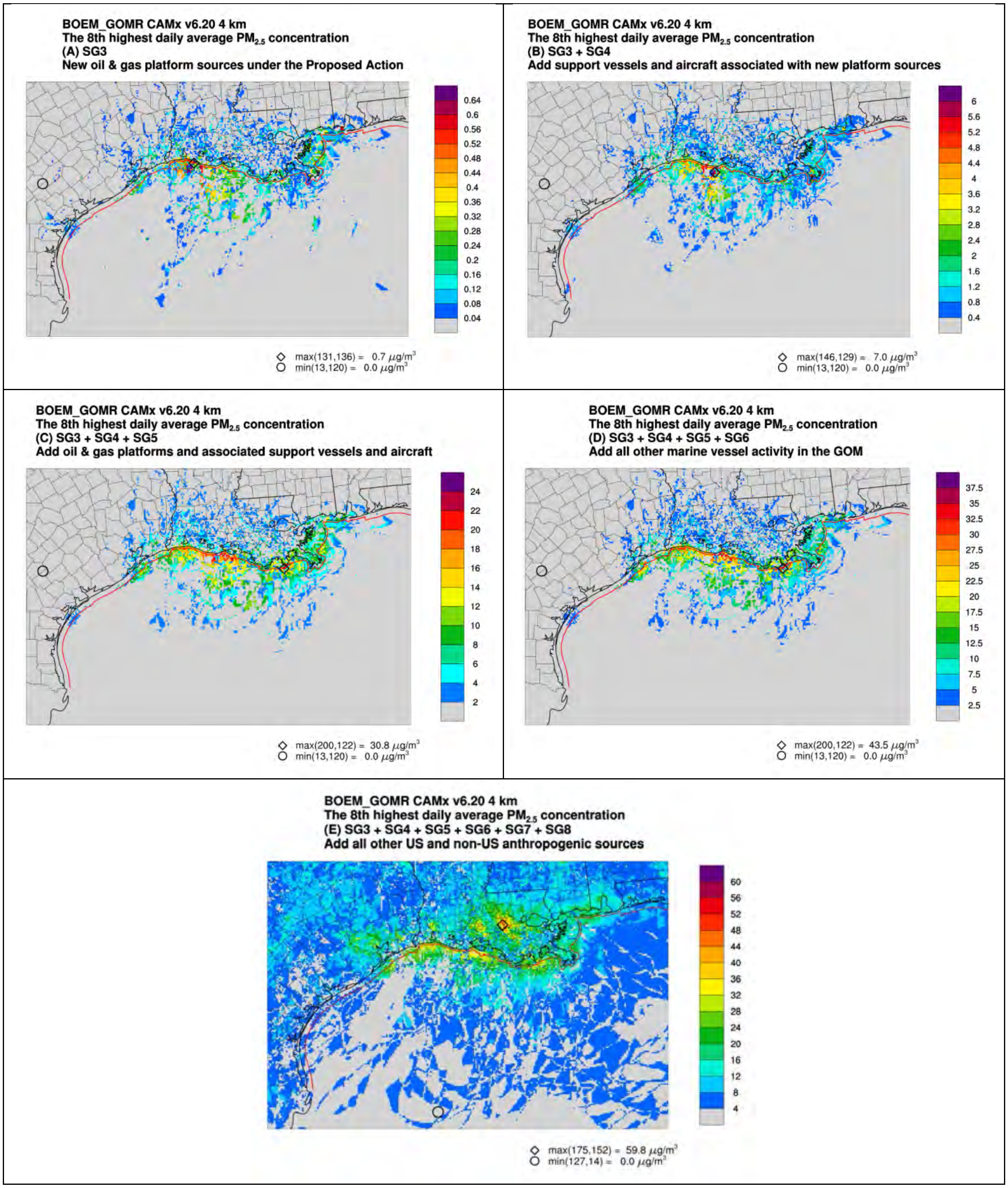

Figure D-48. Contributions of Source Groups A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources 8th Highest Daily Average $PM_{2.5}$ Concentration (note different color scales used in each panel).

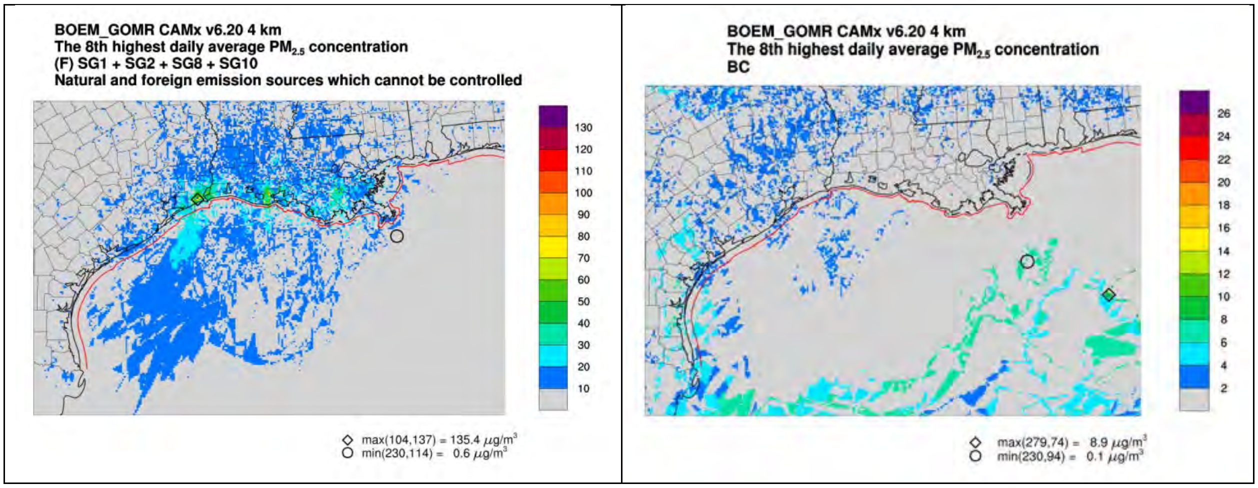

Figure D-49. Contributions from (left) Source Group F (natural and non-U.S. emission sources including boundary conditions) and (right) Boundary Conditions Only to Future Year All-sources 8^{th} Highest 24-hour $PM_{2.5}$ (note use of different color scale in each panel).

D.7.1.4.2 Annual Average $PM_{2.5}$

Modeled annual average $PM_{2.5}$ for the base year, future year, and the future – base differences are shown in **Figure D-50**. Average $PM_{2.5}$ concentrations decrease on most locations between the base and future year scenarios with changes over the western GOM between ± 0.5 μg/m^3. Increases of up to 2.5 μg/m^3 are calculated to occur in coastal Vermilion Parish, Louisiana.

Source group contributions to the annual average $PM_{2.5}$ concentrations under the future year scenario are shown in **Figure D-51**. Impacts of the new sources associated with the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group B) are largely focused on the area offshore of western Louisiana with a maximum impact of 2.2 μg/m^3 as compared to a combined maximum impact of all GOM sources (Source Group D) of 9.3 μg/m^3. Source Group F contributions (natural and non-U.S. emission sources including boundary conditions) shown in the left panel of **Figure D-52** are dominated by fire emissions near Beaumont, Texas, and in Vermilion and Lafourche Parishes, Louisiana. Boundary condition contributions are less than 2 μg/m^3 in the coastal areas as shown in the right panel of **Figure D-52**.

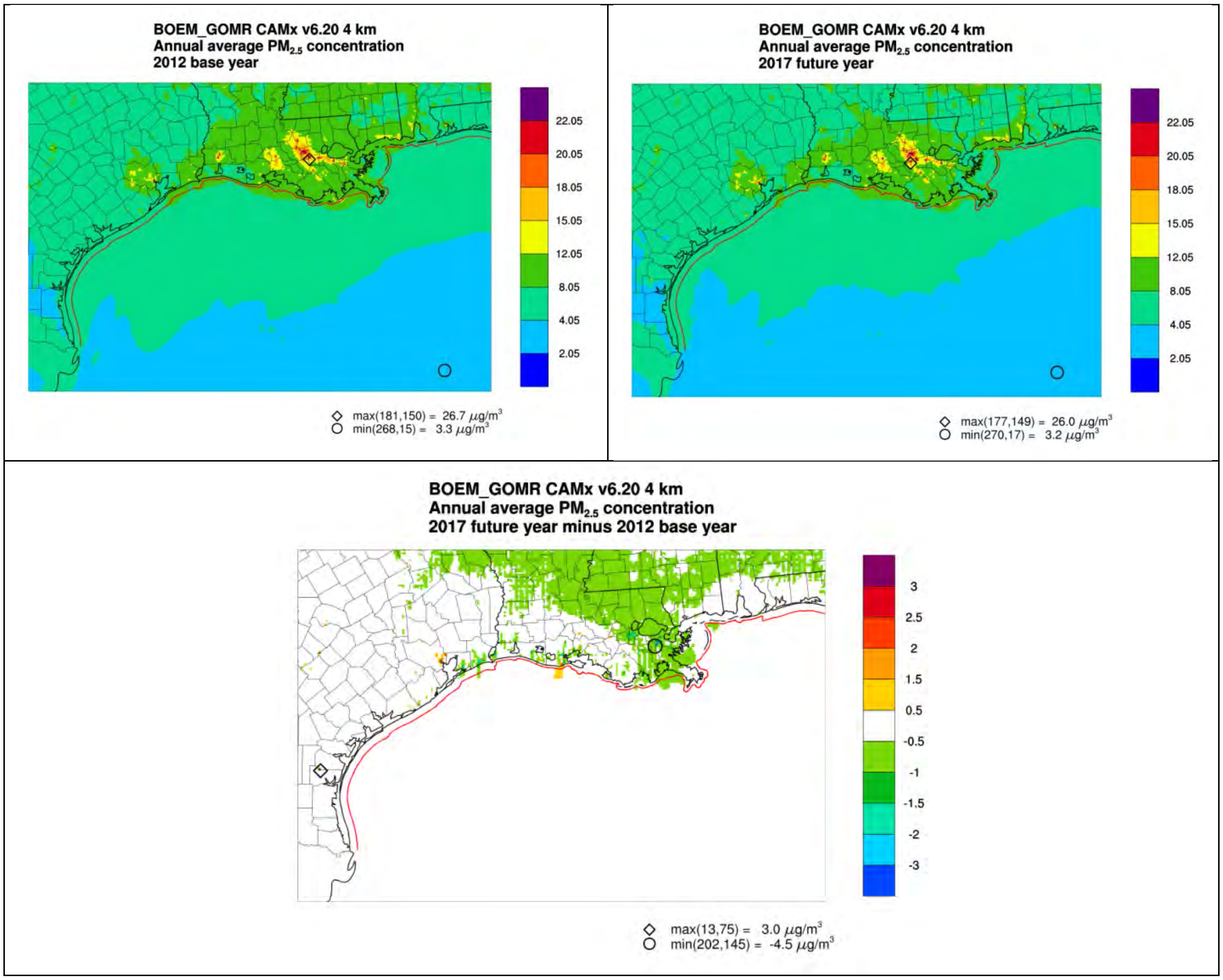

Figure D-50. Modeled Annual Average $PM_{2.5}$ Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

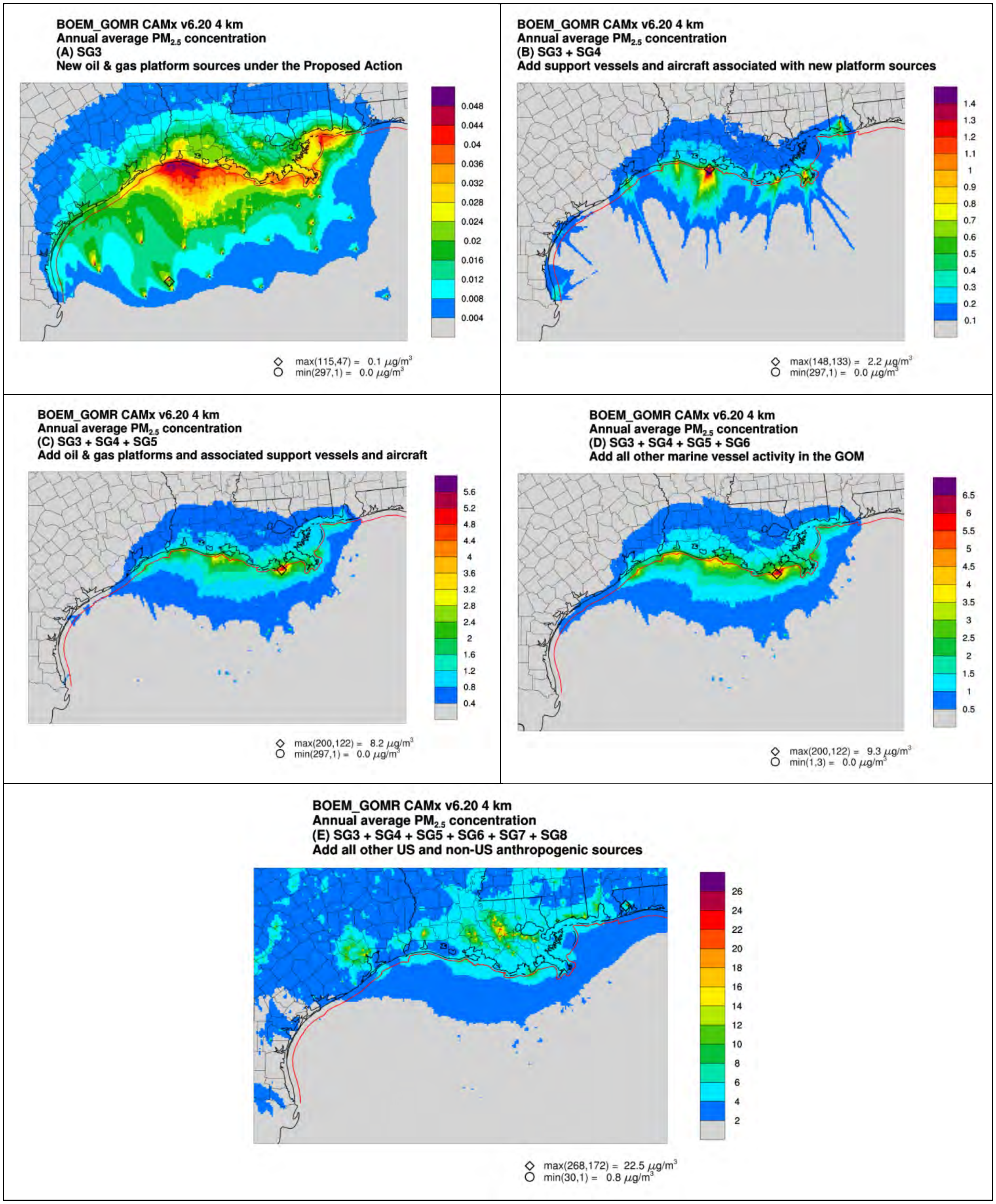

Figure D-51. Contributions of Source Group A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources Annual Average $PM_{2.5}$ Concentration (note use of different color scales in each panel).

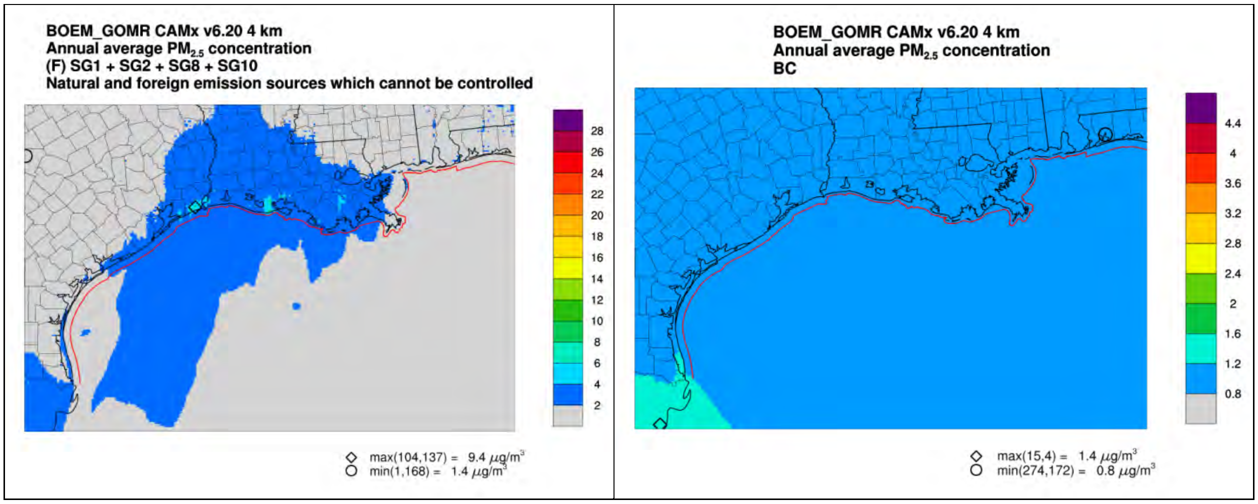

Figure D-52. Contributions from (left) Source Group F (natural and non-U.S. emission sources including boundary conditions) and (right) Boundary Conditions Only to Future Year All-sources Annual Average $PM_{2.5}$ (note use of different color scale in each panel).

D.7.1.5 NAAQS Analysis for other Criteria Air Pollutants

D.7.1.5.1 PM_{10}

Figure D-53 displays modeled 2nd highest daily average PM_{10} concentrations than can be compared with the 24-hour average PM_{10} NAAQS (150 µg/m^3) for the base and future scenarios and the base-future differences. Areas of elevated PM_{10} are evident in urban and port areas and in fire zones along the Gulf Coasts of Texas and Louisiana (impacts of fires on PM_{10} can be discerned from the left panel of **Figure D-55** described below). The PM_{10} decreases are modeled along the Louisiana coast with increases of between 2 and 5 µg/m^3 in waters farther offshore associated with new emissions from the 2017-2022 GOM Multisale EIS scenario sources, from which this Supplemental EIS tiers.

Source group contributions to the 2nd highest daily average PM_{10} concentrations are shown in **Figure D-54**. The maximum contribution of the new platforms and associated support vessels and aircraft under the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group B) is predicted to be 10.7 µg/m^3 or 7% of the NAAQS. The maximum contribution of all oil and gas platforms and support vessels and helicopters (Source Group C) is 41 µg/m^3 (28% of the NAAQS). Fires dominate contributions from natural and non-U.S. sources (**Figure D-55**).

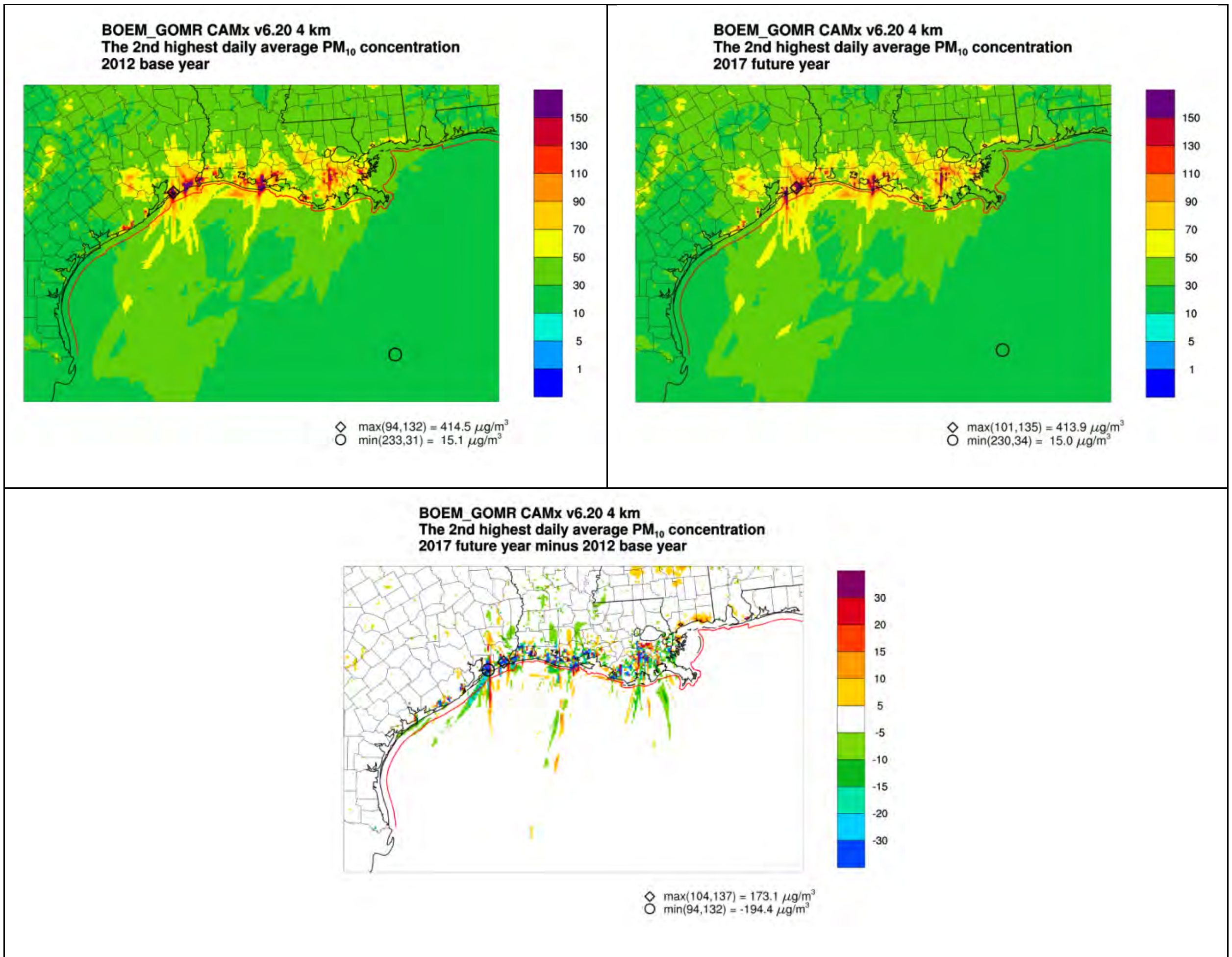

Figure D-53. Modeled 2nd Highest 24-hour Average PM_{10} Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

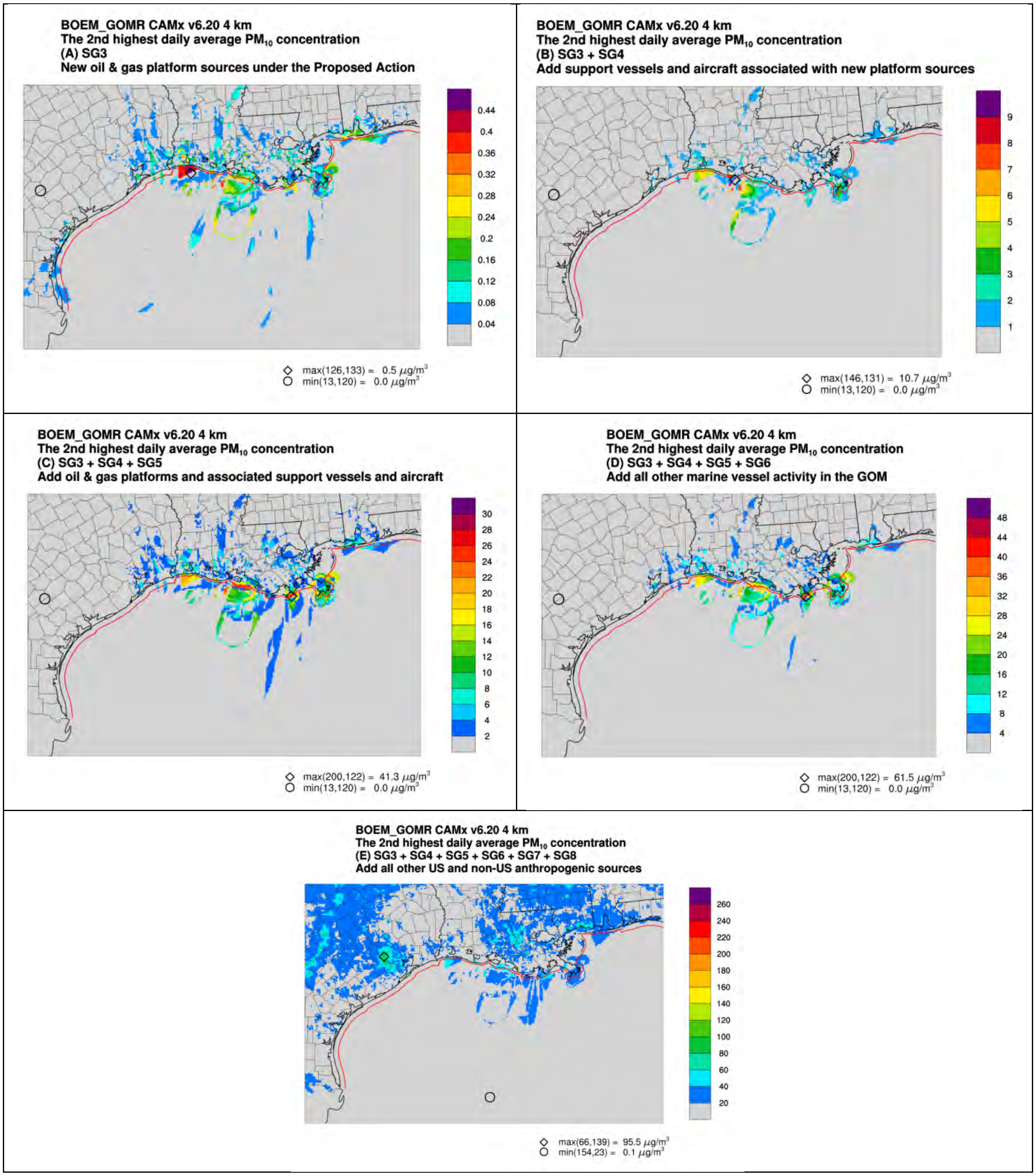

Figure D-54. Contributions of Source Groups A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources 2nd Highest Daily Average PM_{10} Concentration (note use of different color scales in each panel).

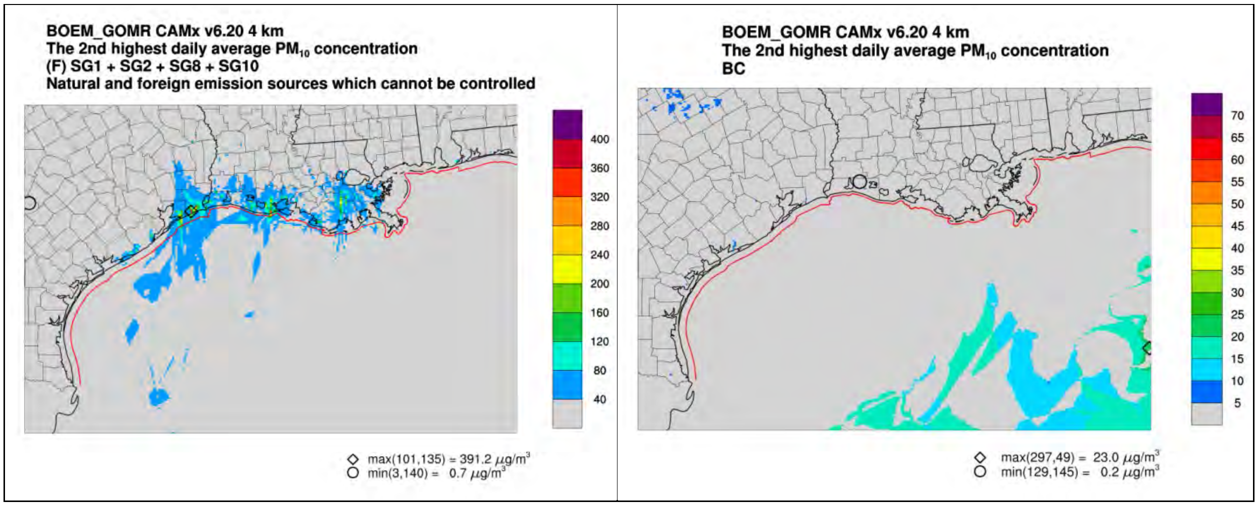

Figure D-55. Contributions from (left) Source Group F (natural and non-U.S. emission sources including boundary conditions) and (right) Boundary Conditions Only to Future Year All-sources 2nd Highest Daily Average PM_{10} Concentration (note use of different color scale in each panel).

D.7.1.5.2 NO_2

Results are presented here for both the 1-hour average NO_2 NAAQS (100 ppb) and the annual average NO_2 NAAQS (53 ppb). **Figures D-56 and D-57** display modeled 1-hour average NO_2 design values (based on the 8th highest daily average) for the base and future year scenarios along with source group contributions to the future year design values. All modeled 1-hour NO_2 concentrations are below the NAAQS (100 ppb); concentrations in the immediate vicinity of the Louisiana Offshore Oil Port (LOOP) peak at 98.5 ppb. Concentrations decrease between the base and future year scenarios at most locations except for of as much as a 32-ppb increase in coastal Vermilion Parish, Louisiana. Increases are also projected offshore of Texas and Alabama and in some interior portions of Texas.

Source Group contributions to the 8th highest daily average NO_2 concentrations are shown in **Figure D-57**. Contributions from new platforms and support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group B) are dominated by vessel and possibly helicopter traffic in the port areas, most notably in Vermilion Parish, Louisiana, where the maximum contribution is 55.6 ppb. Combined contributions from new and existing platforms and support vessels and helicopters (Source Group C) are dominant in the area of the LOOP. Contributions from natural and foreign sources are less than 10 ppb (not shown).

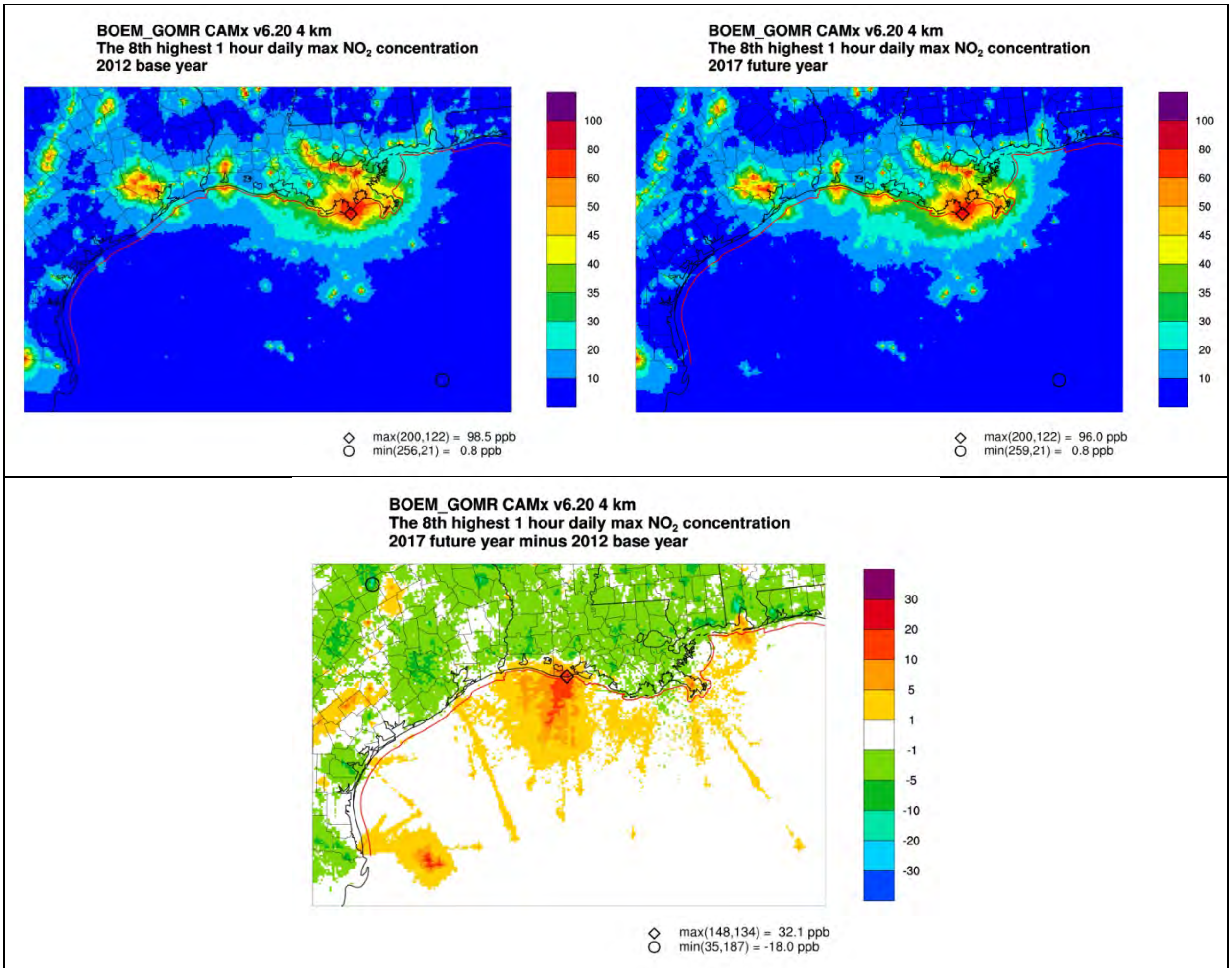

Figure D-56. Modeled 8th Highest 1-hour NO_2 Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

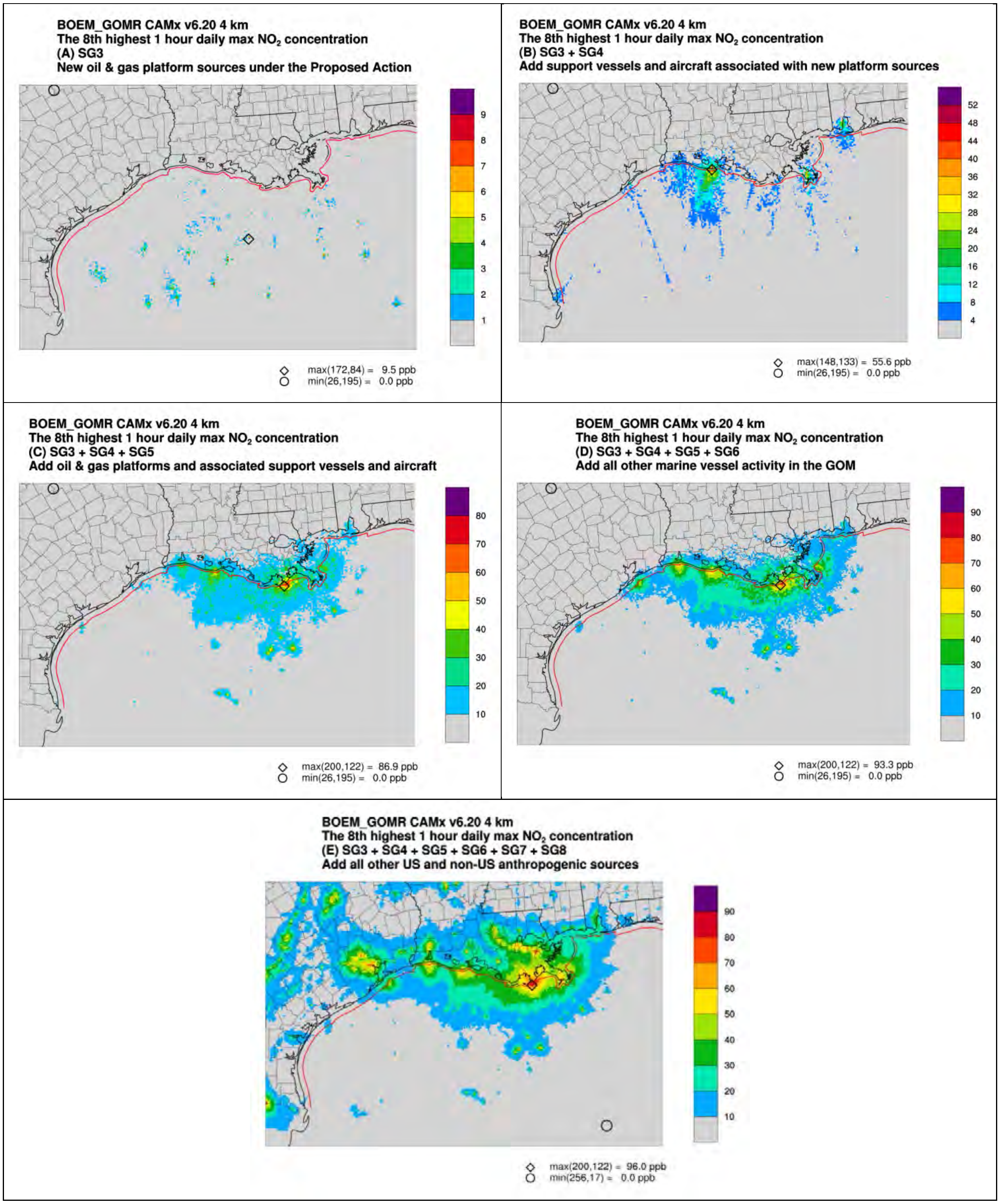

Figure D-57. Contributions of Source Group A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources 8th Highest Daily Average NO_2 Concentrations (note use of different color scales in each panel).

Figures D-58 and D-59 display modeled annual average NO_2 concentrations for the base case and future year scenarios, along with source group contributions to the future year annual averages. All modeled concentrations are below the NAAQS. Increases between the base case and future year scenarios of as much as 8 ppb are modeled to occur near the entrance to the Freshwater Bayou Canal in Vermilion Parish, Louisiana. Somewhat larger increases are modeled in the Permian Basin of west Texas.

Contributions of Source Groups to the annual average NO_2 concentrations are shown in **Figure D-59**. These results are similar to those for 1-hour NO_2 shown above. Maximum impacts from new platforms and support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario are as much as 8.6 ppb (16% of the NAAQS).

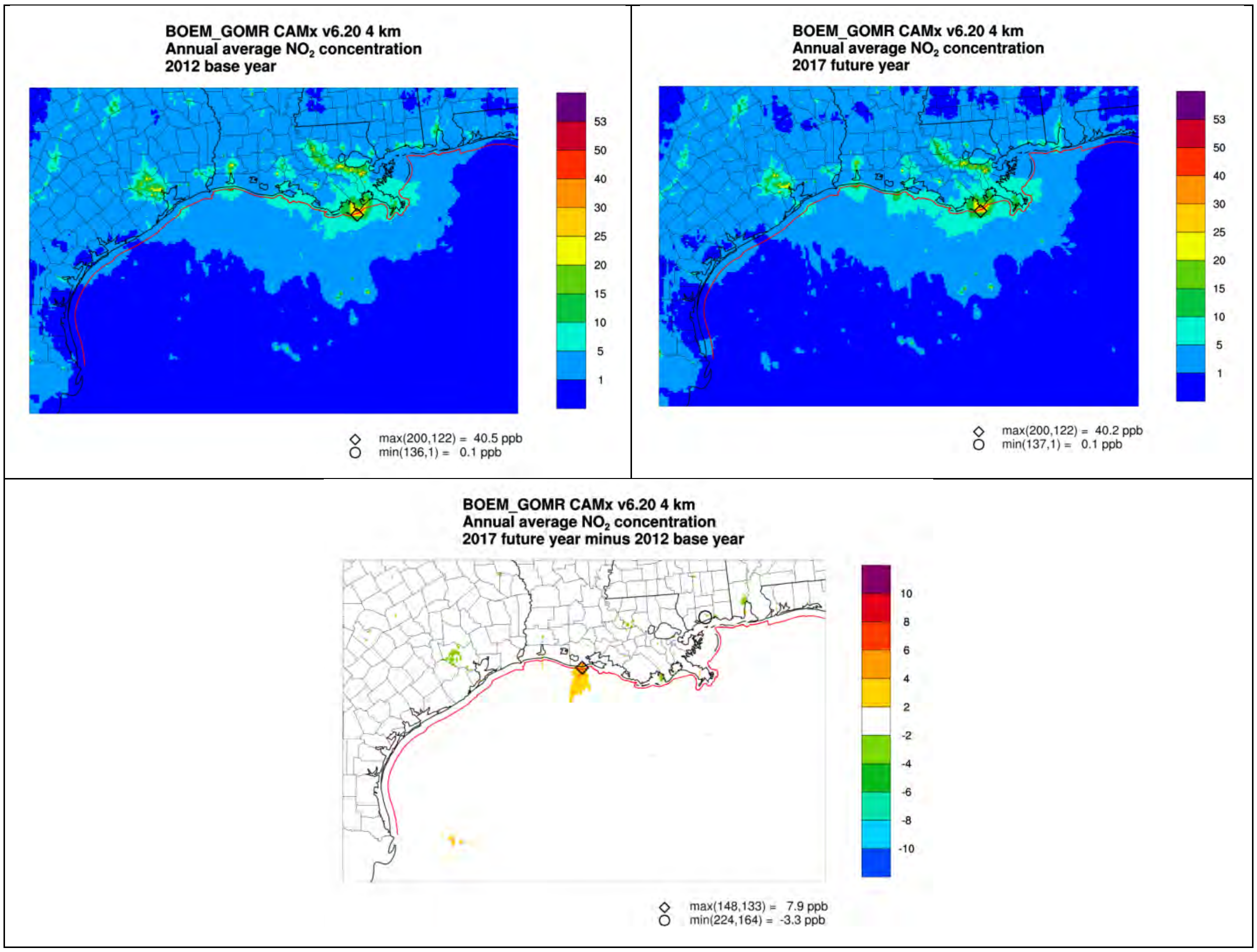

Figure D-58.   Modeled Annual Average NO_2 Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

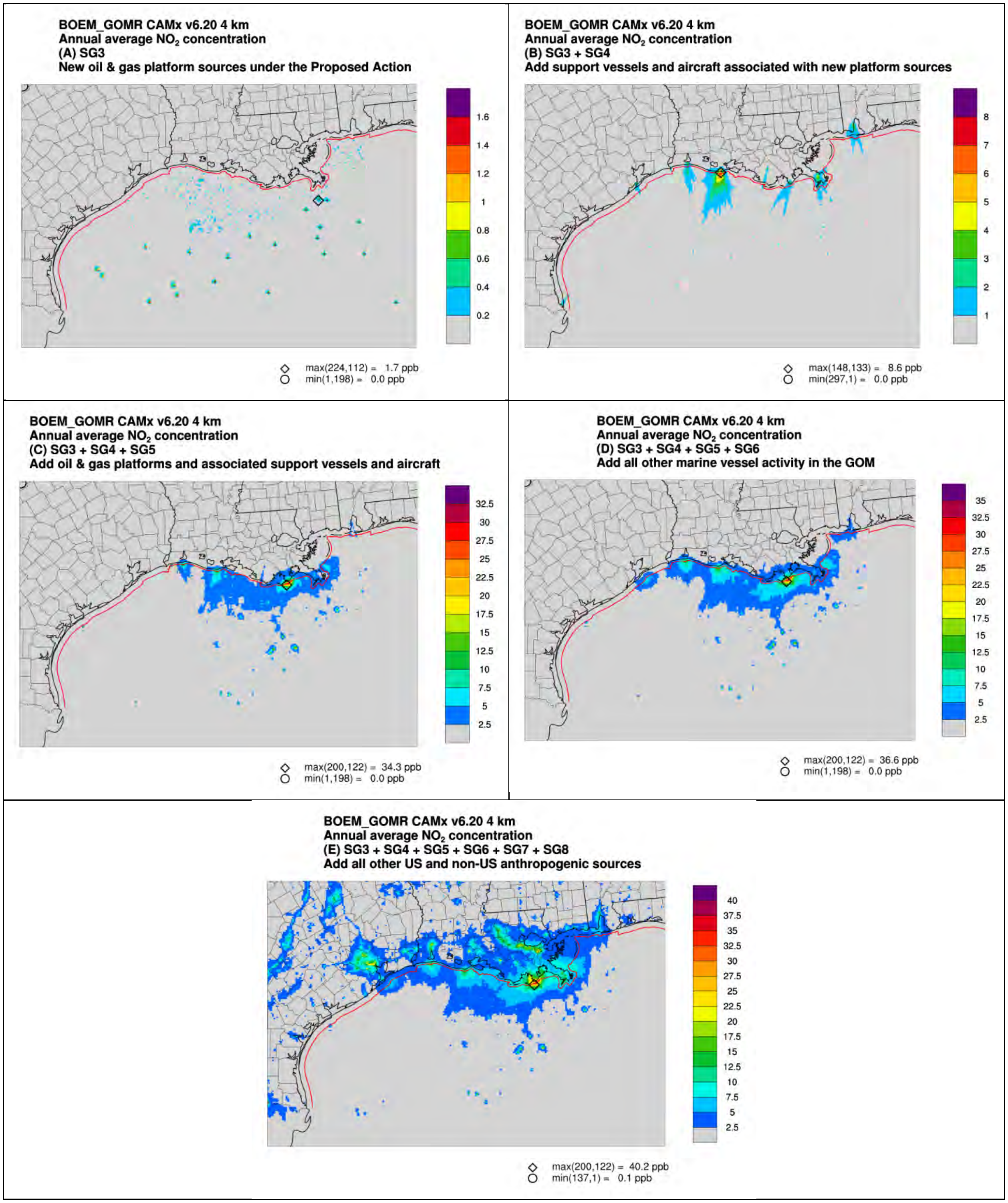

Figure D-59. Contributions of Source Groups A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources Annual Average NO_2 Concentrations.

D.7.1.5.3 SO_2

Results are presented here for both the 1-hour average primary SO_2 NAAQS (75 ppb) and the 3-hour average secondary SO_2 NAAQS (0.5 ppm).

Figure D-60 displays modeled 1-hour SO_2 design values (based on the 4^{th} highest daily maximum 1-hour average SO_2 concentration) for the base, future, and future-base scenarios. Modeled values for the base year are generally below the NAAQS except in the immediate vicinity of some major point sources. Sources in areas with deepwater platforms are evident with maximum values up to 50 ppb. Concentrations decrease in most locations in the future year scenario as sources are retired or apply control equipment with projected maximum impacts all below the NAAQS. No increases in excess of 5 ppb are modeled along the Gulf Coast or over the open ocean.

Contributions of source groups to the modeled 1-hour SO_2 concentrations are shown in **Figure D-61**. New sources associated with the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group B) are modeled to contribute less than 1 ppb.

Figure D-62 displays modeled 3-hour SO_2 design values (based on the annual 2^{nd} highest block, 3-hour average SO_2 concentration) for the base, future, and future-base scenarios. All modeled values are below the NAAQS (500 ppb). These results are similar to those for the 1-hour SO_2 described above.

Contributions of source groups to the modeled 3-hour SO_2 concentrations are shown in **Figure D-63**. Results are similar to those for the 1-hour SO_2 concentrations described above.

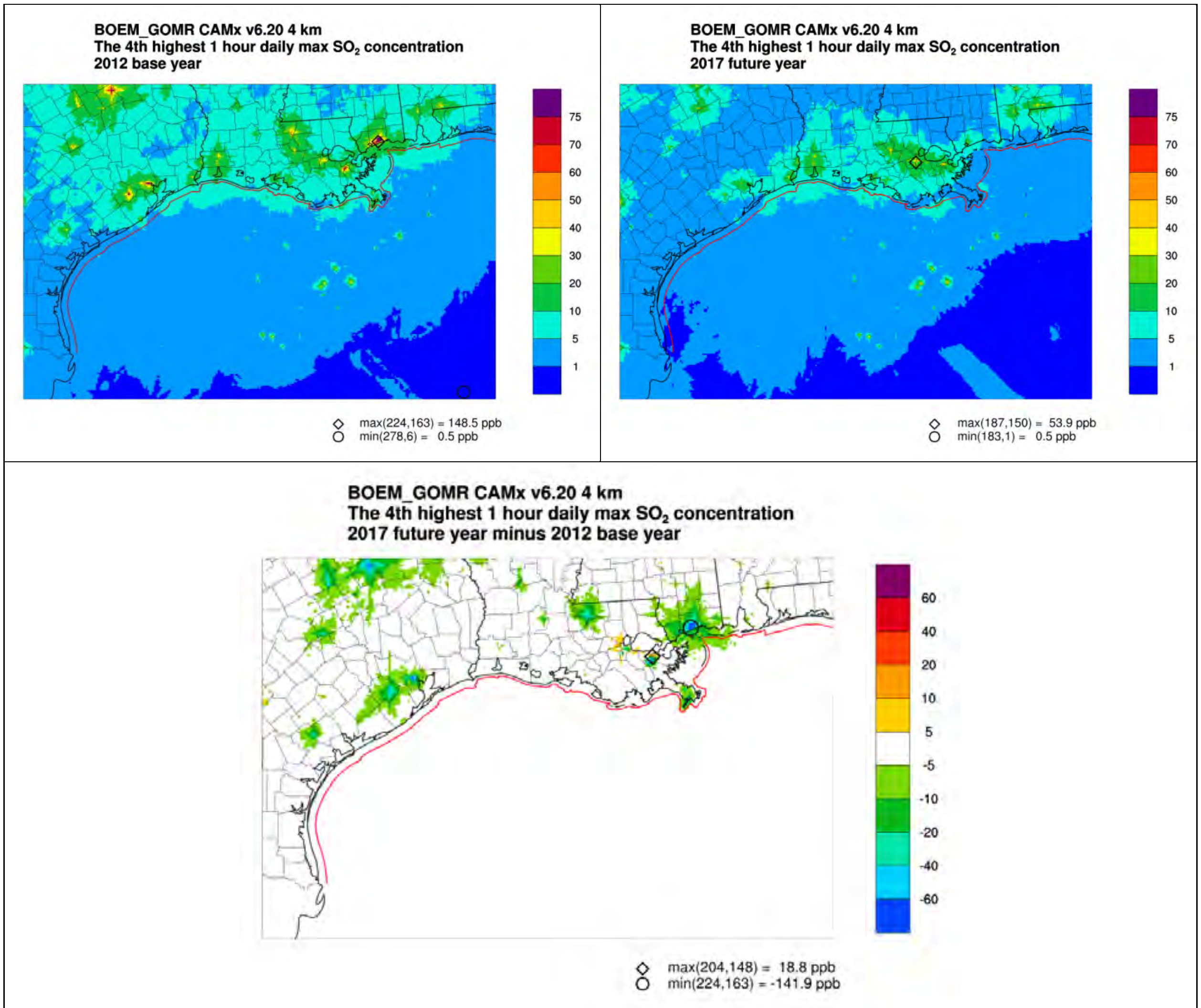

Figure D-60. Modeled 4th Highest Daily Maximum 1-hour SO_2 Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

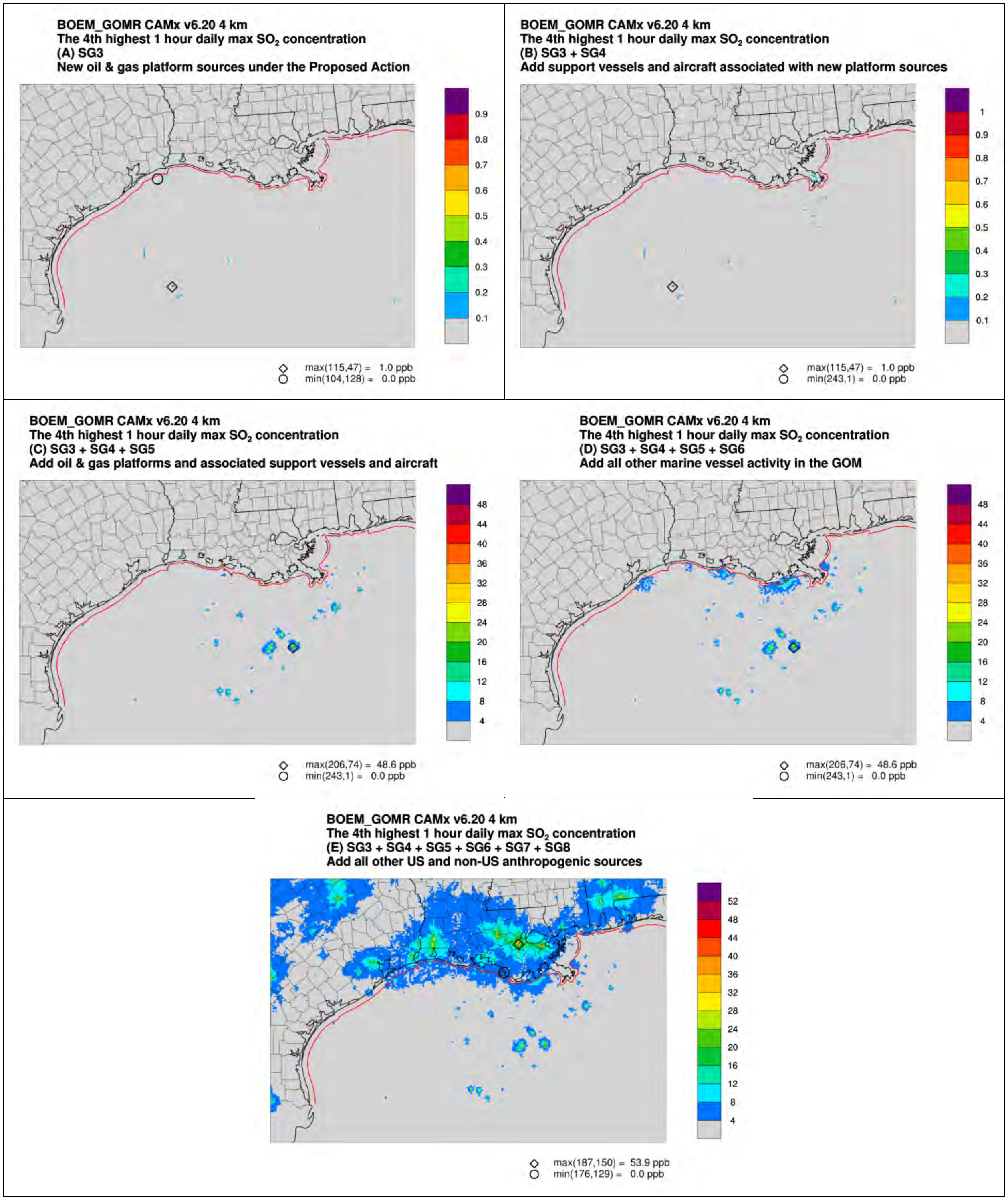

Figure D-61. Contributions of Source Group A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources 4th Highest Daily Maximum 1-hour SO_2 Concentration (note different color scales used in each panel).

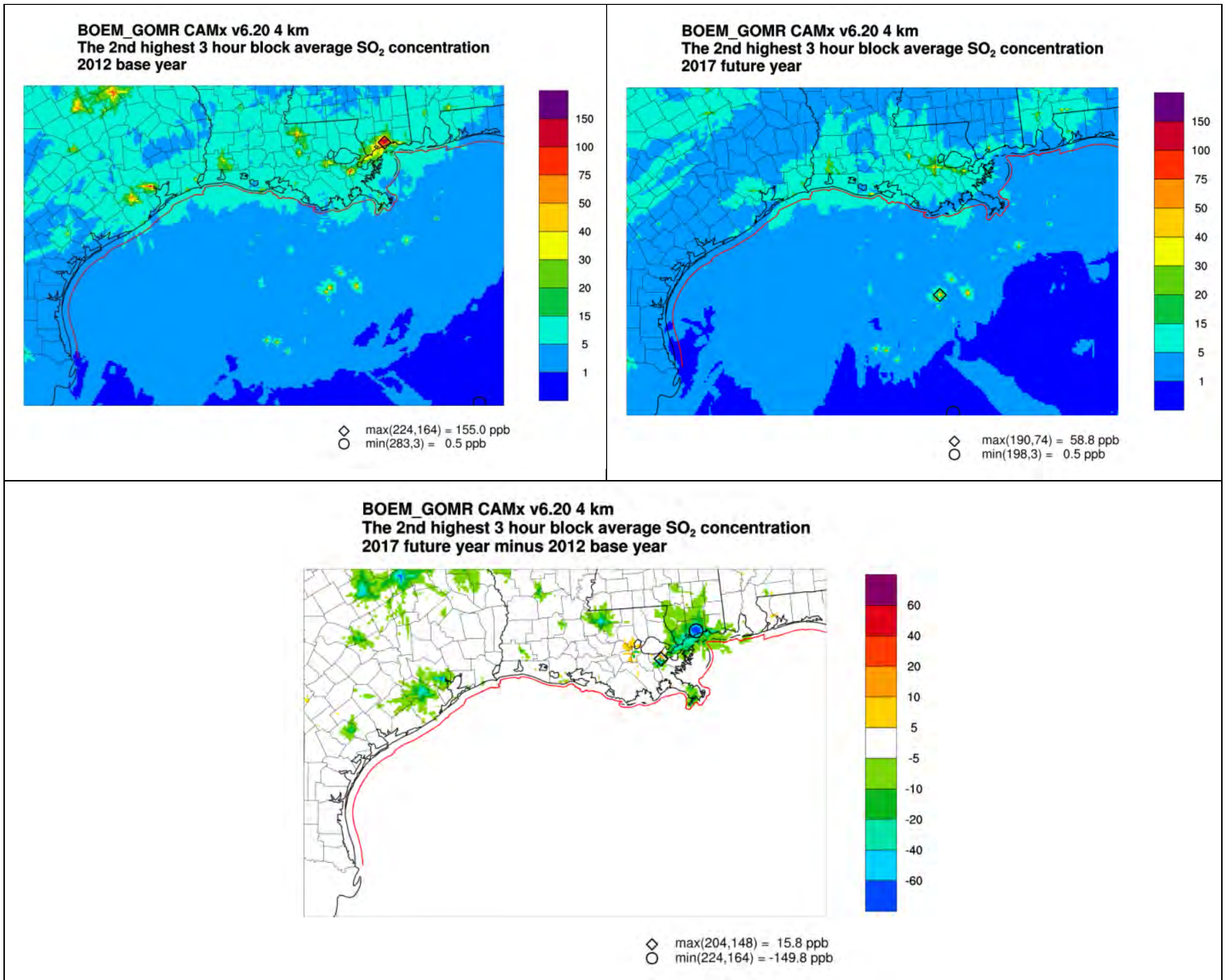

Figure D-62. Modeled Annual 2nd Highest Block 3-hour SO_2 Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

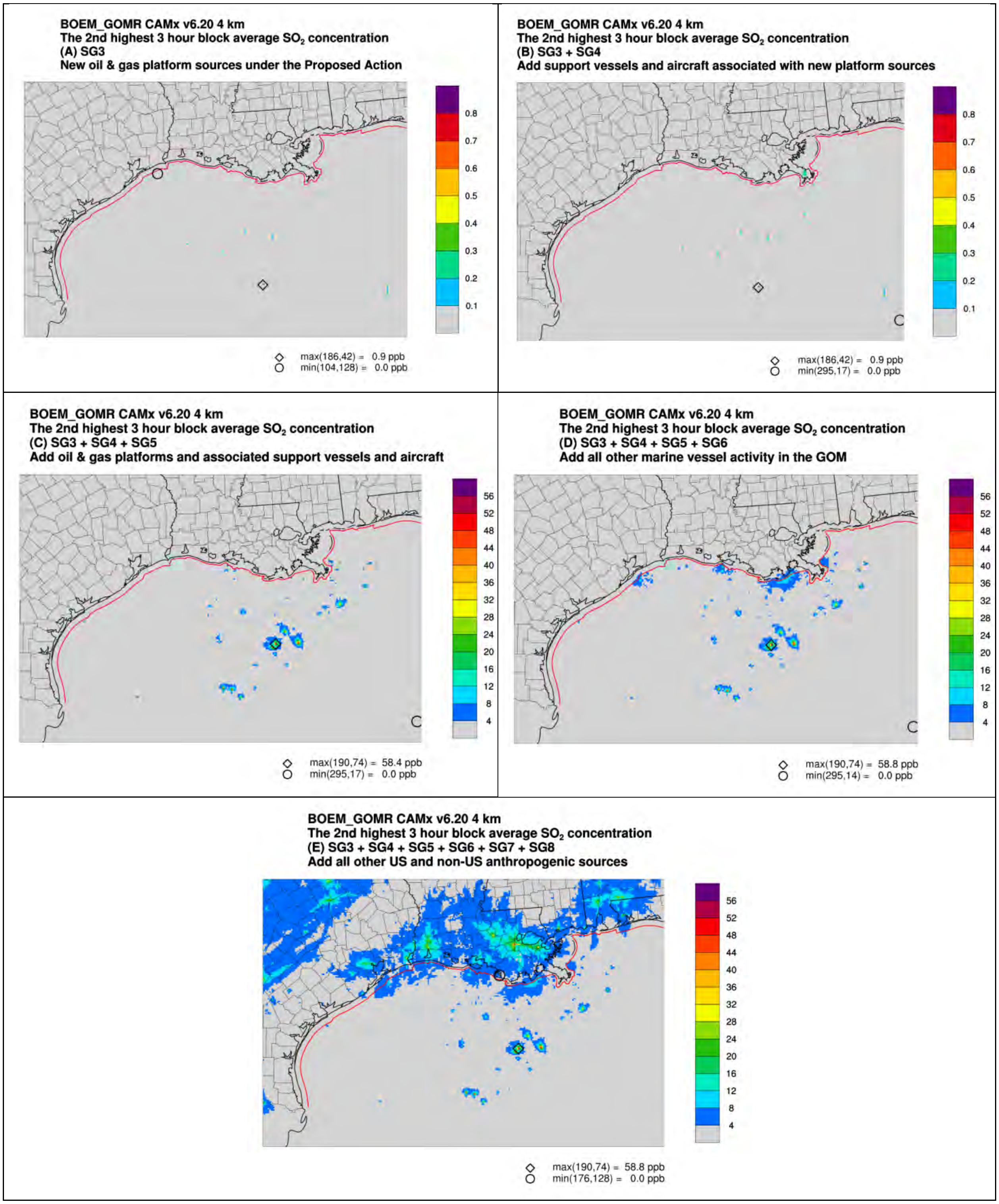

Figure D-63. Contributions of Source Group A (top left), B (top right), C (middle left), D (middle right), and E (bottom) to the Future Year All-sources 2^{nd} Highest 3-hour Block Average SO_2 Concentration (note different color scales used in each panel).

D.7.1.5.4 CO

Results are presented here for both the 8-hour average (9 ppm) and 1-hour average (35 ppm) CO NAAQS.

Figure D-64 displays modeled 8-hour CO design values (based on the annual 2nd highest nonoverlapping running 8-hour average) for the base, future, and future-base scenarios. Similarly, **Figure D-65** displays modeled 1-hour CO design values (based on the annual 2nd highest daily maximum 1-hour average) for the base, future, and future-base scenarios. All values are below the NAAQS. The maximum predicted 8-hour design value in the future year is predicted to be 8.3 ppb at the entrance to the Freshwater Bayou Canal in Vermilion Parish, Louisiana. Differences between the base and future year scenarios are less than 3 ppm.

Individual source group contributions to CO design values were not calculated as the CAM_x source apportionment methods do not include tracers for CO.

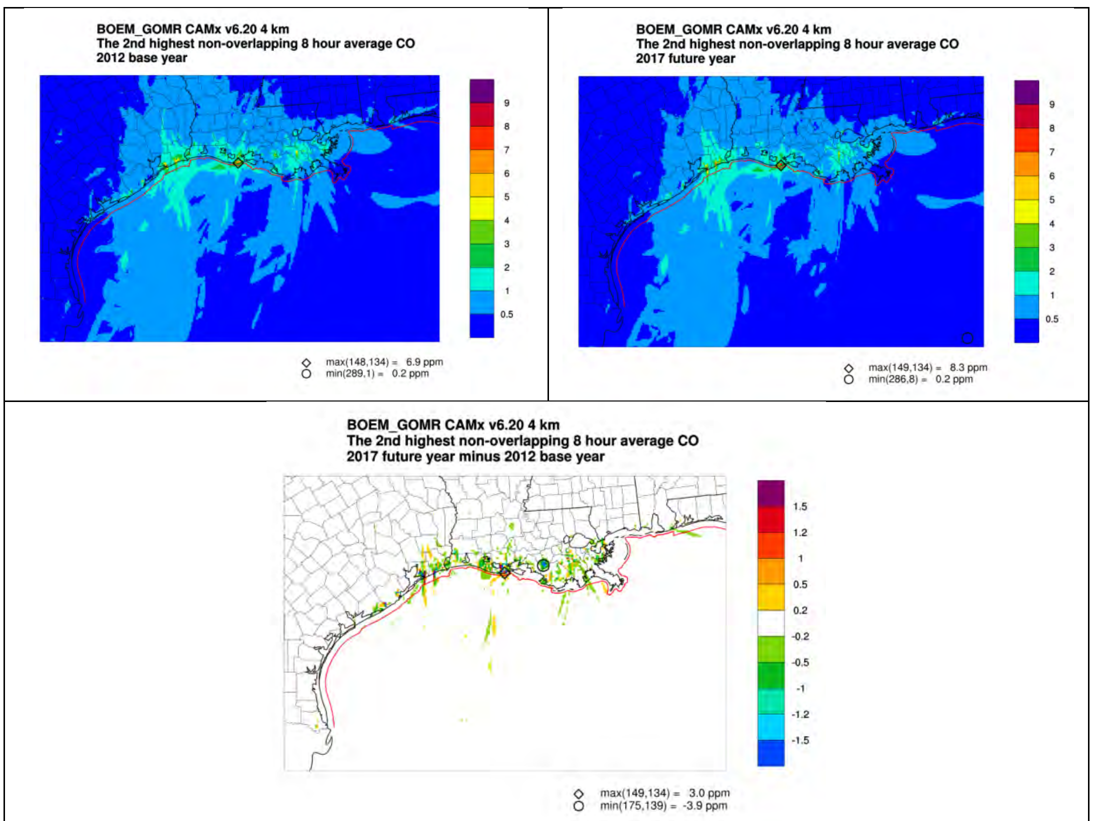

Figure D-64. Modeled Annual 2nd Highest Non-overlapping Running 8-hour Average CO Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

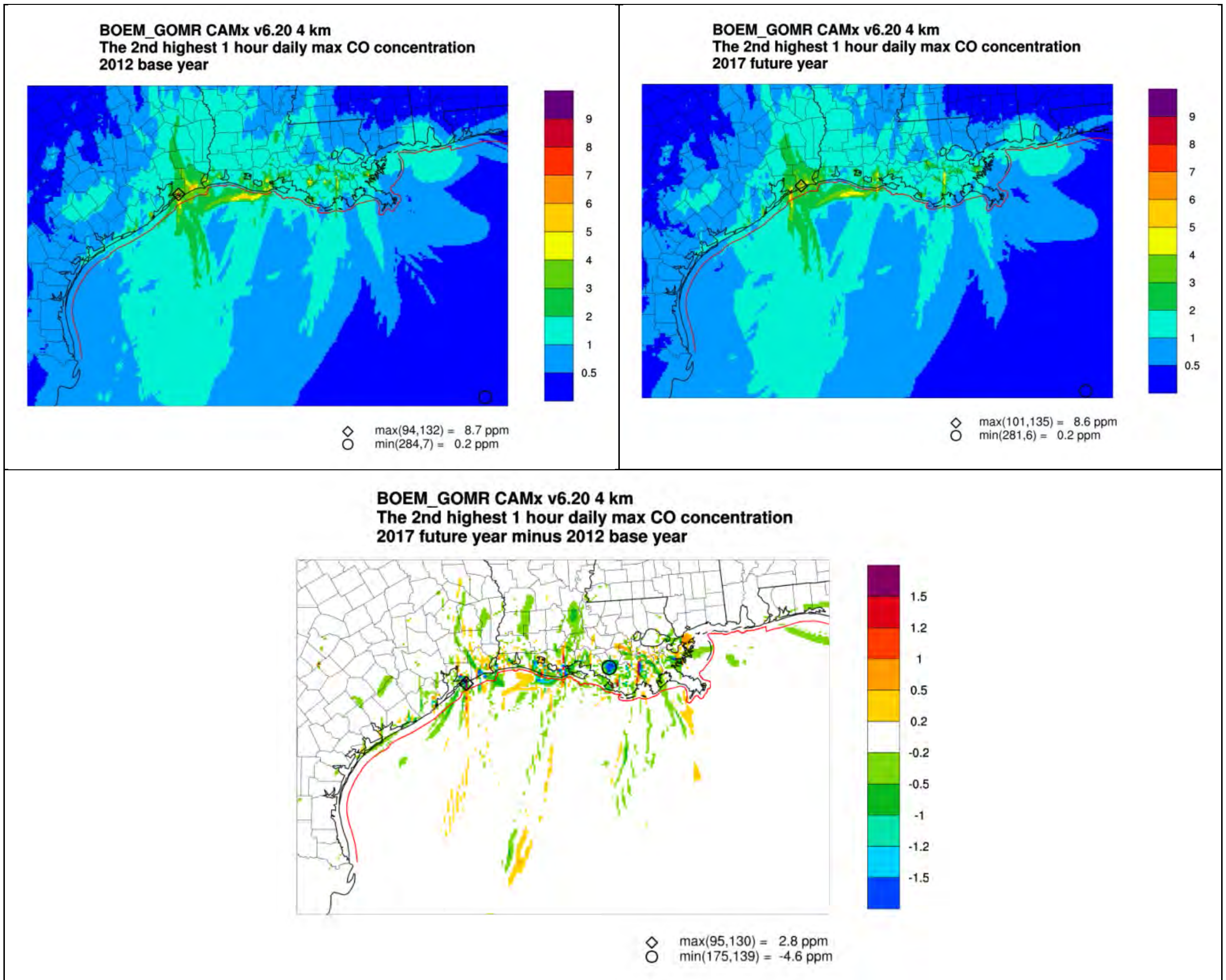

Figure D-65. Modeled Annual 2nd Highest 1-hour Average CO Concentrations for the Base Year (top left), Future Year (top right), and the Future – Base Difference (bottom).

D.7.2 PSD Increments

Incremental impacts of each source group at Class I and sensitive Class II areas were calculated for all pollutants for which PSD increments have been set (NO_2, SO_2, PM_{10}, $PM_{2.5}$). Increment consumption is based on the source group contribution calculated from the CAMx source contribution results. Increment consumption for 24-hour averages and the 3-hour average SO_2 are based on the annual second highest values. Comparisons of impacts from the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario with maximum allowed PSD increments are presented here as an evaluation of a "threshold of concern" for potentially significant adverse impacts, but they do not represent a regulatory PSD increment consumption analysis.

Results of the PSD increments analysis are summarized in **Table D-24** in terms of the maximum increment consumption over all Class I/II areas within the 4-km modeling domain. Maximum impacts occur at the Breton Wilderness Class I area for all PSD pollutants and averaging times. Concentration increments from Source Groups A and B are less than the maximum allowed

PSD increments for all pollutants and averaging times except for the 24-hour $PM_{2.5}$ increment from Source Group B at the Breton Wilderness Class I area where the maximum impact (2.19 µg/m^3) exceeds the Class I PSD increment (2 µg/m^3) by just under 10%. The maximum Source Group A 24-hour average $PM_{2.5}$ increment is 0.53 µg/m^3, indicating that support vessels or helicopter traffic associated with new offshore platforms, rather than emissions from the platforms themselves, are largely responsible for pushing the maximum impact above the Class I PSD increment at Breton Wilderness. The 24-hour $PM_{2.5}$ impact from Source Group B averaged over all grid cells covering the Breton Wilderness Class I area is 1.79 µg/m^3. Maximum impacts from Source Group C exceed the annual and 24-hour $PM_{2.5}$, the 24-hour PM_{10}, and the annual NO_2 Class I PSD increments at Breton Wilderness. A summary of impacts from Source Groups A, B, and C for all Class I/II areas is provided in **Table D-25**.

Table D-24. Maximum Source Group Contributions for PSD Pollutants at Class I and Sensitive Class II Areas in the 4-km Modeling Domain.

Group	Max @ Any Class I Area	Percent of PSD Class I Increment	Class I Area Where Max Occurred	Max @ Any Class II Area	Percent of PSD Class II Increment	Class II Area Where Max Occurred
PM_{10} Annual (Increment = 4 µg/m^3, 17 µg/m^3)						
A	0.04449	1.1%	Breton Wilderness	0.04196	0.2%	Gulf Islands NS
B	0.29475	7.4%	Breton Wilderness	0.35482	2.1%	Gulf Islands NS
C	1.44391	36.1%	Breton Wilderness	1.24095	7.3%	Gulf Islands NS
PM_{10} 24-Hour (Class I, II Increment = 8 µg/m^3, 30 µg/m^3)						
A	0.53529	6.7%	Breton Wilderness	0.61362	2.0%	Gulf Islands NS
B	2.19999	27.5%	Breton Wilderness	2.45061	8.2%	Gulf Islands NS
C	14.4191	180.2%	Breton Wilderness	13.9928	46.6%	Gulf Islands NS
$PM_{2.5}$ Annual (Class I, II Increment = 1 µg/m^3, 4 µg/m^3)						
A	0.04449	4.4%	Breton Wilderness	0.04196	1.0%	Gulf Islands NS
B	0.29152	29.2%	Breton Wilderness	0.34969	8.7%	Gulf Islands NS
C	1.43641	143.6%	Breton Wilderness	1.23711	30.9%	Gulf Islands NS
$PM_{2.5}$ 24-Hour (Class I, II Increment = 2 µg/m^3, 9 µg/m^3)						
A	0.53527	26.8%	Breton Wilderness	0.6136	6.8%	Gulf Islands NS
B	2.19194	109.6%	Breton Wilderness	2.44002	27.1%	Gulf Islands NS
C	14.3964	719.8%	Breton Wilderness	13.9795	155.3%	Gulf Islands NS
NO_2 Annual (Class I, II Increment = 2.5 µg/m^3, 25 µg/m^3)						
A	0.12789	5.1%	Breton Wilderness	0.14467	0.6%	Gulf Islands NS
B	0.65768	26.3%	Breton Wilderness	0.93535	3.7%	Gulf Islands NS
C	2.61628	104.7%	Breton Wilderness	1.95517	7.8%	Breton NWR
SO_2 Annual (Class I, II Increment = 2 µg/m^3, 20 µg/m^3)						
A	0.00113	0.1%	Breton Wilderness	0.00121	0.0%	Gulf Islands NS
B	0.00271	0.1%	Breton Wilderness	0.00178	0.0%	Gulf Islands NS
C	0.0684	3.4%	Breton Wilderness	0.05601	0.3%	Breton NWR
SO_2 24-Hour (Class I, II Increment = 5 µg/m^3, 91 µg/m^3)						
A	0.01009	0.2%	Breton Wilderness	0.01104	0.0%	Breton NWR
B	0.01891	0.4%	Breton Wilderness	0.0156	0.0%	Breton NWR
C	0.53913	10.8%	Breton Wilderness	0.41742	0.5%	Breton NWR
SO_2 3-Hour (Class I, II Increment = 25 µg/m^3, 512 µg/m^3)						
A	0.02228	0.1%	Breton Wilderness	0.01655	0.0%	Breton NWR

Group	Max @ Any Class I Area	Percent of PSD Class I Increment	Class I Area Where Max Occurred	Max @ Any Class II Area	Percent of PSD Class II Increment	Class II Area Where Max Occurred
B	0.03451	0.1%	Breton Wilderness	0.02296	0.0%	Breton NWR
C	1.17783	4.7%	Breton Wilderness	1.03688	0.2%	Breton NWR

NS = National Seashore; NWR = National Wildlife Refuge.

D.7.3 AQRV Impacts

D.7.3.1 Visibility

Incremental visibility impacts were calculated for each source group as well as the cumulative impact of all sources combined. The approach used the incremental concentrations as quantified by the CAMx PSAT source apportionment tool simulation for each source group. Changes in light extinction from CAMx model concentration increments due to emissions from each source group were calculated for each day at grid cells that intersect Class I and sensitive Class II areas within the 12-km modeling domain.

Calculation of incremental visibility impacts followed procedures recommended by the Federal Land Managers (FLAG, 2010) as described in **Section D.6.2.3.1**.

For each individual source group, the estimated visibility degradation at each Class I and sensitive Class II area in the 12-km modeling domain due to emissions from the source group are presented in terms of the number of days that exceed a threshold change in deciview (Δdv) relative to background conditions. The number of days with a Δdv greater than 0.5 and 1.0 are reported.

Results of the FLAG (2010) incremental visibility impact assessment for Source Groups A and B are presented in **Tables D-26 and D-27**, respectively. For Source Group A, the annual 8^{th} highest Δdv exceed the 1.0 threshold at Breton Wilderness, Breton National Wildlife Refuge, and Gulf Islands National Seashore. Incremental impacts for Source Group B are larger and include days with the 8^{th} highest Δdv greater than 1.0 at Padre Island National Seashore in addition to the areas mentioned above, as well as values greater than 0.5 at Chassahowitzka Wilderness and St. Marks National Wildlife Refuge.

Table D-25. Source Group Contributions for PSD Pollutants at All Class I and Sensitive Class II Areas in the 4-km Modeling Domain.

Source Group A										
		Pollutant	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		PM_{25} (µg/m^3)		SO_2 (µg/m^3)		
		Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Breton Wilderness	LA	FWS	0.128	0.535	0.044	0.535	0.044	0.022	0.010	0.001
Class II	State	Owner	PSD Class II Increment[1]							
			25	30	17	9	4	512	91	20
Breton NWR	LA	FWS	0.063	0.436	0.036	0.436	0.036	0.017	0.011	0.001
Gulf Islands NS	FL,MS	NPS	0.145	0.614	0.042	0.614	0.042	0.014	0.007	0.001
Padre Island NS	TX	NPS	0.014	0.169	0.014	0.169	0.014	0.006	0.002	0.000
Source Group B										
		Pollutant	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		PM_{25} (µg/m^3)		SO_2 (µg/m^3)		
		Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Breton Wilderness	LA	FWS	0.658	2.200	0.295	2.192	0.292	0.035	0.019	0.003
Class II	State	Owner	PSD Class II Increment[1]							
			25	30	17	9	4	512	91	20
Breton NWR	LA	FWS	0.321	1.752	0.182	1.748	0.181	0.023	0.016	0.002
Gulf Islands NS	FL,MS	NPS	0.935	2.451	0.355	2.440	0.350	0.017	0.008	0.002
Padre Island NS	TX	NPS	0.181	1.013	0.166	1.012	0.165	0.006	0.003	0.001
Source Group C										
		Pollutant	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		PM_{25} (µg/m^3)		SO_2 (µg/m^3)		
		Averaging Time	Annual[3]	24-hour[2]	Annual[3]	24-hour[4]	Annual[3]	3-hour[2]	24-hour[2]	Annual[3]
Class I	State	Owner	PSD Class I Increment[1]							
			2.5	8	4	2	1	25	5	2
Breton Wilderness	LA	FWS	2.616	14.419	1.444	14.396	1.436	1.178	0.539	0.068
Class II	State	Owner	PSD Class II Increment[1]							
			25	30	17	9	4	512	91	20
Breton NWR	LA	FWS	1.955	12.577	1.127	12.559	1.122	1.037	0.417	0.056
Gulf Islands NS	FL,MS	NPS	1.521	13.993	1.241	13.979	1.237	0.410	0.196	0.016
Padre Island NS	TX	NPS	0.198	2.031	0.225	2.030	0.224	0.044	0.022	0.002

NS = National Seashore; NWR = National Wildlife Refuge.

[1] The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.

[2] Based on 2nd highest 24-hour average.

[3] Annual arithmetic mean.

[4] Based on 2ndhighest 24-hour average.

Table D-26. Incremental Visibility Impacts Relative to Natural Background Conditions from Source Group A.

Area	Max Δdv	8^{th} High Δdv	No. of Days	
			>1.0	>0.5
Class I Areas				
Bandelier National Monument	0.00067	0.00016	0	0
Black Canyon of the Gunnison National Park	0.00002	0.00000	0	0
Bosque del Apache National Wildlife Refuge	0.00050	0.00018	0	0
Bosque del Apache (Chupadera Unit) Wilderness	0.00036	0.00013	0	0
Bosque del Apache (Indian Well Unit) Wilderness	0.00036	0.00014	0	0
Bosque del Apache (Little San Pascual Unit) Wilderness	0.00072	0.00023	0	0
Big Bend National Park	0.00746	0.00286	0	0
Bradwell Bay Wilderness	0.08487	0.05269	0	0
Breton Wilderness	2.65806	1.54415	22	57
Caney Creek Wilderness	0.21478	0.07569	0	0
Cape Romain Wilderness	0.08319	0.01800	0	0
Carlsbad Caverns National Park	0.00337	0.00163	0	0
Chassahowitzka Wilderness	0.26500	0.11299	0	0
Cohutta Wilderness	0.07214	0.02483	0	0
Dolly Sods Wilderness	0.01130	0.00424	0	0
Eagles Nest Wilderness	0.00009	0.00001	0	0
Everglades National Park	0.13374	0.04721	0	0
Flat Tops Wilderness	0.00002	0.00000	0	0
Great Sand Dunes National Monument	0.00020	0.00006	0	0
Great Smoky Mountains National Park	0.02866	0.01263	0	0
Guadalupe Mountains National Park	0.00283	0.00094	0	0
Hercules-Glades Wilderness	0.05899	0.02394	0	0
James River Face Wilderness	0.00768	0.00391	0	0
Joyce-Kilmer-Slickrock Wilderness	0.02655	0.00881	0	0
La Garita Wilderness	0.00013	0.00001	0	0
Linville Gorge Wilderness	0.01892	0.00436	0	0
Mammoth Cave National Park	0.04330	0.01815	0	0
Maroon Bells-Snowmass Wilderness	0.00007	0.00001	0	0
Mingo National Wildlife Refuge	0.07764	0.04615	0	0
Mount_Zirkel Wilderness	0.00002	0.00000	0	0
Okefenokee National Wildlife Refuge	0.06476	0.03510	0	0
Otter Creek Wilderness	0.01108	0.00356	0	0
Pecos Wilderness	0.00091	0.00023	0	0
Rawah Wilderness	0.00005	0.00001	0	0
Rocky Mountain National Park	0.00023	0.00003	0	0
Saint Marks National Wildlife Refuge	0.24139	0.19294	0	0
Salt Creek Wilderness	0.00278	0.00149	0	0
San Pedro Parks Wilderness	0.00038	0.00010	0	0
Shenandoah National Park	0.02361	0.00945	0	0
Shining Rock Wilderness	0.02231	0.01030	0	0
Sipsey Wilderness	0.09946	0.02484	0	0

Area	Max Δdv	8th High Δdv	No. of Days	
			>1.0	>0.5
Swanquarter National Wildlife Refuge	0.01852	0.00864	0	0
Upper Buffalo Wilderness	0.05460	0.02255	0	0
Weminuche Wilderness	0.00018	0.00002	0	0
West Elk Wilderness	0.00006	0.00001	0	0
Wheeler Peak Wilderness	0.00037	0.00012	0	0
White Mountain Wilderness	0.00085	0.00042	0	0
Wichita Mountains National Wildlife Refuge	0.02963	0.01625	0	0
Wichita Mountains (Charons Garden Unit) Wilderness	0.02932	0.01390	0	0
Wichita Mountains (North Mountain Unit) Wilderness	0.02983	0.01408	0	0
Wolf Island Wilderness	0.10444	0.02825	0	0
Class II Areas				
Breton National Wildlife Refuge	2.51391	1.44000	13	41
Gulf Islands National Seashore	3.59820	1.79194	26	64
Padre Island National Seashore	1.28497	0.44893	2	5

Table D-27. Incremental Visibility Impacts Relative to Natural Background Conditions from Source Group B.

Area	Max Δdv	8th High Δdv	No. of Days	
			>1.0	>0.5
Class I Areas				
Bandelier NM	0.00588	0.00225	0	0
Black Canyon of the Gunnison National Park	0.00027	0.00003	0	0
Bosque del Apache National Wildlife Refuge	0.00927	0.00254	0	0
Bosque del Apache (Chupadera Unit) Wilderness	0.00674	0.00173	0	0
Bosque del Apache (Indian Well Unit) Wilderness	0.00692	0.00183	0	0
Bosque del Apache (Little San Pascual Unit) Wilderness	0.01274	0.00311	0	0
Big Bend National Park	0.06000	0.03458	0	0
Bradwell Bay Wilderness	0.43077	0.29328	0	0
Breton Wilderness	7.77098	6.27094	155	256
Caney Creek Wilderness	1.37302	0.48258	1	7
Cape Romain Wilderness	0.31147	0.08130	0	0
Carlsbad Caverns National Park	0.03024	0.01639	0	0
Chassahowitzka Wilderness	1.35442	0.55791	3	9
Cohutta Wilderness	0.37888	0.12203	0	0
Dolly Sods Wilderness	0.06063	0.03063	0	0
Eagles Nest Wilderness	0.00128	0.00016	0	0
Everglades National Park	0.72032	0.18655	0	2
Flat Tops Wilderness	0.00022	0.00003	0	0
Great Sand Dunes National Monument	0.00329	0.00067	0	0
Great Smoky Mountains National Park	0.15002	0.07991	0	0
Guadalupe Mountains National Park	0.02529	0.01502	0	0
Hercules-Glades Wilderness	0.41027	0.16105	0	0
James River Face Wilderness	0.05739	0.02478	0	0

Joyce-Kilmer-Slickrock Wilderness	0.15156	0.07538	0	0
La Garita Wilderness	0.00252	0.00019	0	0
Linville Gorge Wilderness	0.10346	0.03554	0	0
Mammoth Cave National Park	0.23624	0.09683	0	0
Maroon Bells-Snowmass Wilderness	0.00103	0.00006	0	0
Mingo National Wildlife Refuge	0.44782	0.25368	0	0
Mount_Zirkel Wilderness	0.00019	0.00003	0	0
Okefenokee National Wildlife Refuge	0.40346	0.21507	0	0
Otter Creek Wilderness	0.06577	0.02996	0	0
Pecos Wilderness	0.00863	0.00303	0	0
Rawah Wilderness	0.00062	0.00016	0	0
Rocky Mountain National Park	0.00128	0.00028	0	0
Saint Marks National Wildlife Refuge	1.04546	0.79486	2	23
Salt Creek Wilderness	0.03543	0.01558	0	0
San Pedro Parks Wilderness	0.00562	0.00171	0	0
Shenandoah National Park	0.13636	0.05190	0	0
Shining Rock Wilderness	0.12422	0.06132	0	0
Sipsey Wilderness	0.47703	0.15148	0	0
Swanquarter National Wildlife Refuge	0.09369	0.04563	0	0
Upper Buffalo Wilderness	0.42865	0.16699	0	0
Weminuche Wilderness	0.00268	0.00031	0	0
West Elk Wilderness	0.00100	0.00006	0	0
Wheeler Peak Wilderness	0.00491	0.00148	0	0
White Mountain Wilderness	0.01424	0.00635	0	0
Wichita Mountains National Wildlife Refuge	0.19286	0.10693	0	0
Wichita Mountains (Charons Garden Unit) Wilderness	0.18960	0.08842	0	0
Wichita Mountains (North Mountain Unit) Wilderness	0.19390	0.09435	0	0
Wolf Island Wilderness	0.39934	0.13342	0	0
Class II Areas				
Breton National Wildlife Refuge	7.10912	4.34015	104	193
Gulf Islands National Seashore	10.54646	6.33562	198	311
Padre Island National Seashore	5.10452	3.05326	115	204

D.7.3.1.2 Cumulative Visibility Analysis

For the cumulative visibility impacts analysis, the MATS software was applied with observed PM species concentrations and monthly average relative humidity from IMPROVE monitoring sites to calculate daily visibility impairment at Class I areas from which the W20% and B20% visibility days metrics are determined as described in **Section D.7.2.3.1**. Since not all Class I areas have a co-located IMPROVE monitoring site, IMPROVE observations were mapped to nearby Class I areas that did not include an IMPROVE monitor. In **Table D-28**, the Class I area of interest is shown in the first column and the IMPROVE site used to represent observed visibility at the Class I area is shown in the third column. For example, the IMPROVE data from Dolly Sods Wilderness was used to represent observed visibility for both Dolly Sods Wilderness and Otter Creek Wilderness. The MATS includes mappings of IMPROVE site to Class I areas. However, MATS does not include a mapping for the Breton Wilderness or Bradwell Bay Class I areas and, therefore, cumulative visibility results for these areas are not included in this analysis.

Tables D-28 and D-29 resent results for the W20% visibility days, and **Tables D-30 and D-31** present results for the B20% visibility days. Visibility improvement between the base and future year scenarios (i.e., positive BY-FY results in **Tables D-29 and D-31**) are seen at most Class I areas, with eight areas experiencing reductions in visibility on the W20% days. All of these areas are in New Mexico and Colorado, and Gulf of Mexico sources (Source Group D) contribute less than 0.02 dv to visibility impairment in these areas. The maximum contribution from new platforms and support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) scenario (Source Group B) to any area on the W20% days is 0.04 dv at Caney Creek, Arkansas. Contributions from all Gulf of Mexico sources (Source Group D) are the greatest (0.34 dv) at St. Marks National Wildlife Refuge, Florida.

For the B20% visibility days, 11 areas experience reductions in visibility. All but one of these areas are located in New Mexico and Colorado; the lone exception is Big Bend National Park in Texas. Contributions from Gulf of Mexico sources to these 11 areas are all less than 0.01 dv. The maximum contribution from new platforms and support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS (from which this Supplemental EIS tiers) (Source Group B) to any area on the B20% days is 0.01 dv, which occurs at several sites. Contributions from all Gulf of Mexico sources (Source Group D) are the greatest (0.08 dv) at St. Marks Wilderness in Florida.

Table D-28. Cumulative Visibility Results for 20% Worst Visibility Days (W20%) at Class I Areas for Base (2012) Year (BY) and Future Year (FY) Scenarios with All Sources Included and with Contributions from Each Source Group Removed.

					FY DV without Source Group				
Class I Name	State	IMPROVE Site	BY DV	FY DV	A	B	C	D	E
Bandelier NM	NM	BAND1	11.79	11.93	11.93	11.93	11.93	11.93	7.56
Big Bend NP	TX	BIBE1	16.40	16.11	16.11	16.11	16.10	16.09	11.13
Black Canyon of the Gunnison NM	CO	WEMI1	10.11	10.05	10.05	10.05	10.05	10.05	9.34
Bosque del Apache	NM	BOAP1	13.65	13.90	13.90	13.90	13.90	13.90	10.69
Caney Creek Wilderness	AR	CACR1	22.66	20.59	20.58	20.55	20.45	20.36	13.36
Carlsbad Caverns NP	TX	GUMO1	15.17	15.14	15.14	15.14	15.14	15.14	9.33
Chassahowitzka	FL	CHAS1	21.77	20.43	20.43	20.41	20.35	20.18	11.45
Cohutta Wilderness	GA	COHU1	23.94	21.11	21.11	21.11	21.09	21.06	12.89
Dolly Sods Wilderness	WV	DOSO1	23.45	19.52	19.52	19.52	19.52	19.51	14.64
Eagles Nest Wilderness	CO	WHRI1	8.81	8.72	8.72	8.72	8.72	8.72	7.84
Everglades NP	FL	EVER1	18.33	17.63	17.63	17.63	17.63	17.51	15.00
Flat Tops Wilderness	CO	WHRI1	8.81	8.72	8.72	8.72	8.72	8.72	7.84
Great Sand Dunes NM	CO	GRSA1	11.52	11.62	11.62	11.62	11.62	11.62	8.94
Great Smoky Mountains NP	TN	GRSM1	23.75	20.30	20.30	20.29	20.29	20.28	13.84
Guadalupe Mountains NP	TX	GUMO1	15.17	15.14	15.14	15.14	15.14	15.14	9.33
Hercules-Glades Wilderness	MO	HEGL1	23.50	21.48	21.47	21.46	21.42	21.37	13.21
James River Face Wilderness	VA	JARI1	23.50	20.75	20.75	20.74	20.74	20.73	16.07
Joyce-Kilmer-Slickrock Wilderness	TN	GRSM1	23.75	20.30	20.30	20.29	20.29	20.28	13.84
La Garita Wilderness	CO	WEMI1	10.11	10.05	10.05	10.05	10.05	10.05	9.34
Linville Gorge Wilderness	NC	LIGO1	22.61	19.38	19.38	19.37	19.37	19.36	13.29
Maroon Bells-Snowmass Wilderness	CO	WHRI1	8.81	8.72	8.72	8.72	8.72	8.72	7.84
Mammoth Cave NP	KY	MACA1	26.11	22.68	22.68	22.68	22.67	22.66	14.97
Mount Zirkel Wilderness	CO	MOZI1	9.33	9.20	9.20	9.20	9.20	9.20	7.25
Okefenokee	GA	OKEF1	23.31	21.99	21.99	21.98	21.93	21.87	12.62
Otter Creek Wilderness	WV	DOSO1	23.45	19.52	19.52	19.52	19.52	19.51	14.64
Pecos Wilderness	NM	WHPE1	10.04	10.10	10.10	10.10	10.10	10.10	6.73
Rawah Wilderness	CO	MOZI1	9.33	9.20	9.20	9.20	9.20	9.20	7.25
Cape Romain	SC	ROMA1	23.40	21.77	21.77	21.77	21.73	21.68	13.12
Rocky Mountain NP	CO	ROMO1	12.02	11.86	11.86	11.86	11.86	11.86	9.19

Table D-28. Cumulative Visibility Results for 20% Worst Visibility Days (W20%) at Class I Areas for Base (2012) Year (BY) and Future Year (FY) Scenarios with All Sources Included and with Contributions from Each Source Group Removed. (continued)

					FY DV without Source Group				
Class I Name	State	IMPROVE Site	BY DV	FY DV	A	B	C	D	E
Salt Creek	NM	SACR1	17.22	17.79	17.79	17.79	17.79	17.78	7.30
St. Marks	FL	SAMA1	23.01	21.18	21.18	21.16	21.06	20.84	13.43
San Pedro Parks Wilderness	NM	SAPE1	9.94	9.98	9.98	9.98	9.98	9.98	7.15
Shenandoah NP	VA	SHEN1	22.95	19.42	19.42	19.42	19.41	19.39	14.90
Shining Rock Wilderness	NC	SHRO1	21.90	18.78	18.78	18.77	18.77	18.76	12.25
Sipsey Wilderness	AL	SIPS1	23.98	21.48	21.48	21.47	21.46	21.44	13.01
Swanquarter	NC	SWAN1	22.29	20.39	20.39	20.39	20.38	20.37	13.42
Upper Buffalo Wilderness	AR	UPBU1	22.93	20.90	20.89	20.87	20.79	20.71	12.97
West Elk Wilderness	CO	WHRI1	8.81	8.72	8.72	8.72	8.72	8.72	7.84
Weminuche Wilderness	CO	WEMI1	10.11	10.05	10.05	10.05	10.05	10.05	9.34
White Mountain Wilderness	NM	WHIT1	14.24	14.60	14.60	14.60	14.59	14.59	8.15
Wheeler Peak Wilderness	NM	WHPE1	10.04	10.10	10.10	10.10	10.10	10.10	6.73
Wichita Mountains	OK	WIMO1	21.55	20.33	20.33	20.32	20.31	20.30	10.33
Wolf Island	GA	OKEF1	23.31	21.99	21.99	21.98	21.93	21.87	12.62

NM = National Monument; NP = National Park.

Table D-29. Differences in Cumulative Visibility Results for 20% Worst Visibility Days (W20%) at Class I Areas Between the Future Year (FY) and Base Year (BY) Scenarios and Contributions of Each Source Group to the Future Year Scenario Visibility.

				FY DV without Source Group				
Class I Name	State	IMPROVE Site	BYFY DV	A	B	C	D	E
Bandelier NM	NM	BAND1	-0.14	0.00	0.00	0.00	0.00	4.37
Big Bend NP	TX	BIBE1	0.29	0.00	0.00	0.01	0.02	4.98
Black Canyon of the Gunnison NM	CO	WEMI1	0.06	0.00	0.00	0.00	0.00	0.71
Bosque del Apache	NM	BOAP1	-0.25	0.00	0.00	0.00	0.00	3.21
Caney Creek Wilderness	AR	CACR1	2.07	0.01	0.04	0.14	0.23	7.23
Carlsbad Caverns NP	TX	GUMO1	0.03	0.00	0.00	0.00	0.00	5.81
Chassahowitzka	FL	CHAS1	1.34	0.00	0.02	0.08	0.25	8.98
Cohutta Wilderness	GA	COHU1	2.83	0.00	0.00	0.02	0.05	8.22
Dolly Sods Wilderness	WV	DOSO1	3.93	0.00	0.00	0.00	0.01	4.88
Eagles Nest Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.88
Everglades NP	FL	EVER1	0.70	0.00	0.00	0.00	0.12	2.63
Flat Tops Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.88
Great Sand Dunes NM	CO	GRSA1	-0.10	0.00	0.00	0.00	0.00	2.68
Great Smoky Mountains NP	TN	GRSM1	3.45	0.00	0.01	0.01	0.02	6.46
Guadalupe Mountains NP	TX	GUMO1	0.03	0.00	0.00	0.00	0.00	5.81
Hercules-Glades Wilderness	MO	HEGL1	2.02	0.01	0.02	0.06	0.11	8.27
James River Face Wilderness	VA	JARI1	2.75	0.00	0.01	0.01	0.02	4.68
Joyce-Kilmer-Slickrock Wilderness	TN	GRSM1	3.45	0.00	0.01	0.01	0.02	6.46
La Garita Wilderness	CO	WEMI1	0.06	0.00	0.00	0.00	0.00	0.71
Linville Gorge Wilderness	NC	LIGO1	3.23	0.00	0.01	0.01	0.02	6.09
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.88
Mammoth Cave NP	KY	MACA1	3.43	0.00	0.00	0.01	0.02	7.71
Mount Zirkel Wilderness	CO	MOZI1	0.13	0.00	0.00	0.00	0.00	1.95
Okefenokee	GA	OKEF1	1.32	0.00	0.01	0.06	0.12	9.37
Otter Creek Wilderness	WV	DOSO1	3.93	0.00	0.00	0.00	0.01	4.88
Pecos Wilderness	NM	WHPE1	-0.06	0.00	0.00	0.00	0.00	3.37
Rawah Wilderness	CO	MOZI1	0.13	0.00	0.00	0.00	0.00	1.95
Cape Romain	SC	ROMA1	1.63	0.00	0.00	0.04	0.09	8.65
Rocky Mountain NP	CO	ROMO1	0.16	0.00	0.00	0.00	0.00	2.67

Table D-29. Differences in Cumulative Visibility Results for 20% Worst Visibility Days (W20%) at Class I Areas Between the Future Year (FY) and Base Year (BY) Scenarios and Contributions of Each Source Group to the Future Year Scenario Visibility (continued).

				FY DV without Source Group				
Class I Name	State	IMPROVE Site	BYFY DV	A	B	C	D	E
Salt Creek	NM	SACR1	-0.57	0.00	0.00	0.00	0.01	10.49
St. Marks	FL	SAMA1	1.83	0.00	0.02	0.12	0.34	7.75
San Pedro Parks Wilderness	NM	SAPE1	-0.04	0.00	0.00	0.00	0.00	2.83
Shenandoah NP	VA	SHEN1	3.53	0.00	0.00	0.01	0.03	4.52
Shining Rock Wilderness	NC	SHRO1	3.12	0.00	0.01	0.01	0.02	6.53
Sipsey Wilderness	AL	SIPS1	2.50	0.00	0.01	0.02	0.04	8.47
Swanquarter	NC	SWAN1	1.90	0.00	0.00	0.01	0.02	6.97
Upper Buffalo Wilderness	AR	UPBU1	2.03	0.01	0.03	0.11	0.19	7.93
West Elk Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.88
Weminuche Wilderness	CO	WEMI1	0.06	0.00	0.00	0.00	0.00	0.71
White Mountain Wilderness	NM	WHIT1	-0.36	0.00	0.00	0.01	0.01	6.45
Wheeler Peak Wilderness	NM	WHPE1	-0.06	0.00	0.00	0.00	0.00	3.37
Wichita Mountains	OK	WIMO1	1.22	0.00	0.01	0.02	0.03	10.00
Wolf Island	GA	OKEF1	1.32	0.00	0.01	0.06	0.12	9.37

NM = National Monument; NP = National Park.

Table D-30. Cumulative Visibility Results for 20% Best Visibility Days (B20%) at Class I Areas for Base (2012) Year (BY) and Future Year (FY) Scenarios with All Sources Included and with Contributions from Each Source Group Removed.

					FY DV without Source Group				
Class I Name	State	IMPROVE Site	BY DV	FY DV	A	B	C	D	E
Bandelier NM	NM	BAND1	3.81	3.96	3.96	3.96	3.96	3.96	1.51
Big Bend NP	TX	BIBE1	5.76	5.86	5.86	5.86	5.86	5.86	3.50
Black Canyon of the Gunnison NM	CO	WEMI1	2.04	2.18	2.18	2.18	2.18	2.18	1.55
Bosque del Apache	NM	BOAP1	5.57	5.60	5.60	5.60	5.60	5.60	3.60
Caney Creek Wilderness	AR	CACR1	9.82	9.25	9.25	9.24	9.22	9.20	5.15
Carlsbad Caverns NP	TX	GUMO1	5.08	5.03	5.03	5.03	5.03	5.03	2.39
Chassahowitzka	FL	CHAS1	14.05	13.55	13.55	13.54	13.52	13.34	8.22
Cohutta Wilderness	GA	COHU1	11.47	10.59	10.59	10.59	10.59	10.58	4.62
Dolly Sods Wilderness	WV	DOSO1	9.18	8.38	8.38	8.38	8.38	8.37	5.63
Eagles Nest Wilderness	CO	WHRI1	0.48	0.39	0.39	0.39	0.39	0.39	0.00
Everglades NP	FL	EVER1	11.29	11.08	11.08	11.07	11.06	10.99	8.01
Flat Tops Wilderness	CO	WHRI1	0.48	0.39	0.39	0.39	0.39	0.39	0.00
Great Sand Dunes NM	CO	GRSA1	3.57	3.56	3.56	3.56	3.56	3.56	2.20
Great Smoky Mountains NP	TN	GRSM1	11.10	9.78	9.78	9.78	9.78	9.77	4.22
Guadalupe Mountains NP	TX	GUMO1	5.08	5.03	5.03	5.03	5.03	5.03	2.39
Hercules-Glades Wilderness	MO	HEGL1	11.29	10.84	10.84	10.84	10.83	10.82	5.94
James River Face Wilderness	VA	JARI1	12.36	11.26	11.26	11.26	11.25	11.25	7.13
Joyce-Kilmer-Slickrock Wilderness	TN	GRSM1	11.10	9.78	9.78	9.78	9.78	9.77	4.22
La Garita Wilderness	CO	WEMI1	2.04	2.18	2.18	2.18	2.18	2.18	1.55
Linville Gorge Wilderness	NC	LIGO1	9.96	9.21	9.21	9.21	9.20	9.19	4.85
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.48	0.39	0.39	0.39	0.39	0.39	0.00
Mammoth Cave NP	KY	MACA1	14.20	13.04	13.04	13.04	13.03	13.02	7.41
Mount Zirkel Wilderness	CO	MOZI1	0.89	0.79	0.79	0.79	0.79	0.79	0.00
Okefenokee	GA	OKEF1	13.40	12.89	12.89	12.89	12.88	12.85	7.58
Otter Creek Wilderness	WV	DOSO1	9.18	8.38	8.38	8.38	8.38	8.37	5.63
Pecos Wilderness	NM	WHPE1	1.09	1.24	1.24	1.24	1.24	1.24	0.00
Rawah Wilderness	CO	MOZI1	0.89	0.79	0.79	0.79	0.79	0.79	0.00
Cape Romain	SC	ROMA1	13.79	13.09	13.09	13.09	13.09	13.08	8.48
Rocky Mountain NP	CO	ROMO1	1.64	1.62	1.62	1.62	1.62	1.62	0.53
Salt Creek	NM	SACR1	7.11	7.42	7.42	7.42	7.42	7.42	2.89
St. Marks	FL	SAMA1	13.73	13.00	12.99	12.99	12.92	12.75	8.31
San Pedro Parks Wilderness	NM	SAPE1	1.30	1.37	1.37	1.37	1.37	1.37	0.61

					FY DV without Source Group				
Class I Name	State	IMPROVE Site	BY DV	FY DV	A	B	C	D	E
Shenandoah NP	VA	SHEN1	8.68	7.66	7.66	7.66	7.65	7.65	4.56
Shining Rock Wilderness	NC	SHRO1	6.58	5.81	5.80	5.80	5.79	5.79	2.03
Sipsey Wilderness	AL	SIPS1	13.10	12.20	12.20	12.19	12.16	12.13	6.79
Swanquarter	NC	SWAN1	11.76	11.09	11.09	11.08	11.08	11.08	7.45
Upper Buffalo Wilderness	AR	UPBU1	10.35	9.80	9.80	9.79	9.77	9.76	5.03
West Elk Wilderness	CO	WHRI1	0.48	0.39	0.39	0.39	0.39	0.39	0.00
Weminuche Wilderness	CO	WEMI1	2.04	2.18	2.18	2.18	2.18	2.18	1.55
White Mountain Wilderness	NM	WHIT1	3.24	3.45	3.45	3.45	3.45	3.45	1.41
Wheeler Peak Wilderness	NM	WHPE1	1.09	1.24	1.24	1.24	1.24	1.24	0.00
Wichita Mountains	OK	WIMO1	9.53	9.24	9.24	9.24	9.24	9.24	5.36
Wolf Island	GA	OKEF1	13.40	12.89	12.89	12.89	12.88	12.85	7.58

NM = National Monument; NP = National Park.

Table D-31. Differences in Cumulative Visibility Results for 20% Best Visibility Days (B20%) at Class I Areas Between the Future Year (FY) and Base Year (BY) Scenarios and Contributions of Each Source Group to the Future Year Scenario Visibility.

				Source Group Contribution to FY DV				
Class I Name	State	IMPROVE Site	BY - FY DV	A	B	C	D	E
Bandelier NM	NM	BAND1	-0.15	0.00	0.00	0.00	0.00	2.45
Big Bend NP	TX	BIBE1	-0.10	0.00	0.00	0.00	0.00	2.36
Black Canyon of the Gunnison NM	CO	WEMI1	-0.14	0.00	0.00	0.00	0.00	0.63
Bosque del Apache	NM	BOAP1	-0.03	0.00	0.00	0.00	0.00	2.00
Caney Creek Wilderness	AR	CACR1	0.57	0.00	0.01	0.03	0.05	4.10
Carlsbad Caverns NP	TX	GUMO1	0.05	0.00	0.00	0.00	0.00	2.64
Chassahowitzka	FL	CHAS1	0.50	0.00	0.01	0.03	0.21	5.33
Cohutta Wilderness	GA	COHU1	0.88	0.00	0.00	0.00	0.01	5.97
Dolly Sods Wilderness	WV	DOSO1	0.80	0.00	0.00	0.00	0.01	2.75
Eagles Nest Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.39
Everglades NP	FL	EVER1	0.21	0.00	0.01	0.02	0.09	3.07
Flat Tops Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.39
Great Sand Dunes NM	CO	GRSA1	0.01	0.00	0.00	0.00	0.00	1.36
Great Smoky Mountains NP	TN	GRSM1	1.32	0.00	0.00	0.00	0.01	5.56
Guadalupe Mountains NP	TX	GUMO1	0.05	0.00	0.00	0.00	0.00	2.64
Hercules-Glades Wilderness	MO	HEGL1	0.45	0.00	0.00	0.01	0.02	4.90
James River Face Wilderness	VA	JARI1	1.10	0.00	0.00	0.01	0.01	4.13
Joyce-Kilmer-Slickrock Wilderness	TN	GRSM1	1.32	0.00	0.00	0.00	0.01	5.56

				Source Group Contribution to FY DV				
Class I Name	State	IMPROVE Site	BY - FY DV	A	B	C	D	E
La Garita Wilderness	CO	WEMI1	-0.14	0.00	0.00	0.00	0.00	0.63
Linville Gorge Wilderness	NC	LIGO1	0.75	0.00	0.00	0.01	0.02	4.36
Maroon Bells-Snowmass Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.39
Mammoth Cave NP	KY	MACA1	1.16	0.00	0.00	0.01	0.02	5.63
Mount Zirkel Wilderness	CO	MOZI1	0.10	0.00	0.00	0.00	0.00	0.79
Okefenokee	GA	OKEF1	0.51	0.00	0.00	0.01	0.04	5.31
Otter Creek Wilderness	WV	DOSO1	0.80	0.00	0.00	0.00	0.01	2.75
Pecos Wilderness	NM	WHPE1	-0.15	0.00	0.00	0.00	0.00	1.24
Rawah Wilderness	CO	MOZI1	0.10	0.00	0.00	0.00	0.00	0.79
Cape Romain	SC	ROMA1	0.70	0.00	0.00	0.00	0.01	4.61
Rocky Mountain NP	CO	ROMO1	0.02	0.00	0.00	0.00	0.00	1.09
Salt Creek	NM	SACR1	-0.31	0.00	0.00	0.00	0.00	4.53
St. Marks	FL	SAMA1	0.73	0.01	0.01	0.08	0.25	4.69
San Pedro Parks Wilderness	NM	SAPE1	-0.07	0.00	0.00	0.00	0.00	0.76
Shenandoah NP	VA	SHEN1	1.02	0.00	0.00	0.01	0.01	3.10
Shining Rock Wilderness	NC	SHRO1	0.77	0.01	0.01	0.02	0.02	3.78
Sipsey Wilderness	AL	SIPS1	0.90	0.00	0.01	0.04	0.07	5.41
Swanquarter	NC	SWAN1	0.67	0.00	0.01	0.01	0.01	3.64
Upper Buffalo Wilderness	AR	UPBU1	0.55	0.00	0.01	0.03	0.04	4.77
West Elk Wilderness	CO	WHRI1	0.09	0.00	0.00	0.00	0.00	0.39
Weminuche Wilderness	CO	WEMI1	-0.14	0.00	0.00	0.00	0.00	0.63
White Mountain Wilderness	NM	WHIT1	-0.21	0.00	0.00	0.00	0.00	2.04
Wheeler Peak Wilderness	NM	WHPE1	-0.15	0.00	0.00	0.00	0.00	1.24
Wichita Mountains	OK	WIMO1	0.29	0.00	0.00	0.00	0.00	3.88
Wolf Island	GA	OKEF1	0.51	0.00	0.00	0.01	0.04	5.31

NM = National Monument; NP = National Park.

D.7.3.2 Acid Deposition

The CAMx-predicted wet and dry fluxes of sulfur- and nitrogen-containing species were processed to estimate total annual sulfur and nitrogen deposition values at each Class I and sensitive Class II area in the 12/4-km modeling domain. As described in **Section D.6.2.3.2**, the maximum annual sulfur and nitrogen deposition values from any grid cell that intersects a Class I or sensitive Class II receptor area was used to represent deposition for that area, in addition to the average annual deposition values of all grid cells that intersect a Class I or sensitive Class II receptor area. Maximum and average predicted sulfur and nitrogen deposition impacts were estimated separately for each source group and together across all source groups.

As a screening analysis, incremental deposition values in Class I/II areas for combined Source Groups A (new platforms associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers) and B (new platforms and associated support vessels and helicopters associated with the 2017-2022 GOM Multisale EIS scenario, from which this Supplemental EIS tiers) were compared to the eastern and western U.S. Deposition Analysis Thresholds (DATs) listed in **Table D-32**. These DATs are specified in the FLAG guidance[25] and are further described in **Section D.6.2.3.2** above. Results of the incremental deposition analysis are summarized in **Table D-33** for Class I/II areas in the 4-km modeling domain. Deposition results were also obtained for all other sensitive areas throughout the 12 km-modeling domain, but the highest deposition values all occurred within the 4-km domain. The dividing line between the eastern and western DATs specified in the FLAG guidance is the Mississippi River, which makes sense for most locations in the U.S. but it is not necessarily clear which DAT would be most appropriate for coastal locations along the Gulf of Mexico so results are compared here against both DATs. Note that comparisons of deposition impacts from cumulative sources as represented by Source Groups C, D, E, and F to the DAT are not appropriate. Incremental nitrogen deposition exceeds the western and eastern DATs at all three locations. Incremental sulfur deposition is below the DATs in all cases except the sulfur deposition from Source Group B at Breton Wilderness and Gulf Islands National Seashore, which exceeds the western DAT but not the eastern DAT.

Table D-32. Deposition Analysis Threshold Values (kg/ha/yr) as Defined in the Federal Land Manager Guidance (FLAG, 2010).

	Nitrogen	Sulfur
East	0.010	0.010
West	0.005	0.005

Table D-33. Incremental Deposition Impacts from Source Groups A and B at Class I and Sensitive Class II Areas in the 4-km Domain.

Area		Source Group A				Source Group B			
		Nitrogen		Sulfur		Nitrogen		Sulfur	
		Max	Avg	Max	Avg	Max	Avg	Max	Avg
Breton Wilderness	Annual Deposition	0.0589	0.0501	0.0045	0.0039	0.3496	0.2701	0.0079	0.0061
	Exceeds Eastern DAT?	Yes	Yes	No	No	Yes	Yes	No	No
	Exceeds Western DAT?	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Gulf Islands National Seashore	Annual Deposition	0.0909	0.0383	0.0046	0.0025	0.4560	0.2151	0.0064	0.0039
	Exceeds Eastern DAT?	Yes	Yes	No	No	Yes	Yes	No	No
	Exceeds Western DAT?	Yes	Yes	No	No	Yes	Yes	Yes	No

[25] *Guidance on Nitrogen and Sulfur Deposition Analysis Thresholds* (http://www.nature.nps.gov/air/Pubs/pdf/flag/nsDATGuidance.pdf).

Area		Source Group A				Source Group B			
		Nitrogen		Sulfur		Nitrogen		Sulfur	
		Max	Avg	Max	Avg	Max	Avg	Max	Avg
Padre Island National Seashore	Annual Deposition	0.0458	0.0190	0.0012	0.0010	0.2410	0.1044	0.0019	0.0015
	Exceeds Eastern DAT?	Yes	Yes	No	No	Yes	Yes	No	No
	Exceeds Western DAT?	Yes	Yes	No	No	Yes	Yes	No	No

Cumulative deposition from all sources combined for the base case and future year scenarios were compared against applicable critical load levels in each Class I/II area for which critical loads were identified as described in **Section D.6.2.3.2**. Results are summarized in **Table D-34**. Cumulative nitrogen deposition is projected to decrease in all areas between the 2012 base case and the 2017 future year, consistent with an overall reduction in NO_x emissions. Nevertheless, maximum nitrogen deposition is modeled to continue exceeding the critical load thresholds under the future year scenario for all areas except the Padre Island National Seashore. Sulfur deposition values are lower, and larger sulfur emission reductions help to reduce sulfur deposition from above the critical load to below the critical load at Breton Wilderness, Breton National Wildlife Refuge, and Cohutta Wilderness (based on maximum grid cell values). Nevertheless, the maximum grid cell sulfur deposition still exceeds the critical load at the Gulf Islands National Seashore by a small margin.

Table D-34. Cumulative Nitrogen (N) and Sulfur (S) Deposition Impacts (kg/ha/yr) under the Base and Future Year Scenarios (shading indicates values exceeding the Critical Load threshold).

Class I/II Area	Critical Load Threshold	2012 Base Case				2017 Future Year			
		N-Max	N-Avg	S-Max	S-Avg	N-Max	N-Avg	S-Max	S-Avg
Big Bend National Park	3	3.6	2.5	2.3	1.1	3.6	2.5	2.2	1.0
Breton Wilderness	3	7.8	7.1	4.1	3.6	7.7	6.9	2.8	2.5
Breton National Wildlife Refuge	3	7.2	6.9	3.7	3.5	7.0	6.7	2.6	2.4
Gulf Islands National Seashore	3	13.8	7.0	5.3	4.4	13.0	6.7	3.6	2.9
Padre Island National Seashore	5	4.5	2.2	1.5	1.2	4.6	2.2	1.1	0.9
Bradwell Bay Wilderness	5	6.5	6.2	2.5	2.3	6.0	5.8	1.8	1.7
Saint Marks National Wildlife Refuge	3	6.8	5.2	2.5	2.0	6.2	4.7	1.8	1.5
Saint Marks Wilderness	3	6.1	4.9	2.0	1.9	5.6	4.5	1.5	1.4
Chassahowitzka Wilderness	3	6.8	6.1	2.5	2.5	6.0	5.4	1.9	1.9
Everglades National Park	5	7.5	4.7	3.9	2.2	6.9	4.5	2.4	1.7
Okefenokee National Wildlife Refuge	3	6.0	5.7	2.3	2.1	5.6	5.3	1.8	1.7
Okefenokee Wilderness	3	6.5	5.5	2.6	2.1	6.1	5.1	2.1	1.7
Wolf Island Wilderness	3	3.3	3.1	2.1	2.0	3.0	2.8	1.5	1.4

Class I/II Area	Critical Load Threshold	2012 Base Case				2017 Future Year			
		N-Max	N-Avg	S-Max	S-Avg	N-Max	N-Avg	S-Max	S-Avg
Cohutta Wilderness	5	11.5	10.2	5.4	4.3	10.6	9.3	3.6	2.9
Sipsey Wilderness	5	9.4	9.0	3.2	3.2	9.1	8.6	2.1	2.1
Guadalupe Mountains National Park	3	3.3	2.6	1.1	0.7	3.2	2.5	0.9	0.6
Wichita Mountains (Charons Garden Unit) Wilderness	5	5.6	5.6	1.7	1.7	5.4	5.4	1.5	1.5
Wichita Mountains (North Mountain Unit) Wilderness	5	6.3	6.3	1.8	1.8	6.1	6.1	1.5	1.5
Wichita Mountains National Wildlife Refuge	5	6.5	6.0	1.8	1.7	6.2	5.8	1.5	1.5
Caney Creek Wilderness	5	9.3	9.2	3.7	3.6	9.1	9.0	2.3	2.3
Upper Buffalo Wilderness	5	7.4	7.4	2.5	2.5	7.1	7.1	1.7	1.7

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KEYWORD INDEX

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The Department of the Interior Mission

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) is responsible for managing development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.